Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, New Mexico 87115

APR 30 1991

FEDERAL EXPRESS

Mr. John J. Surmeier
Chief, Uranium Recovery Branch
Division of Low-Level Waste
Management and Decommissioning
Office of Nuclear Materials Safety
and Safeguards
1 White Flint North
11555 Rockville Pike
Rockville, MD 20852

Dear Mr. Surmeier:

Enclosed is a copy of the Comment and Response Document presenting the U.S. Department of Energy (DOE) responses to the open issues identified in your draft Technical Evaluation Report (dTER) for the Falls City, Texas, uranium mill site. This document contains additional information regarding the Falls City site which will address the open issues identified in the dTER.

We have also included a technical analysis of the impacts of subsurface mineral extraction from beneath the disposal cell. The DOE is currently proposing to not obtain the subsurface mineral rights beneath the disposal cell. The mineral extraction analysis shows that there is no impact to the disposal cell from activities associated with recovering minerals from beneath the cell.

We have scheduled the start of remedial action for August 1, 1991, and we are seeking your approval to enable construction activities to begin. A meeting has been scheduled at your offices in Rockville at 8:30 a.m. on May 15, 1991, to discuss obtaining approval to begin construction activities at the Falls City site. We expect personnel from your staff to discuss the enclosed information and give the DOE a determination as to whether it is sufficient to satisfy the open issues and allow construction to begin.

If you or your staff should require any additional information, please contact Mr. Paul Mann of my staff at FTS 845-5637.

Sincerely,

for George J. Rael
Mark L. Matthews
Project Manager
Uranium Mill Tailings Remedial Action
Project Office

Enclosure

ccs on page 2

ADD:
B Jagannath

Ltr. Encl.
1 1

WM-65
NL04

cc w/enclosure:
C. Smythe, UMTRA
P. Mann, UMTRA
D. Bierley, JEG
C. Spencer, MK-F
G. Gartzke, BRC

cc w/o enclosure:
M. Abrams, UMTRA
S. Hill, JEG
J. Oldham, MK-F

RESPONSE TO COMMENTS
ON NRC OPEN ISSUES
FALLS CITY, TEXAS
UMTRA PROJECT SITE

APRIL 30, 1991

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 1

Section: 2.3.5

DOE needs to provide a map showing the location of all abandoned, currently being developed (mined or otherwise processed) or undeveloped natural resources in the region and site area.

SECTION 2

Response: ____________ By: G. Lindsey
Date: March 27, 1991

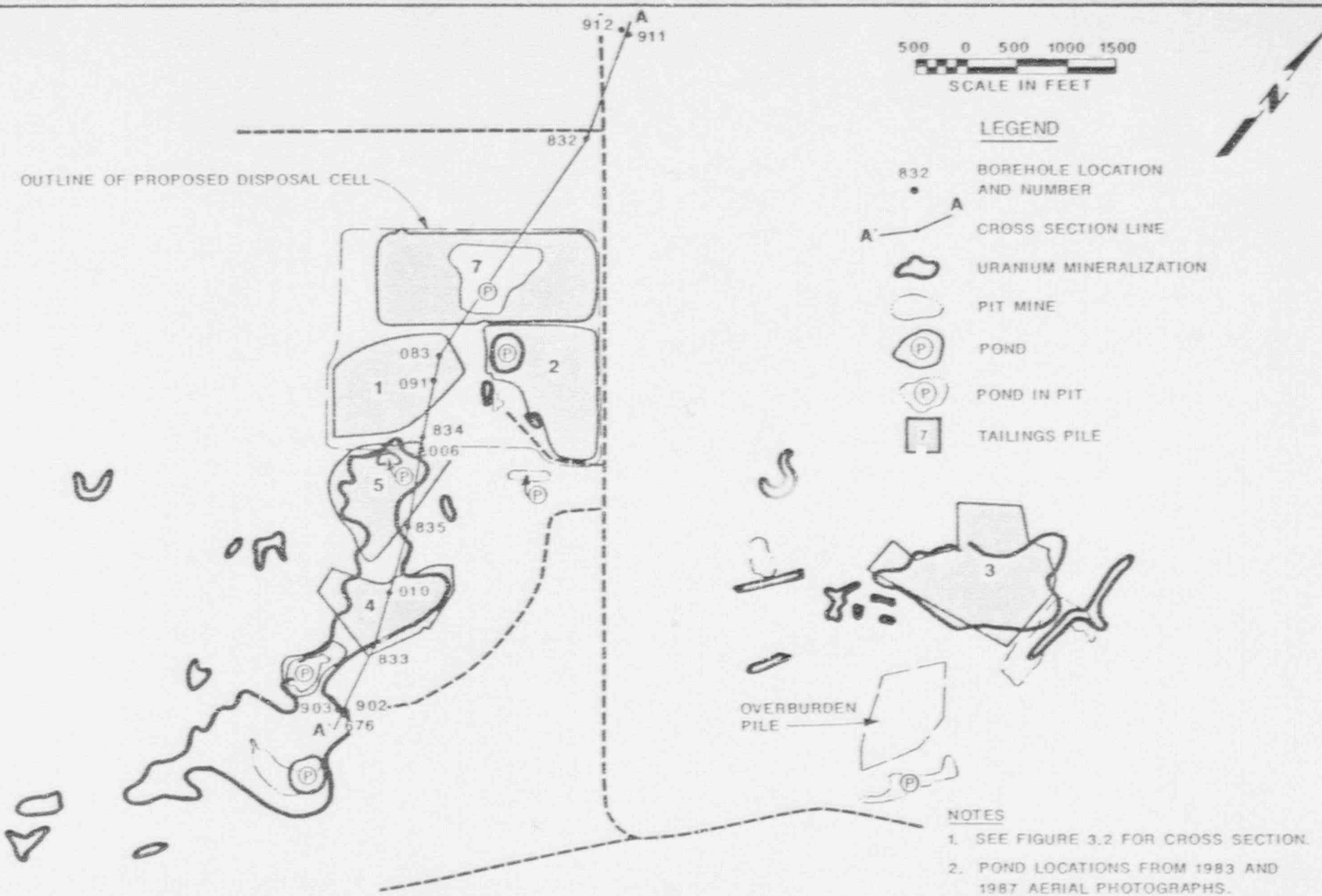
Figure 1.1 has been prepared showing a modified map from Eargle et al., 1971, using additional data from aerial photos dated 1-27-83 and 2-28-83.

Plans for Implementation: The figure will be included in the final RAP.

SECTION 3

Confirmation of Implementation:

Checked by: ____________ Date: ____________
Approved By: ____________ Date: ____________



NOTES

1. SEE FIGURE 3.2 FOR CROSS SECTION.
2. POND LOCATIONS FROM 1983 AND 1987 AERIAL PHOTOGRAPHS.
3. URANIUM MINERALIZATION LOCATIONS FROM J.A. MacKALLOR et al., 1962.

FIGURE 1.1
MINING FEATURES
FALLS CITY, TEXAS, SITE

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 2

Section: 2.4.3

DOE needs to define a specific design acceleration rather than recommend a range of acceleration values, .05 to .10 g, as design acceleration. If the cell design used the .10 g design acceleration, then DOE should specify .10 g as the design acceleration.

SECTION 2

Response: ________ By: G. Lindsey
Date: March 27, 1991

In paragraph 6.3.4 of Attachment 2, the sentence will be revised to read "...a design acceleration of 0.10 g is recommended." This is the minimum allowable acceleration for UMTRA Project sites as per the Technical Approach Document, 1989.

Plans for Implementation: The RAP will be modified accordingly.

SECTION 3

Confirmation of Implementation:

Checked by: ________ Date: ________
Approved By: ________ Date: ________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 3

Section: 2.4.4

DOE needs to provide discussion of potential impacts that future development of hydrocarbons may have on the Falls City site.

SECTION 2

Response: By: G. Lindsey
Date: March 27, 1991

Section 6.2 will be amended with the following discussion to show the potential for development of hydrocarbons that potentially could occur below the site and the very limited subsidence that may result. The potential impacts were also discussed in Sections 6.3.3 and 6.3.6.

To be inserted in Section 6.2

Exploration and development of hydrocarbons may potentially occur directly below the disposal cell. As discussed in the following Sections 6.3.3 and 6.3.6, fluid withdrawal has resulted in small amounts of displacement and minor earthquakes in this region (Verbeek, 1979; Reid, 1973; Castle and Youd, 1972; Bunker and Mackellor, 1973; and Tucker, 1962). The earthquakes occur along existing compaction faults, which also are the structural traps for hydrocarbons.

The nearest oil and gas fields are along the Hysaw and Hobson faults, approximately 8 km (5 miles) southeast of the site. Earthquakes associated with production pumping are less than magnitude 4.0. A magnitude 4.0 on the nearest fault would result in an on-site acceleration of approximately 0.08 g (Nuttli, 1982). This is less than the design acceleration of 0.10 g.

Subsidence associated with the pumping of hydrocarbons is typically determined by a regional geodetic survey. Such subsidence would be very minor compared to the few feet of differential subsidence that could occur across the cell as a consequence of material and thickness differences, which has been determined to not result in rupture of the cover (RAC Calculation #20-438-0601). The potential for localized differential subsidence caused by pumping of hydrocarbons is expected to occur on the faults that bound the site area rather than within the unfaulted graben block that lies between the fault systems (see Figure 3.1).

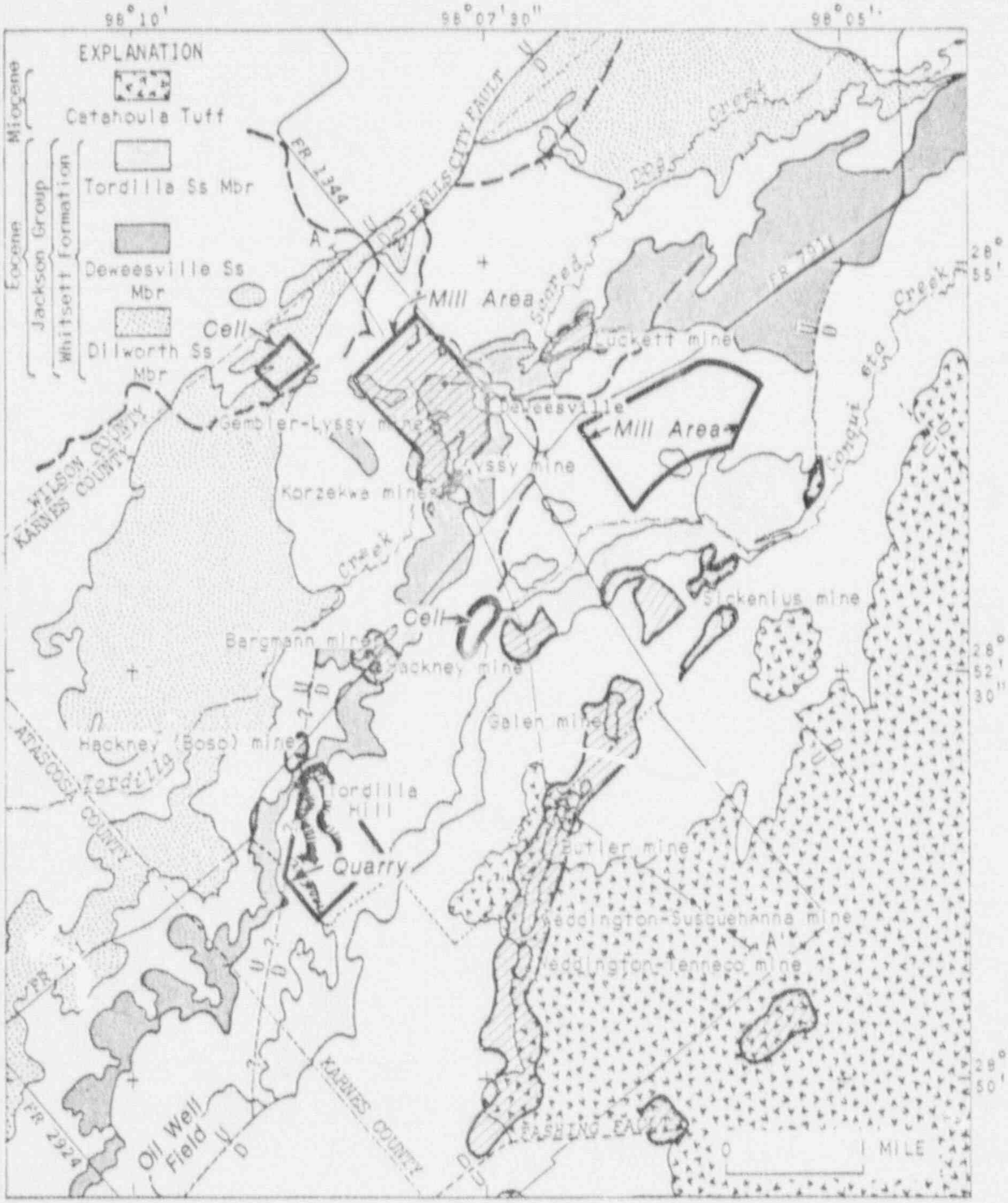
As discussed in the preliminary final RAP, oil and gas production at the Falls City site would be at depths exceeding 5000 feet. There are no other economical mineral deposits at the site.

Plans for Implementation: The RAP will be revised and the new figure included.

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________
Approved By: ______________________ Date: ______________________



MODIFIED FROM EARGLE et al. (1971)
AND EARGLE AND WEEKS (1968).

LEGEND

URANIUM MINES, MILL AREAS, AND DISPOSAL CELLS AS LABELED

ROCK QUARRY (TORDILLA HILL)

DRAINAGE DIVIDE

FIGURE 3.1
MINERAL RESOURCES NEAR FALLS CITY, TEXAS, SITE

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 4

Section: 3.2.5

DOE needs to provide missing investigation and testing information as identified in Section 3.2.5 of this TER. (Section 3.2.5, item 1).

SECTION 2

Response: By: TSC/RAC
Date: April 30, 1991

1. Missing Information from RAP Documents

   A. Locations of Holes 526 and 527 have been added on Drawing No. FCT-PS-10-0417, and pertinent calculations. Hole 526 is located in the windblown area near Pile No. 3 and Hole 527 is located in Pile No. 3. They are within Parcel B of the site. Boring logs for both Holes 526 and 527 could not be found. Hole 526 was probably a very shallow hole for the purpose of determining the radium content.

   B. Locations of starter berms were provided to the NRC in February, 1991. The berm locations were added on Drawing No. FCT-PS-10-0417. They were also added on profiles developed in new Calculation No. 20-43-07-00.

   C. Test Pits TP-2, TP-4, TP-9, and TP-10 were not conducted. Logs for TP-5 through TP-8 are not available. TP-5 through TP-8 were performed for obtaining surface bag samples.

   D. Unconsolidated-undrained (UU) test data for sample 032-02 was provided to the NRC in February 1991, and were also included in the revised "Geotechnical Properties" Calculation No. 20-438-01-02, pages 86-87.

E. Page D-214 (Table D.4.4), Page D-222 (Table D.4.13), and Page D-224 (Table D.4.15) are contained in Volume I of Information for Bidders Section 3, "La Mesa Borrow Area - Geotechnical Data - Laboratory Test Results".

F. No tests have been performed on samples retrieved from Test Pits 006 and 010. These two test pits have been deleted in the statements at the bottom of Sheet 191 (former Sheet No. 146) of Calculation 20-438-01-02 "Geotechnical Properties". Tests performed on samples for Test Pit 010 were tabulated on Page 14, Calculation No. 20-438-01-02.

Plans for Implementation: The information will be incorporated into the final RAP.

SECTION 3

Confirmation of Implementation:

Checked by: ____________________ Date: ____________________
Approved By: ____________________ Date: ____________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 5

Section: 3.2.5

DOE needs to address staff concerns on the coefficients of hydraulic conductivity for the radon barrier and in situ tailings materials at this site (Section 3.2.5, item 2).

SECTION 2

Response: ______ By: TSC/RAC
Date: April 30, 1991

If the NRC concurs with the proposed groundwater compliance strategy, then the saturated hydraulic conductivity of the radon barrier and in situ tailings, and its impact on infiltration and seepage will not be an issue. Any remaining NRC concerns regarding the saturated hydraulic conductivity of materials can be addressed by amending the RAS/RAP with additional text on the subject as noted.

Plans for Implementation: As noted above.

SECTION 3

Confirmation of Implementation:

Checked by: ______ Date: ______
Approved By: ______ Date: ______

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 6

Section: 3.2.5

DOE needs to address staff concerns on the strength and compressibility characterizations of in situ tailings (sand, sand-slime, and slime), of relocated tailings, berm materials (Section 3.2.5, items 3, 4, 5, 7, and 8).

SECTION 2

Response: By: TSC/RAC
Date: April 30, 1991

Item 3. In-situ tailings were hydraulically placed in the current locations and are expected to be in a state of equilibrium under the exiting conditions. With respect to the average relative density of this material as determined from the piezocone data, the average relative density of this material has been revised to the range of 35, 46, and 50, percent respectively, in the tailings piles 7, 1, and 2. The revised relative density values are presented in the Calc. No. 20-438-01-02 "Geotechnical Properties", and the reasons for the revisions are as follows:

The relative density included in the piezocone sounding report were calculated based on the assumption that there is no perched water or groundwater table in these tailings piles. However, perched water was encountered in some locations within the tailings pile as indicated in some borings logs next to the piezocone soundings. Thus, relative density was corrected for those tailings below the perched water table. Also, it is worthwhile to point out that relative density does not apply for sand-slime materials at the Falls City site because of high percentage of fines contained in these materials.

The cohesion value from the UU test previously selected (cohesion c ≈ 600 psf) may be high for the hydraulically placed and unsaturated in situ sand tailings. The sand was hydraulically deposited only a short time ago and has not undergone any significant geological or chemical weathering to exhibit a significant cohesion component in shear strength. The UU test for the unsaturated in situ sand sample was subsequently re-evaluated and revised with a cohesion (c) of 200 psf. This value may be more reasonable because the cohesion component is derived from the clay component of sand. Also, this value would be similar to the cohesion value of slime tailings, which have an estimated undrained strength (Su) of 400 psf, or a cohesion (c) of 200 psf. In the revised slope stability analyses, for conservatism, it was assumed that all in situ tailings were slime tailings, which have the weakest strength among all types of tailings material. Adequate factors of safety were obtained against slope failures under different loading conditions analyzed. The UU strength parameter for in situ sand tailings was not actually used in the revised slope stability analyses.

Item 4. The OCR characterization analyzed previously for in situ slime tailings at shallow depth may be unconservative. The slimes at this site have a natural moisture content of nearly 100 percent, which is approximately equal to their liquid limit, and are in a very soft consistency state. The tailings at this site were hydraulically placed in their current location and are in a state of equilibrium due to self weight, weight of existing soil cover, and any consolidation/compaction as a result of earth moving operations associated with placing the soil cover. The tailings are expected to be normally consolidated for the entire depth. The OCR characterization analyzed previously using piezocone data may not be adequately supported by other data such as consolidation test data. In view of this, the undrained strength and consolidation characterizations of the in situ slime tailings were re-evaluated and revised to be a normally consolidated clay for the entire depth of the slime layer. Settlement calculations were revised using the normally consolidated compressibility parameters (Cc) and coefficient of consolidation (Cv). It should be noted that the unit for Cv values presented in the dRAP and Information for Bidders was not correct. The units should be in (in^2/sec) rather than (cm^2/sec). The correction has been made in Calculation No. 20-438-01-02.

Slope stability calculation was also revised using the normally consolidated undrained strength values with Su/p ratio of 0.28. An undrained shear strength of 150 psf was conservatively assumed for the upper five feet of the slime layer.

Item 5. The composite samples, which consisted of sand, sand-slime, and slime tailings, were mixed in a bucket during field investigations and were remolded in the laboratory for testing. In the previous calculations these samples were assumed to be representative of the tailings after they are relocated and compacted in the disposal cell. The DOE concurred with the NRC's comment that, since the tailings placement specifications do not specify any requirements for mixing the tailings before placing them in the disposal cell, these composite samples may not necessarily be representative of the materials placed in the cell. The relocated tailings may be placed such that material in some locations may consist entirely of sand, entirely of sand-slime, or entirely of slime. In view of this, all the laboratory results of tests performed on remolded tailings were re-evaluated. The values for index and physical properties were presented separately for remolded sand, sand-slime, slime, and composite samples. For conservatism, the lowest reasonable values were selected for strength parameters and were used for appropriate analyses (MKES Calculation No. 20-438-01-02).

Item 7. The DOE agreed with the NRC's comments that the UU strength previously selected for relocated tailings were higher than the CU strength. The higher strength may be due to the unsaturated condition of the test specimens. The test data was subsequently re-evaluated. As mentioned in Item 5 above, the lowest reasonable strength parameters were selected based on the tests performed on remolded sand, sand-slime, slime, and composite samples. In the slope stability analyses, the revised UU strength used for short-term cases was $c = 600$ psf and $\emptyset = 13°$; the total stress strength from CU tests used for long-term seismic case was $c = 250$ psf and $\emptyset = 17°$; and the effective stress strength from CU tests used for long-term static cases was $c = 200$ psf and $\emptyset = 20°$. These values are deemed to be appropriate.

Item 8. The has DOE reevaluated the test data. As a result, the revised UU strength for the berm material is cohesion of 1050 psf and zero (0) friction angle. No CU tests were performed on this material. It was assumed, for conservatism, that the berm and the in situ slime tailings have the same strength. As mentioned in Item 3 above, the revised slope stability analyses were performed assuming all the in-situ materials including the berms were slime tailings. Therefore, the strength selected for berm material was not used in the stability evaluation.

Plans for Implementation: The final RAP will include the appropriate information.

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________
Approved By: ______________________ Date: ______________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas   Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 7

Section: 3.2.5, 6.2.1.2

DOE needs to address the staff concerns on the reported organic content of radon barrier borrow material and tailings designated to be relocated to the disposal cell (Section 3.2.5, items 6 and 9).

SECTION 2

Response: ____________   By: TSC/RAC
Date: April 30, 1991

The DOE will implement a field investigation to retrieve additional soil samples from the tailings piles and the windblown areas. Organic content of these materials will be tested and determined.

The DOE will plan a supplementary field program. Additional samples will be collected and tested in the primary borrow area. Following completion of this supplemental program (including sampling and testing), the DOE will address the justification for the planned uses of material.

The organic content of the relocated tailings should not exceed five percent of the total relocated material volume and organics should be well mixed; however, this requirement will be easily met. Providing additional test results, re-evaluating existing tests, and amending the RAS/RAP text may be necessary to address NRC concerns.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________
Approved By: ______________________ Date: ______________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 8

Section: 3.3.1

DOE needs to reevaluate the stability of the disposal slopes using the revised soil parameters, investigate if sliding wedge method of analysis is appropriate, and also evaluate stability of the slope in the vicinity of boring 065.

SECTION 2

Response: ____________ By: RAC
Date: April 30, 1991

Concerns regarding the strength parameters selected for the in situ sand tailings, in situ slime tailings, relocated tailings, and berm materials were addressed in the response to Open Issue 6. The strength parameters of these materials have been reevaluated and revised in Calculation No. 20-438-01-02. Slope stability analyses were re-evaluated assuming all in situ materials were slime tailings, which have the weakest shear strength among all materials (see response to Open Issue 6, Item 4).

The DOE has revised slope stability analyses for the disposal cell slopes. Factors of safety against sliding along the critical slip circle were determined using Bishop's Modified Method of Slices. Computer code UTEXAS2 was used in the calculation of factors of safety against failure for short-term static and seismic, long-term static, and seismic loading conditions. Seismic conditions were analyzed using the pseudostatic method. The values of the seismic coefficients used in the analysis are 0.1 g for long-term and 0.07 g for short-term loading conditions.

Because of the heterogeneous nature and irregular layering sequences of the in situ tailings deposits and various thicknesses of the relocated tailings, it was decided that, instead of performing slope stability analyses for numerous sections, the analyses were made for one critical section only. It was assumed that all in situ materials, including the berms, were slime tailings, which have the weakest strength of all. The embankment geometry was so selected that the critical section had the greatest thickness for the in situ tailings. Another conservative assumption was that the high perched water table existed within the in situ tailings pile, and was uniform across the entire disposal cell. The perched water table will drain after the placement of the radon barrier layer on the disposal embankment because there will be little infiltration from precipitation through the cover. Moreover, the permanent groundwater table was conservatively assumed to be near the interface between the tailings deposit and the foundation. The embankment was found to be safe against slope failure for all loading conditions under this worst-case scenario (MKES Calculation No. 20-438-05-02). Therefore, a sliding wedge failure analysis by sliding along the sand-slime layer is not required.

Plans for Implementation: As noted above.

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________
Approved By: ______________________ Date: ______________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 9

Section: 3.3.2

DOE needs to reevaluate the settlement aspects of the design using revised soil characterization, and also address staff concerns on the locations of the settlement evaluations and localized volume changes under seismic load.

SECTION 2

Response: By: TSC/RAC
Date: April 30, 1991

A revised settlement analysis has been made to predict the total and differential settlement of the disposal cell and the resulting potential for cracking of the radon barrier and ponding on top of the cover. Assumptions and the design parameters used to calculate the total and differential settlement as well as cracking potential of the radon barrier have been detailed in the revised Calculation No. MKE 20-438-06-02.

Highlights of the calculations are as follows:

A. The C_v values for all the materials have been corrected and revised.

B. Instead of characterizing overconsolidation for the in situ slime layer, this layer is assumed to be normally consolidated.

C. To reduce the total differential settlement, certain portions of the in situ slime will be excavated, relocated and recompacted. The total volume for the recompacted in situ slime is approximately 387,000 cu yd.

D. As shown in the revised liquefaction analysis, the potential settlement for the disposal embankment due to earthquake loading is negligible.

With regard to Item C, excavation and relocation of the slime tailings is an extremely conservative and costly solution to the problem of differential settlement. Thus, the DOE may at a later date, evaluate alternative approaches to solving the problems associate with slime settlement.

Plans for Implementation: The revised calculation will be included in the final RAP.

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________
Approved By: ______________________ Date: ______________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 10

Section: 3.3.3

DOE needs to evaluate the liquefaction potential at some of the boring locations with low blow counts, and also address staff concerns on the liquefaction analyses.

SECTION 2

Response: By: TSC/RAC
Date: April 30, 1991

Revised liquefaction analyses have been made and are presented in Calculation No. 438-04-03. It was concluded that the liquefaction potential for in situ tailings would not occur within the disposal cell. Highlights of the calculations are as follows:

A. A calculation to evaluate the perched water within the in situ tailings piles 1, 2 and 7 based on the available data, has been made (Calculation No. 20-438-08-00). It is concluded that the perched water table will finally drain because of the placement of impervious radon barrier layer at the top of the disposal embankment.

B. A fence diagram, as well as soil profile sections, have been made to well define the locations of sand tailings within the pile. See Calculation No. 20-438-07-00.

C. Low blowcounts for sands ranging from 2 to 4 beneath the perched water table were found in Borings B-1, B-2, B-3, B-4, etc. The low blowcounts were encountered because of the type of drilling method practiced during the field investigation. The blowcounts were obtained from sampling by means of hollow stem auger. Therefore, the blowcounts recorded below the perched water were not correct because quick sand conditions developed during the sampling procedure. This is evident because high blowcounts were recorded immediately above the perched water table. As stated in the response to Open Issue 9, the relative density values have also been corrected.

The RAC can analyze locations that the NRC has expressed concerns about. Most of these locations are surrounded by stable material or a failure at these locations will not have catastrophic results. If a location does prove to be potentially dangerous, the area could be densified to alleviate the problem.

Plans for Implementation: As noted above.

SECTION 3

Confirmation of Implementation:

Checked by: ____________________ Date: ____________________
Approved By: ____________________ Date: ____________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas   Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 11

Section: 3.3.4

DOE needs to address the staff concerns on the specifications for the radon barrier borrow and the bedding layer materials.

SECTION 2

Response: ______________   By: TSC/RAC
Date: April 30, 1991

The specification for the radon barrier borrow will be addressed upon the completion of additional field investigations and testing.

The bedding layer between the growth medium and radon barrier layer has been deleted and the gradation for the bedding layer on the sideslope has been calculated and presented in the Calculation No. 20-440-03-00. The bedding material and riprap will obtain from the same borrow source.

Plans for Implementation: As noted above.

SECTION 3

Confirmation of Implementation:

Checked by: ______________   Date: ______________
Approved By: ______________   Date: ______________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 12

Section: 3.4.2

DOE needs to rectify the inconsistencies among the design calculations specifications, RAIP specifications, and contract specifications identified in Section 3.4.2 of the TER.

SECTION 2

Response: By: TSC/RAC
Date: April 30, 1991

A. Revision A of the Falls City, Texas Remedial Action Inspection Plan, Paragraph 6.1.3, states in part: ". . . The nuclear density gauge shall not be used in radioactively contaminated materials, or in areas where the gauge may be affected by background radiation or the chemical composition of the soil (i.e., the first lift of radon barrier material).

B. Revision A of the Falls City, Texas Remedial Action Inspection Plan, Paragraph 6.1.4.1, states in part" . . ."There shall be a minimum of one in-place field density and moisture test per lift.

C. Once the specifications for the radon barrier are revised to address the NRC concerns, the Remedial Action Inspection Plan will be revised accordingly. The DOE cannot revise the Remedial Action Inspection Plan to address NRC comments prior to the specifications for radon barrier being revised.

Plans for Implementation: As noted above.

SECTION 3

Confirmation of Implementation:

Checked by: ________________________ Date: ________________________
Approved By: ________________________ Date: ________________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 13

Section: 4.2.2, 4.3.1

DOE needs to redesign the vegetated top slope of the pile. In redesigning the topslope, it is suggested that DOE use a runoff coefficient of 1.0, a flow concentration factor (FCF) of 3, and appropriate values of allowable shear stress or maximum permissible velocity. DOE also needs to address the conclusions reached in NUREG/CR-3199 with regard to sheet erosion as they relate to the design of the topslope.

SECTION 2

Response: By: TSC/RAC
Date: April 30, 1991

NOTE: For the ease in review, the following response also addresses Open Issues 14 and 15.

The NRC concerns and recommendations regarding the topslope cover design have been addressed in the TAC Calculation FCT-03-91-05-02-00 "Stability of Topslope Vegetation Cover." The conclusions found in NUREG/CR-3199 have been addressed in TAC Calculation FCT-03-01-05-01-00.

Additional issues are discussed below:

FLOODING DETERMINATION

Infiltration Losses

For the design of the vegetated top slope, a runoff coefficient of 0.5 was originally assumed. For the revised design of the top vegetated cover, a runoff coefficient of C=1.0 has been used in calculating the maximum flow rate. See MKE's Calc. No. 20-440-03-00, April 1991.

Computation of PMF

o Topslope - A flow concentration factor of 3.0 has been used in the calculations, referenced above, for the top vegetated cover, as suggested by the NRC to account for "imperfections in the slope and for potential accumulations of flow".

- o Sideslopes - A flow concentration factor (FCF) of 1.5 has been used in redesigning the side slope erosion protection cover, as suggested by the NRC. The NRC feels, and the DOE concurs, that even with the provision of a rock transition zone, the design concentrated flow along the top vegetated cover will not have uniform and sufficient lateral dispersion to warrant an FCF = 1.0, as it flows over the grade break into the steeper sideslope of the disposal cell.

- o Downstream Apron - A flow concentration factor of 1.5 has been used in the revised design of the rock apron also.

Further, several hydraulic conditions and Apron configurations have been considered for sizing the stable rock size. These are described below:

WATER SURFACE PROFILES, CHANNEL VELOCITIES, AND SHEAR STRESSES

Topslopes

The revised design incorporates the following Flow Concentration Factors (FCF), as suggested by the NRC.

Location	FCF
Topslope	3.0
Sideslope	1.5

In addition, the basic allowable soil shear stress has been developed by following the methodology presented in Temple (Temple, D.M., et al., USDA, Stability Design of Grass-Lined Open Channels, Agricultural Handbook Number 667, 1987).

For the vegetated soil cover with a slope of one percent, the flow is subcritical and the effective soil stresses are lower than the allowable soil shear stresses, both for "fair" and "poor" vegetative cover - as found in the above-referenced MKE calculation.

Side Slopes

A flow concentration factor of 1.5 has been used for calculating the design flow along the sideslope, which resulted in an average rock size (D50)min of 7.2 inches.

Downstream Apron

For calculating the apron rock size, the following combinations of apron configurations and hydraulic conditions have been considered:

A. At the grade break from the 20 percent sideslope to the 10 percent slope, the apron is subjected to the same tractive shear as the steeper 20 percent side slope immediately upstream. This resulted in apron rock size, (D50)min of 7.2 inches. However, a (D50)min of 8.0 inches resulted from using U.S. COE 's stilling basin equation (see Table 3 of MKE calculation). However, a collapsed apron with a 3H:1V slope with sheet flow along it with a flow concentration factor of 1.5 (described below) is the governing situation that required a (D50)min of 11.3 inches.

B. The Apron depth has been extended to the maximum potential scour depth that could result from (i) runoff from the top and side slopes of the disposal cell, and (ii) PMF in the swale on the east side of the disposal cell - whichever is maximum. Calculations show that the scour caused by the PMF is greater and accordingly, the apron depth has been extended to this potential scour depth.

As long-term gully encroachment down to the maximum potential scour depth occurs, the apron is assumed to have collapsed with a steep 3H:1V. The stable rock size is calculated to be (D50)min = 11.3 inches under this configuration using PMF values and a flow concentration factor of 1.5. The results are summarized in Table 3 of the MKE calculation.

C. Gullies developed adjacent to the apron will exert a force on the apron rock, the magnitude of which depends on the gully size and flow concentration factor. Assuming a conservative gully section and a flow concentration factor of 3.0, the stable rock size was calculated. The results indicate that the design (D50)min of 11.3 inches will be stable under the conservative assumptions of gully formation.

- Water Surface Profile The water surface profile in the area between the disposal cell and Road 1344, resulting from the PMF, has been calculated using U.S. COE's HEC2 computer program. The results, included in Appendix A of the MKF calculation, show that the PMF stage is lower than the Apron elevation along its entire length. This is to be expected since the Road 1344 elevations are lower than the Apron elevations. The analysis assumed the culverts to be clogged, which resulted in PMF spills over the roadway towards the east, away from the disposal cell.

  Thus, the PMF does not directly affect the Apron, although the resulting scour in the swale could initiate gully development towards the Apron. As stated above, the Apron depth has been extended to the maximum potential scour depth due to the PMF in the swale.

- Hydraulic Jump - The design flow stream (PMF, with a flow concentration factor of 1.5) on the sideslope and the apron has Froude Numbers of 2.03 and 1.31, see Table 5.2 of MKE calculation. The calculated flow depths range from 4 to 5 inches and velocities range from 5 to 6 ft/sec. A hydraulic jump is expected to be submerged, within the swale waterway, where the apron flow meets the water surface in the swale.

- Swale Erosion, Local Gully Erosion and their Effect on the Apron - MKES analyses found that the PMF scour within the swale is deeper than the PMF scour adjacent to the Apron. However, the Apron is extended to the scoured swale elevation on the assumption that over a long period of time, gully erosion would proceed towards the Apron and eventually the base of the apron would have nearly the same elevation as that of the scoured swale.

Prior to this long-term development, the concentrated sheet flow from the disposal cell side slopes would control the erosion adjacent to the Apron. Calculations show that the design rock size for the Apron will be stable under the gully erosive forces caused by concentrated sheet flows immediately downstream of the apron.

Plans for Implementation: The RAP will be modified accordingly.

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________
Approved By: ______________________ Date: ______________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 14

Section: 4.2.5.2, 4.3.2

DOE needs to redesign the riprap for the side slopes of the pile, using a FCF of 1.5.

SECTION 2

Response: By: TSC/RAC
Date: April 30, 1991

See response to Open Issue 13

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: ______________ Date: ______________
Approved By: ______________ Date: ______________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 15

Section: 4.3.3

DOE needs to redesign the riprap for the apron (1) using a FCF of 1.5 in calculating the design flow rate, (2) using the maximum shear stresses produced where the 20% side slope meets the apron, (3) using appropriate velocities and stresses produced in the drainage channel along road 1344, and (4) using appropriate values of flow concentration produced by headward gully advancement.

SECTION 2

Response: ____________ By: TSC/RAC
Date: April 30, 1991

See response to Open Issue 13

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: ____________ Date: ____________
Approved By: ____________ Date: ____________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 16

Section: 4.4.3

DOE should provide durability specifications for the bedding material, in addition to the gradation requirement.

SECTION 2

Response: ______ By: TSC/RAC
Date: April 30, 1991

The bedding layer of the topslope cover has been eliminated.

The bedding material will be from the Knippa quarry, which has been proved to meet the durability criteria. Therefore, the durability specification for the bedding is not required.

Plans for Implementation: None.

SECTION 3

Confirmation of Implementation:

Checked by: ______ Date: ______
Approved By: ______ Date: ______

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 17

Section: 4.4.2

If DOE selects a quarry where only marginal-quality rock is available, additional testing and justification is needed to show that the use of such rock is acceptable.

SECTION 2

Response: ______________ By: TSC/RAC
Date: April 30, 1991

The Knippa quarry has been tested extensively and proved to meet the durability criteria. It will be used for both the riprap and bedding materials.

Plans for Implementation: None.

SECTION 3

Confirmation of Implementation:

Checked by: ______________ Date: ______________
Approved By: ______________ Date: ______________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 18

Section: 5.1, 5.2.3, 5.4.1.4

The DOE needs to establish background hydrochemistry for the Deweesville/Conquista aquifer, unaffected by uranium milling operations and the presence of tailings piles. None of the existing background wells for the site can be considered as upgradient, uncontaminated wells because the site occurs on a hydrologic divide. All of the background wells appear to be within the historical radius of influence of the millsite and the artificial recharge of large volumes of disposed, acidified wastewaters.

SECTION 2

Response: ______________ By: ______________
Date: April 30, 1991

The DOE has initiated three phases of drilling programs beginning in 1985 to establish background water quality. Many of the background wells were dry because of the necessity of locating background monitor wells updip along the topographic divide. The locations of the dry holes are shown on Figure 18.1. The number and placement of the holes demonstrates that DOE has attempted to characterize background water quality in all feasible upgradient and cross-gradient locations. From this, the DOE has concluded that characterization of upgradient background water quality in the Deweesville/Conquista aquifer is not possible. Groundwater quality must be taken from downgradient or cross-gradient monitor wells that have not been influenced by tailings seepage. As a result, background water quality has been established based on geochemistry of groundwater.

Because of the potential hydraulic connection between the Deweesville/Conquista aquifer and the lower Dilworth aquifer by vertical leakage across the lower Conquista and upper Dilworth facies (both behave as an aquitard, and were penetrated by exploration boreholes), the DOE will consider the Deweesville/Conquista/Dilworth as the uppermost aquifer. However, although there is a potential hydraulic connection, the reducing geochemistry within the Conquista and the Dilworth members should prevent the migration of hazardous constituents from the upper units to the Dilworth member. In the final RAP, the Deweesville/Conquista/Dilworth members will be included as the uppermost aquifer, although water quality will still be discussed by formation member.

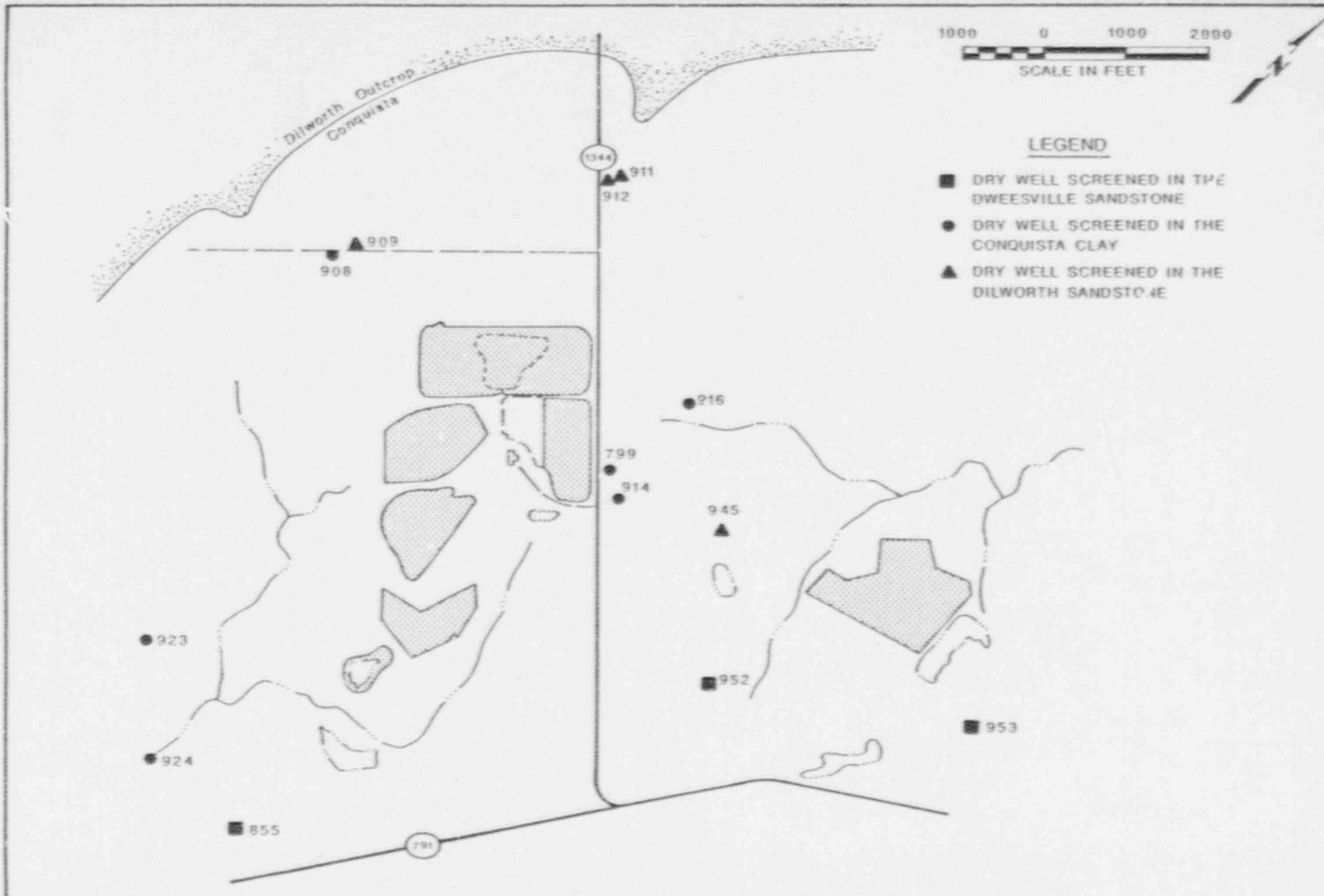


FIGURE 18.1
LOCATION OF DRY MONITOR WELLS
AT THE FALLS CITY, TEXAS, SITE

Deweesville/Conquista members

The locations of background monitor wells (663, 664, 665, 666, 667, 677, 688, 922, and 924) in the Deweesville/Conquista are shown on Figure 3.11 in the preliminary final RAP. Several geochemical approaches were tried while attempting to establish the background water quality for the Deweesville/Conquista members. Among these were both stiff and trilinear diagrams in which the patterns formed by the major cations and anions are used to try to distinguish fluids from different sources. There is virtually no difference in the patterns of the stiff and trilinear diagrams for the background and on-site wells (Figures 18.2 through 18.6). It is, therefore, necessary to investigate the distribution of "indicator" parameters that can be attributed to the milling process and that should behave in a conservative manner in the Deweesville/Conquista groundwater. The presence of uranium ore deposits at the interface between these units significantly complicates this effort. The conditions under which the ore deposits were formed indicate an active geochemical environment. The presence of a uranium mineralization halo around the mined-out ore deposits allows a natural contribution of the same hazardous constituents released during the milling process. The presence of multiple sources of contamination makes the distribution of most of the hazardous constituents very complex. In order to delineate contamination from the mill tailings piles, only those parameters with a regular distribution (e.g., defined plumes) centered on the piles are considered to have been contributed by milling activities.

Examination of the groundwater quality data for the Deweesville/Conquista members suggests that there are eight "indicator" parameters which show a regular distribution centered in the vicinity of the tailings piles. These are pH, oxidation/reduction potential (ORP), and the concentrations of molybdenum (Mo), sulfate (SO_4^{2-}), total organic carbon (TOC), total dissolved solids (TDS), uranium (U), and potentially tritium. The measured total dissolved solids concentration is dominated by the sulfate in solution, therefore, these parameters are interdependent and the measurement of one allows prediction of the other. Thus, there are seven semi-independent indicator parameters that can be used to delineate contamination. Attempts to establish a statistically based limit on the values of these indicator parameters were frustrated by the small number of background wells and samples. The high variability of the indicator parameters in the background wells prevents using a 99 percent upper confidence level as the sole basis for defining background water quality. Therefore, isopleths of indicator parameters were also used to qualitatively assess background water in background monitor wells. Qualitative background limits and some of the 99 percent confidence intervals for indicator parameters are presented in Table 18.1. The delineation of contamination within the Deweesville/Conquista aquifer is complicated by the presence of open pit uranium mines and remnant mineralization. In addition, the geochemical environment is continually modifying the groundwater as it percolates through the subsurface. Recognizing the limitations of this semi-qualitative approach, background monitor wells should not exceed the range of more than two indicator parameters.

Ion	meq/L	meq/L
$Na^{+}+K^{+}$	47.17	
Mg^{2+}	11.43	
Ca^{2+}	33.08	
Fe^{2+}	.64	
Cl^{-}		50.78
SO_4^{2-}		28.73
$HCO_3^{-}+CO_3^{2-}$		3.28
	92.33	82.79

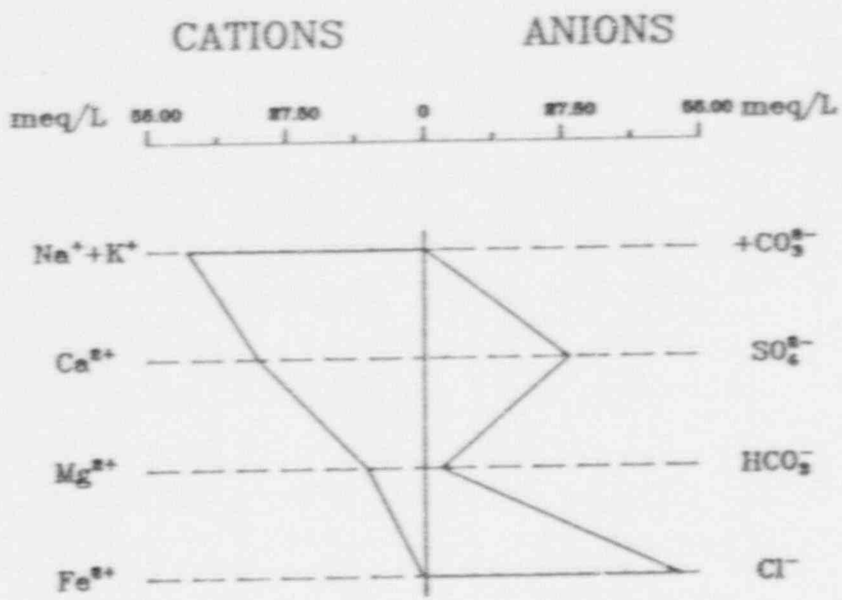


FIGURE 18.2

STIFF DIAGRAM FOR BACKGROUND MONITOR WELL 665
FALLS CITY, TEXAS, SITE

Ion	meq/L	meq/L
$Na^+ + K^+$	35.49	
Mg^{2+}	4.89	
Ca^{2+}	48.00	
Fe^{2+}	.00	
Cl^-		53.60
SO_4^{2-}		36.85
$HCO_3^- + CO_3^{2-}$		2.28
	------	------
	88.39	92.73

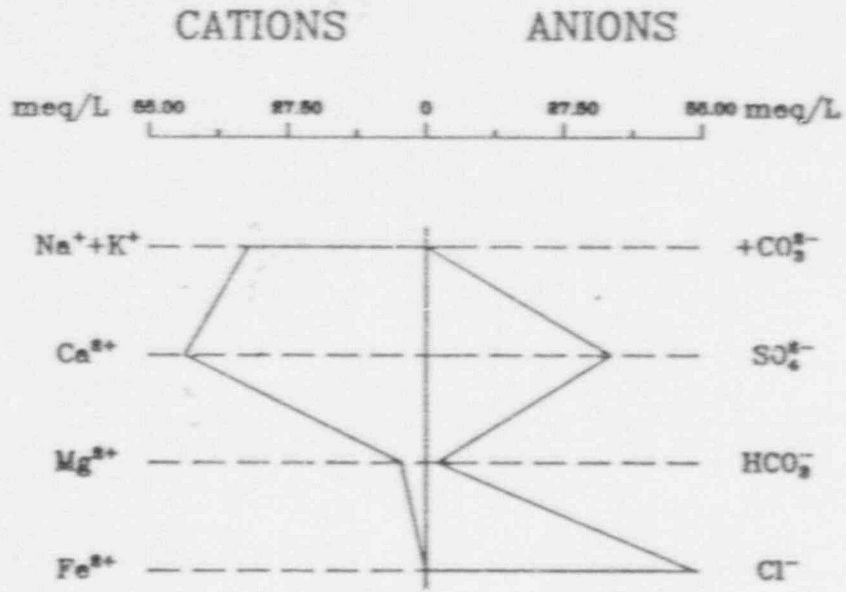


FIGURE 18.3
STIFF DIAGRAM FOR BACKGROUND MONITOR WELL 666
FALLS CITY, TEXAS, SITE

Ion	meq/L	meq/L
$Na^{+}+K^{+}$	38.33	
Mg^{2+}	8.88	
Ca^{2+}	42.42	
Fe^{2+}	.02	
Cl^{-}		47.96
SO_4^{2-}		40.81
$HCO_3^{-}+CO_3^{2-}$		1.80
	89.65	90.57

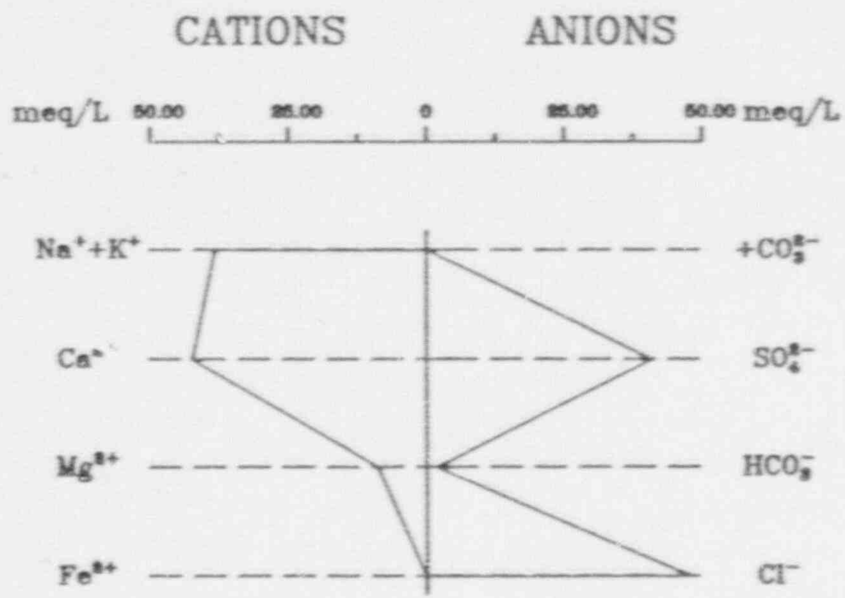


FIGURE 18.4
STIFF DIAGRAM FOR BACKGROUND MONITOR WELL 651
FALLS CITY, TEXAS, SITE

Ion	meq/L	meq/L
$Na^{+}+K^{+}$	72.16	
Mg^{2+}	6.50	
Ca^{2+}	58.88	
Fe^{2+}	.00	
Cl^{-}		77.30
SO_4^{2-}		40.18
$HCO_3^{-}+CO_3^{2-}$		5.16
	137.54	122.64

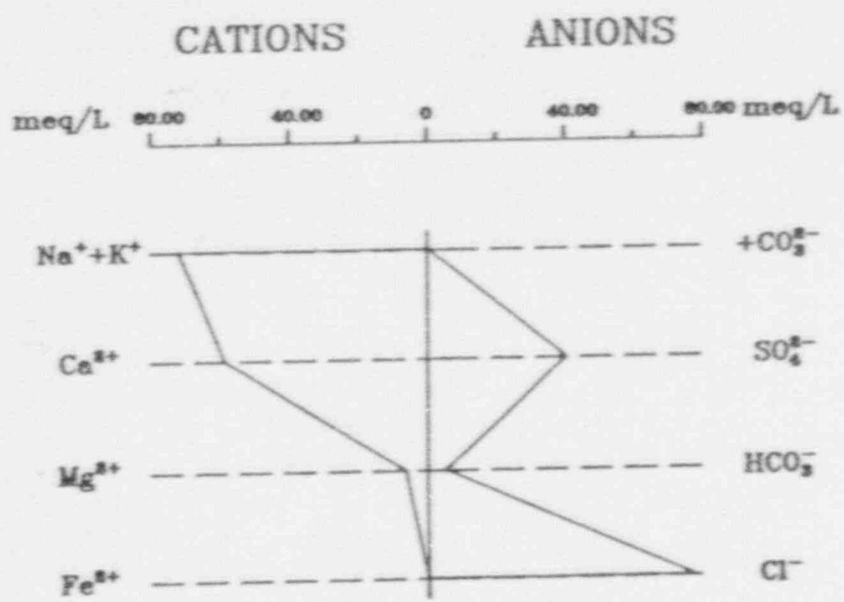


FIGURE 18.5
STIFF DIAGRAM FOR ON-SITE MONITOR WELL 721
FALLS CITY, TEXAS, SITE

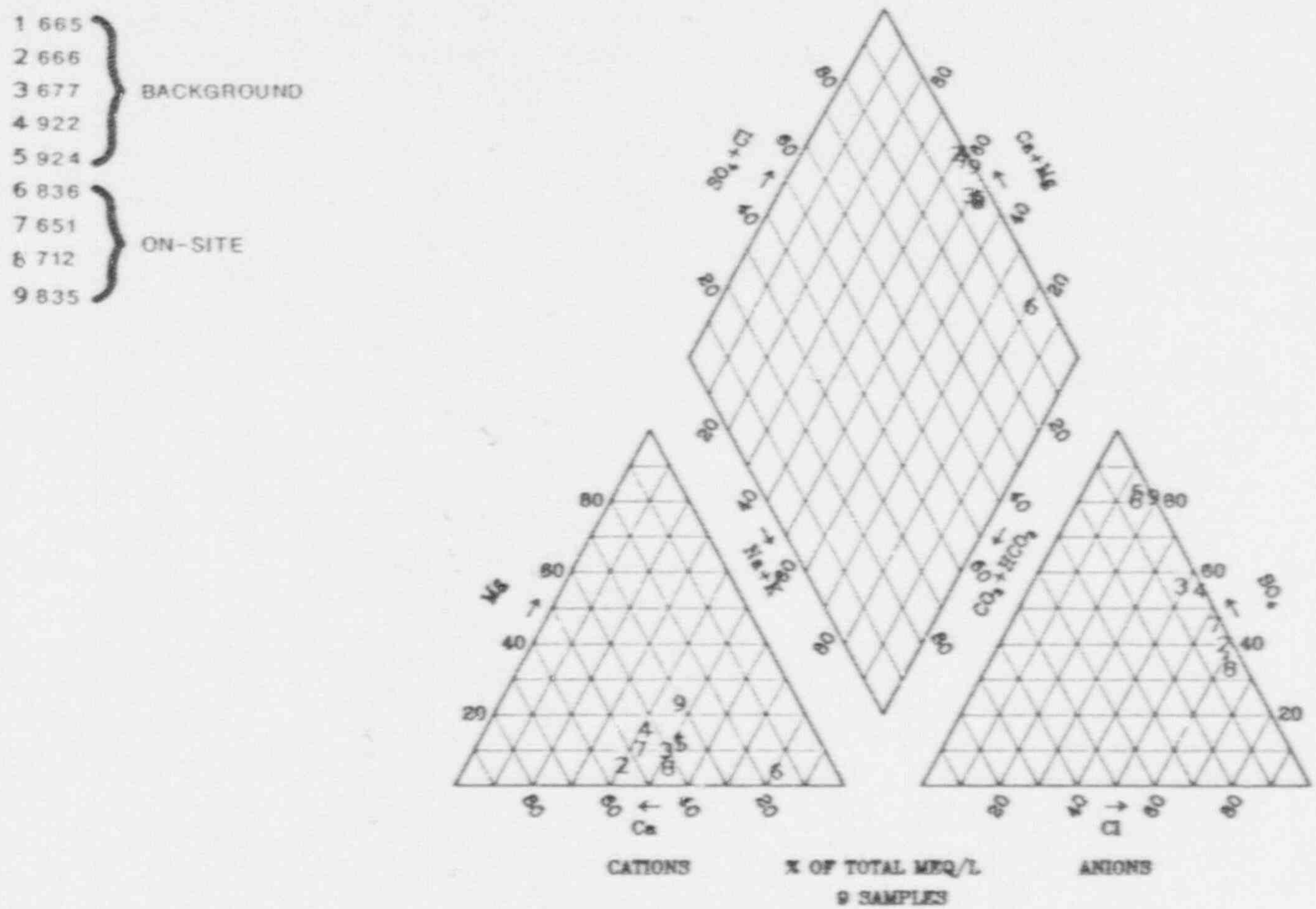


FIGURE 18.6
TRILINEAR DIAGRAM FOR BACKGROUND AND ON-SITE MONITOR WELLS COMPLETED IN THE DEWEESVILLE/CONQUISTA AQUIFER FALLS CITY, TEXAS, SITE

Table 18.1 Indicator Parameters in Deweesville/Conquista Background Wells

Monitor Wells	Date	pH	H^+ (Activity)	ORP (mV)	Mo (mg/l)	Mo (log)	SO4 (mg/l)	TDS (mg/l)	U (mg/l)	U (log) (log(mg/l))	TOC (mg/l)	Tritium[1] (tritium units)
663	6/85	6.8	1.58E-07				1835	3499	0.05	-1.30		<2.4
664	5/89	6.9	1.26E-07		0.02	-1.69	45	2749	0.025	-1.60		
665	6/89	4.4	3.98E-05		0.02	-1.6	2380	6830	0.01	-2	34	2.3±2.4
666	5/89	6.47	3.38E-07	220	0.01	-2	1770	6500	0.064	-1.19	8	2.7±2.
667	7/85	6.8	1.58E-07				703	2786				2.9±2.4
677	4/89	6.47	3.38E-07	3.5	0.54	-0.2	1770	4350	0.025	-1.60	6	
668	7/88	6.9	1.26E-07		0.005	-2.3	920	3300	0.112	-0.95		
922	4/89	5.9	1.26E-06	143	0.005	-2.3	2480	6240	0.059	-1.22	4	<2.2
924	5/89	6.4	3.98E-07	153	0.02	-1.6	2970	4940	0.135	-0.86	3	
Number of Samples		9	9	4	7	7	9	9	8	8	5	NA
Mean		5.3	4.74E-06	129	0.089	.0195	1652	4576	0.060	.045	11.000	
Standard Dev.		0.794	1.32E-05	90	0.199	0.691	937	1623	0.044	0.374	13.000	
t(99,n-1)		2.896	2.896	4.541	3.143	3.143	2.896	2.896	2.998	2.998	3.7	
99% Confidence level[3]		4.758[2]	1.74E-05	336	.325	0.129	2557	6143	0.106	0.113	32.7	
Qualitative Background Limit from Isopleth Maps		5.9	NA	150	0.5		3000	7000	0.2		10	NA

Notes:
1. Sampled 6/89
2. Lower confidence internal
3. Confidence levels are calculated by a method described by USEPA (1989) "Statistical Analysis of Groundwater Monitoring Data of RCRA Facilities -Interim Final Guidance," Office of Solid Waste Management Division, Washington, D.C.
N/A - Not applicable.

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Generally, groundwater with a pH of less than 5.9 is related to the influence of the effects of seepage of acidic tailings fluids. The mean pH (-log a_H+) of the background wells in the Deweesville/Conquista aquifer is on the order of 5.3 and the minimum value of 4.4 in monitor well 665 is below the limiting value. The area influence by the acidity from tailings seepage is shown on Figure 18.7. All background monitor wells are beyond the influence of tailings seepage. Figure 18.7 shows a pocket of relatively high pH solution (pH, 6.08) located in the center of the site. It is probable that an area of high calcite ($CaCO_3$), often found associated with uranium ores, has neutralized the acidic solutions infiltrating from the tailings piles, which indicates that the geochemical environment is controlling the water quality.

The distribution of ORP in the Deweesville/Conquista members is shown on Figure 18.8. Oxidizing acidic tailings fluids have influenced groundwater with an ORP above 150 Mv. Most background wells have an ORP of less or equal to 150 Mv except monitor well 666, as shown on Table 18.1. Because it was not necessary to use oxidants on the uranium ore milled at the Falls City site, the increase in ORP represents the influx of well-aerated, low pH fluids from the milling process. Residual organic material associated with the ore deposits should eventually reestablish more reducing conditions.

The distribution of sulfate and TDS (shown on Figures 18.9 and 18.10, respectively) suggests that wells influenced by tailings seepage are probably greater than 3000 mg/l for sulfate and 7000 mg/l for TDS. No background wells exceed this range, as shown on Table 18.1. Monitor well 924 exceeds the 99 percent confidence level for sulfate and monitor wells 665, 666, and 922 exceed the 99 percent confidence level for TDS.

The distribution of TOC is also an important indicator of the influence of tailings seepage on groundwater. The milling process at the Falls City UMTRA Project site included a solvent extraction step in which kerosene was the carrier solvent. Because kerosene has a finite solubility in water, it will contribute to dissolved organic carbon. The distribution of TOC in the Deweesville/Conquista aquifer is shown on Figure 18.11. Usually, a TOC of less than 10 mg/l is representative of background and the higher concentrations are related to the tailings piles. Only monitor well 665 exceeds the value of 10 mg/l. The upper 99 percent confidence level for TOC is 32.7 mg/l. Generally, background concentrations of TOC are related to naturally occurring organic material in the Deweesville/Conquista members.

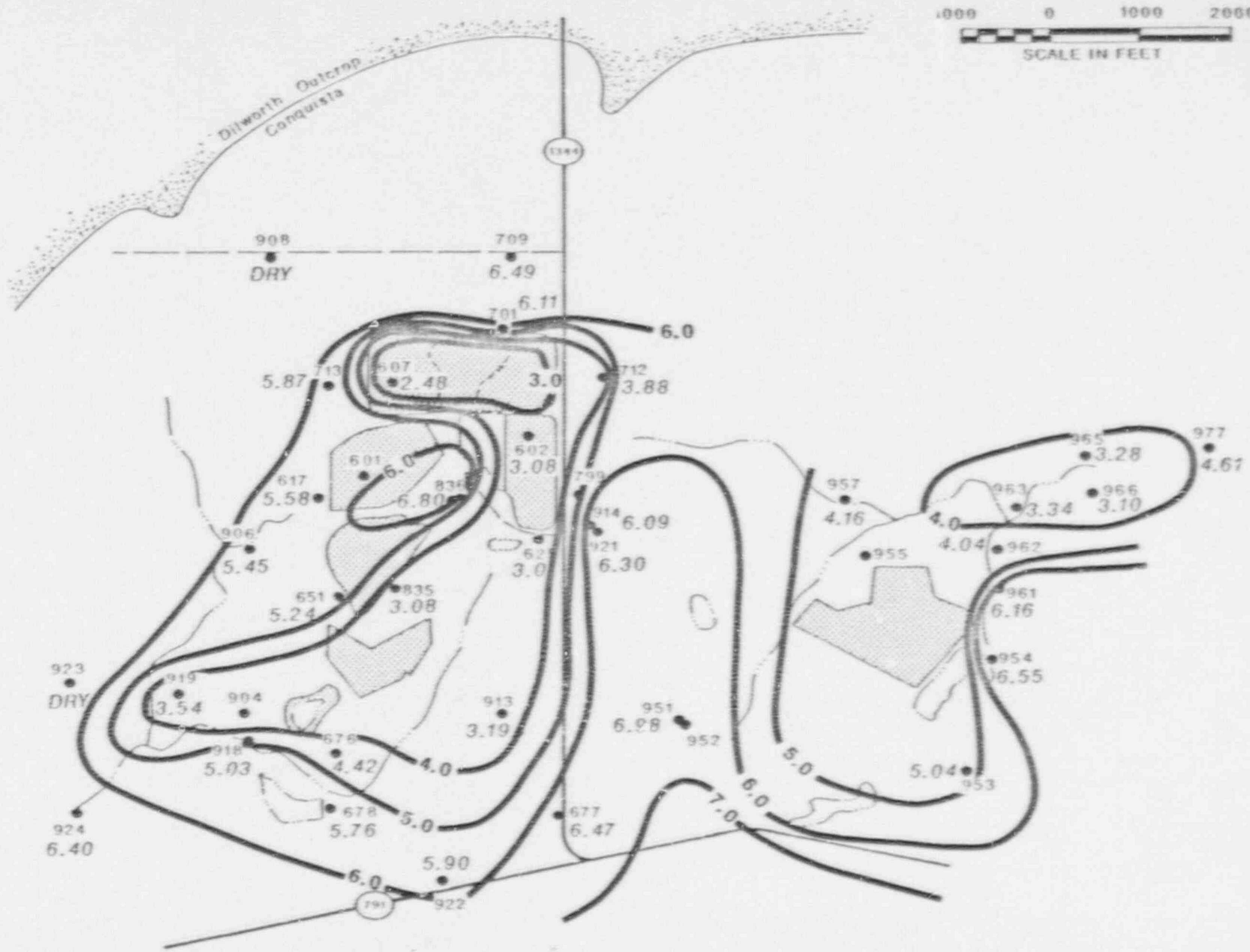

FIGURE 18.7

DISTRIBUTION OF pH WITHIN THE DEWEESVILLE/CONQUISTA AQUIFER FALLS CITY, TEXAS, SITE

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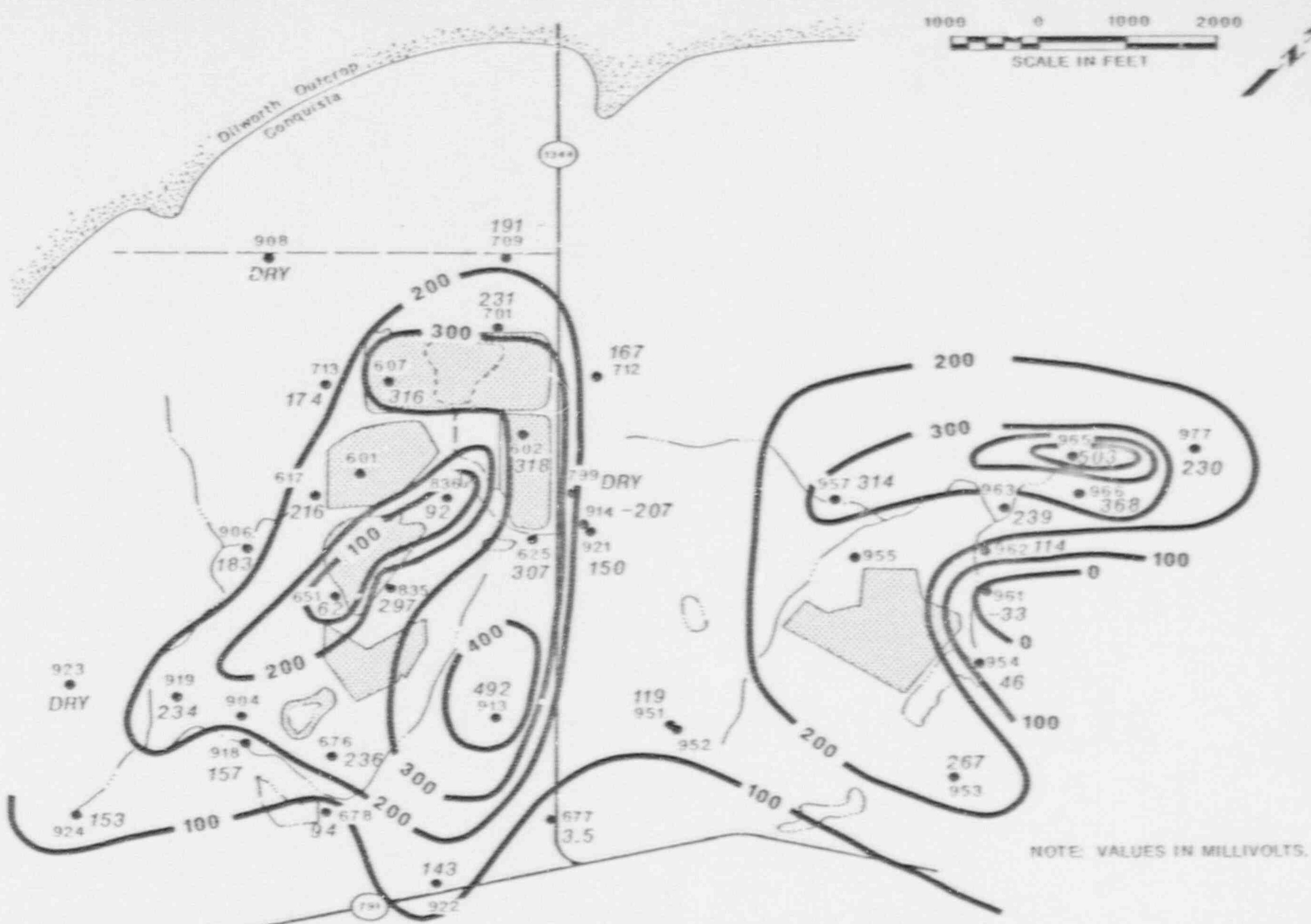
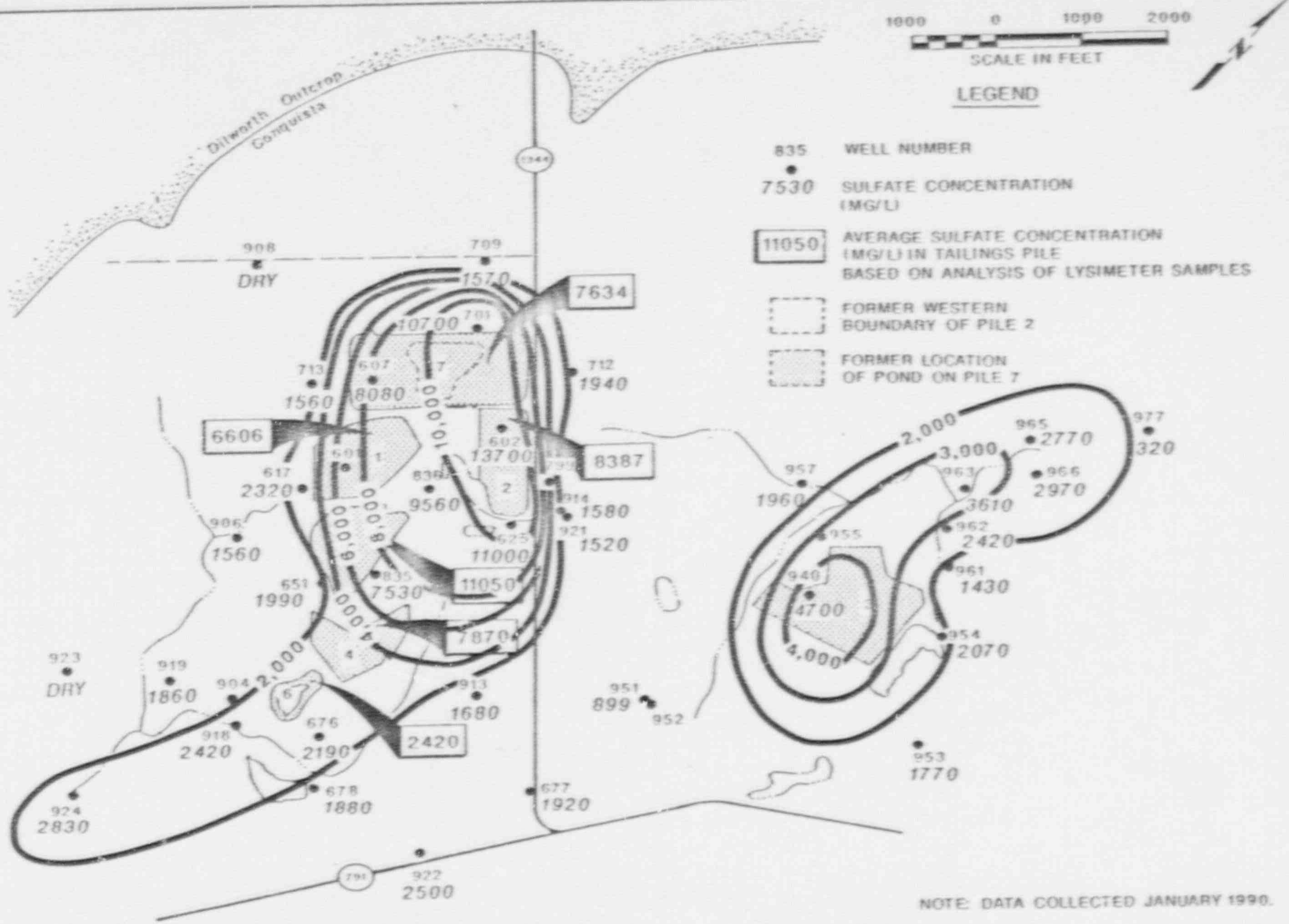


FIGURE 18.8
DISTRIBUTION OF OXIDATION REDUCTION POTENTIAL
WITHIN THE DEWEESVILLE/CONQUISTA AQUIFER
FALLS CITY, TEXAS, SITE



NOTE: DATA COLLECTED JANUARY 1990.

FIGURE 18.9
DISTRIBUTION OF SULFATE WITHIN THE DEWEESVILLE/CONQUISTA AQUIFER
FALLS CITY, TEXAS, SITE

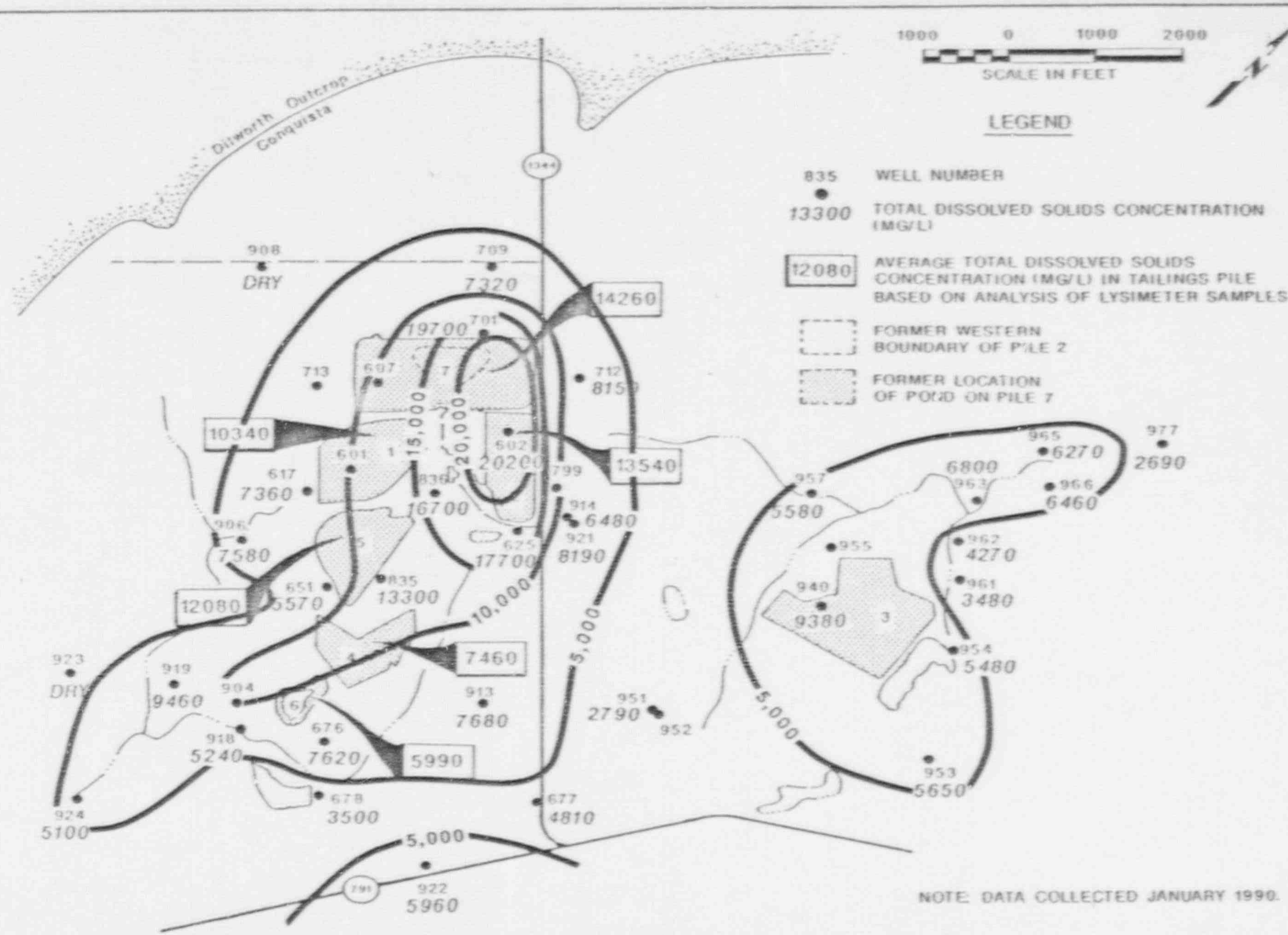


FIGURE 18.10
DISTRIBUTION OF TOTAL DISSOLVED SOLIDS WITHIN THE DEWEESVILLE/CONQUISTA AQUIFER
FALLS CITY, TEXAS, SITE

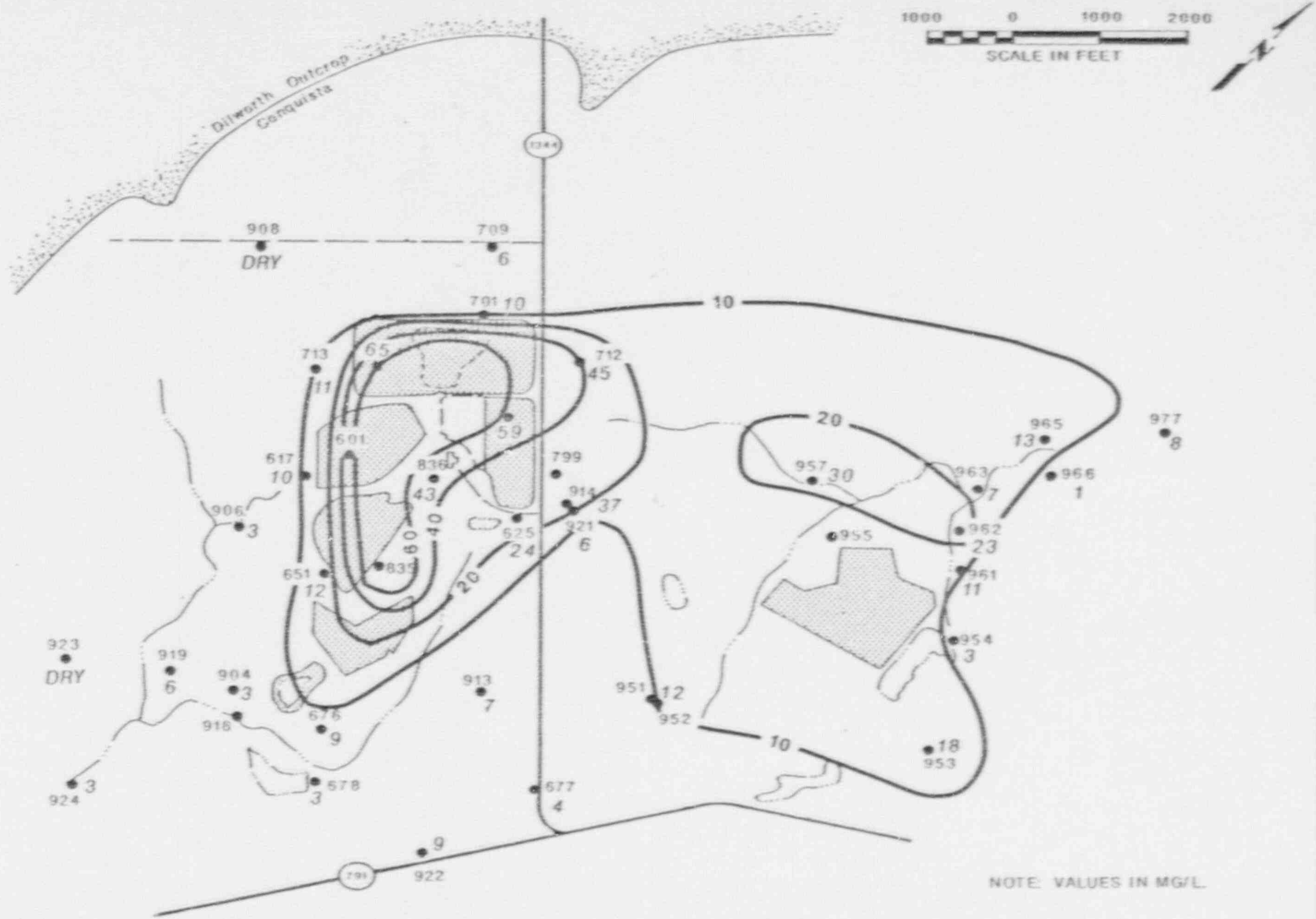


FIGURE 18.11
DISTRIBUTION OF TOTAL ORGANIC CARBON WITHIN THE DEWEESVILLE/CONQUISTA AQUIFER
FALLS CITY, TEXAS, SITE

Figure 18.12 shows the distribution of molybdenum in the Deweesville/Conquista members. The plume for this element is centered at the "moly pit" that was formed during the solution mining effort in the 1970s. It must be recognized that the shape and extent of the plume is influenced by contributions from the tailings piles and the unmined mineralization. The molybdenum and uranium concentrations in groundwater from monitor well 677 are evidence of a much faster than anticipated average groundwater seepage velocity that would have allowed contaminated ground water to have reached the monitor well, as suggested by the NRC. Although average seepage velocity may have some relevance to the movement of conservative ions, it can not be used to interpret the distribution of hazardous constituents that are either precipitated or adsorbed along the flow path. Further discussion of this is provided in the response to Open Issue 21. Concentrations of molybdenum and uranium exceed the MCLs in groundwater samples from monitor well 677 even though all other indicator parameters are within the range of background in groundwater samples from the well.

The distribution of uranium concentrations within the Deweesville/Conquista member is shown on Figure 18.13. The maximum concentrations are located adjacent to the tailings piles and pond 6. Concentrations in excess of approximately 0.200 mg/l seem to be associated with contamination.

Tritium (^3H) analyses of background wells indicate that the background water quality is low in tritium and not influenced by atmospheric testing of nuclear weapons (Table 18.1). Attempts were made to date the time of infiltration of the groundwater in the Deweesville/Conquista aquifer using tritium. The first attempt had relatively high laboratory detection limits (± 2.3 tritium units (TU)) and only two wells (607 and 836) indicated the presence of recent recharge. Samples have recently been submitted to a laboratory with lower detection limits (± 0.2 TU) and the results have not been received to date. These results will be submitted to the NRC upon receipt and interpretation. Although some recharge has occurred to the aquifer from tailings makeup water that was derived from the Carrizo Sandstone, the DOE calculates that a roughly equivalent amount of recharge from precipitation has also occurred. Rates of water use during uranium processing, rates of seepage from the tailings, and rates of recharge from precipitation are tabulated in FCT Calculation No. 04-91-14-18. As demonstrated in this calculation, the unsaturated hydraulic conductivity of the tailings has more influence on seepage than the total water use. Thus, it appears that natural recharge in the vicinity of the tailings is sufficient to contribute tritium to groundwater that is influenced by tailings seepage. None of the background wells have elevated tritium.

In summary, it is evident that background monitor wells are below the 99 percent confidence levels for all of the indicator parameters except the low pH in monitor well 665, molybdenum concentrations in monitor well 677, uranium concentrations in monitor wells 668 and 924, sulfate concentrations in monitor well 924, TDS in monitor wells 665, 666, and 922, and TOC concentrations in monitor well 665. Considering the qualitative background limits derived from isopleth maps, monitor well 665 exceeds the qualitative pH limit of 5.9, monitor well 666 exceeds the qualitative limit of 150 mV for ORP, monitor well 677 slightly exceeds the qualitative limit for molybdenum, and monitor well 665 exceeds the qualitative limit of 10 mg/l for TOC. Because none of the background monitor wells except 665 exceed either the 99 percent confidence levels or qualitative background limits for more than two parameters, the background monitor wells have not been influenced by tailings seepage. Therefore, the use of the monitor wells in the Deweesville/Conquista members listed in the preliminary final RAP to identify background water quality is justified and appropriate. Monitor well 665 will be kept as a background well because it is farther down gradient than other background wells that show no influence of tailings seepage. The high TOC concentration and TDS may be related to substantial distance monitor well 665 is from the outcrop area.

Dilworth member

Even though permeable units within the Dilworth member are included as part of the uppermost aquifer, there is absolutely no geochemical evidence that groundwater within the Dilworth has been contaminated by hazardous constituents related to uranium processing by seepage from the overlying Deweesville/Conquista members. Plots of the indicator parameters of samples (Figures 18.14 through 18.16) collected from the Dilworth member do not show a configuration that indicates that there has been a contribution of fluid other than from recharge by precipitation at the outcrop.

Background water quality within the Dilworth varies as a function of distance from the subcrop area. Presently there is no contamination indicated in the Dilworth based on the distribution of pH and ORP. The distribution of pH in the Dilworth member (Figure 18.14) does not indicate a contribution of low pH fluids from the area of the tailings piles. The pH is typically between 6.1 and 6.5 in the subcrop area and increases to more than 7.0 down dip. The distribution of the

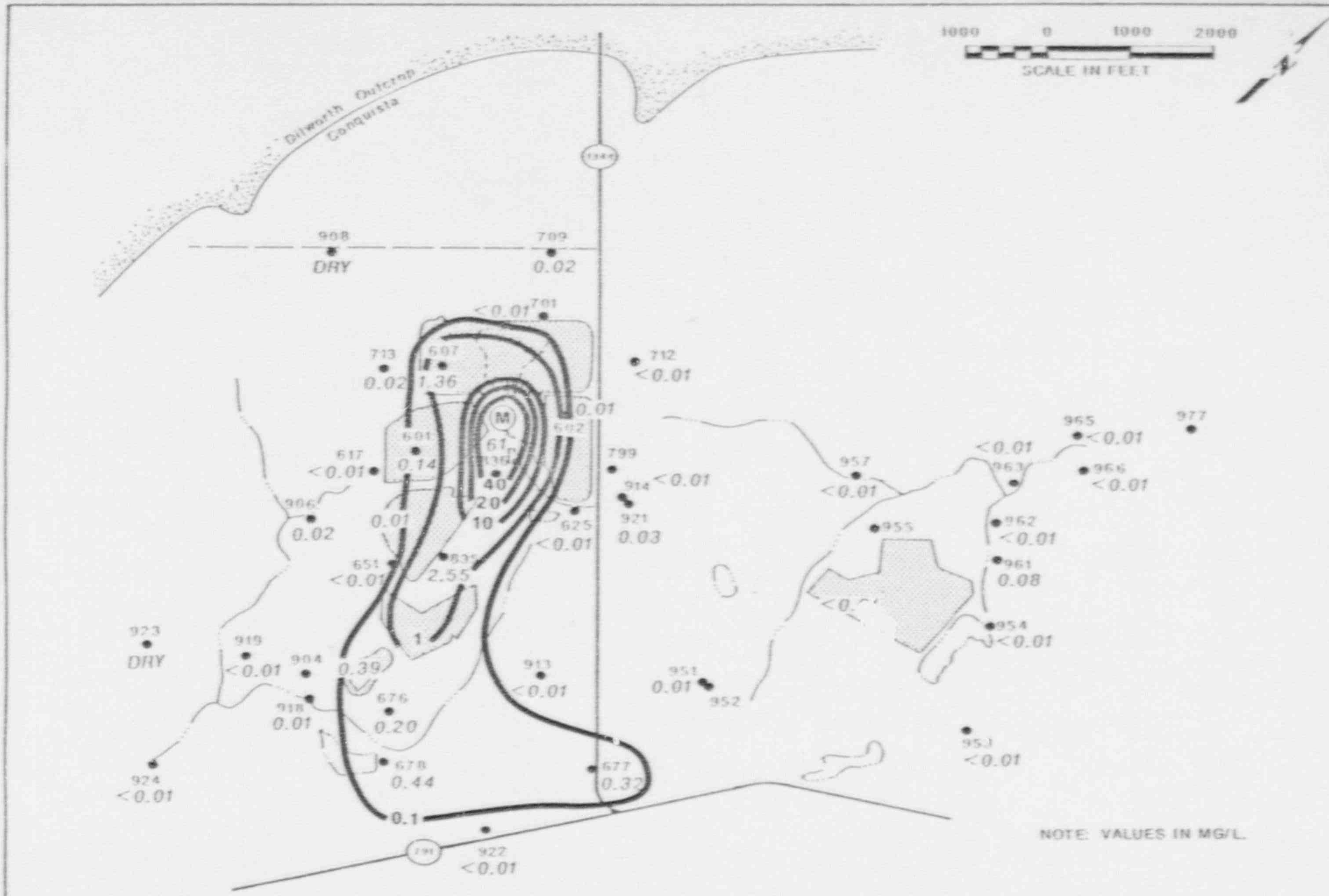


FIGURE 18.12
DISTRIBUTION OF MOLYBDENUM WITHIN THE DEWEESVILLE/CONQUISTA AQUIFER
FALLS CITY, TEXAS, SITE

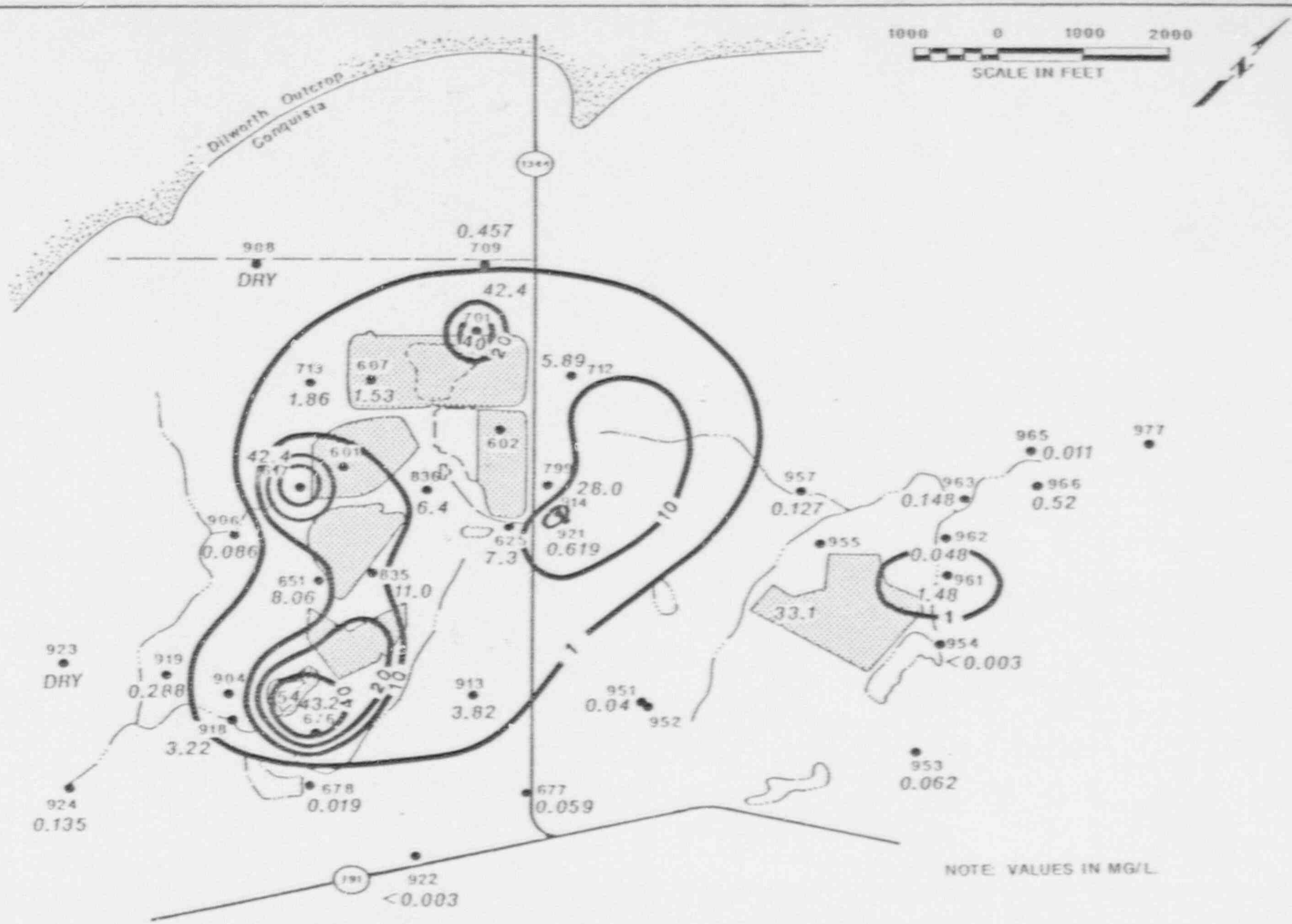


FIGURE 18.13
DISTRIBUTION OF URANIUM WITHIN THE DEWEESVILLE/CONQUISTA AQUIFER
FALLS CITY, TEXAS, SITE

measured ORP in the Dilworth member (Figure 18.15) does not show a significant contribution of oxidized fluids in the vicinity of the tailings piles. The ORP of the Dilworth becomes reducing downdip. This distribution is controlled by the infiltration of precipitation from the outcrop.

Constituents exceeding the proposed EPA Title I standards for the updip and downdip portions of the Dilworth are presented are presented in Table 18.2 in FCT Calculation No. 04-25-13-01-00. Basically, concentrations of arsenic, molybdenum, selenium, sulfide, and uranium are higher in the subcrop zone because they are more soluble in the oxidizing environment. In addition, TOC is slightly higher in the reducing zone. Although concentrations of hazardous constituents decrease in downdip background monitor wells, concentrations of sulfide and TDS increase. From a major ion chemistry standpoint, samples from the Deweesville/Conquista/Dilworth members plot within the same stability field on trilinear diagrams (Figures 18.6 and 18.16).

Background water quality in the Dilworth is also limited use (Class III) based on treatability (FCT Calculation 04-25-13-01-00). The quality of water from the Dilworth member does not compare favorably with groundwater typically used for municipal supply in the coastal plain region of Texas. The proposed EPA MCL for selenium is equalled or exceeded over a wide area and in both the oxidizing and reducing zones of the Dilworth member. While only the median concentration of selenium exceeded the proposed EPA Title I concentration limits, elevated levels of hazardous constituents are found in numerous wells screened in the Dilworth member. Concentration levels exceeding Title I MCLs are reported for arsenic, cadmium, chromium, molybdenum, radium, and uranium. The total noncarbonate hardness, high sodium, and high sulfide concentrations reduce the practicability of treating the water.

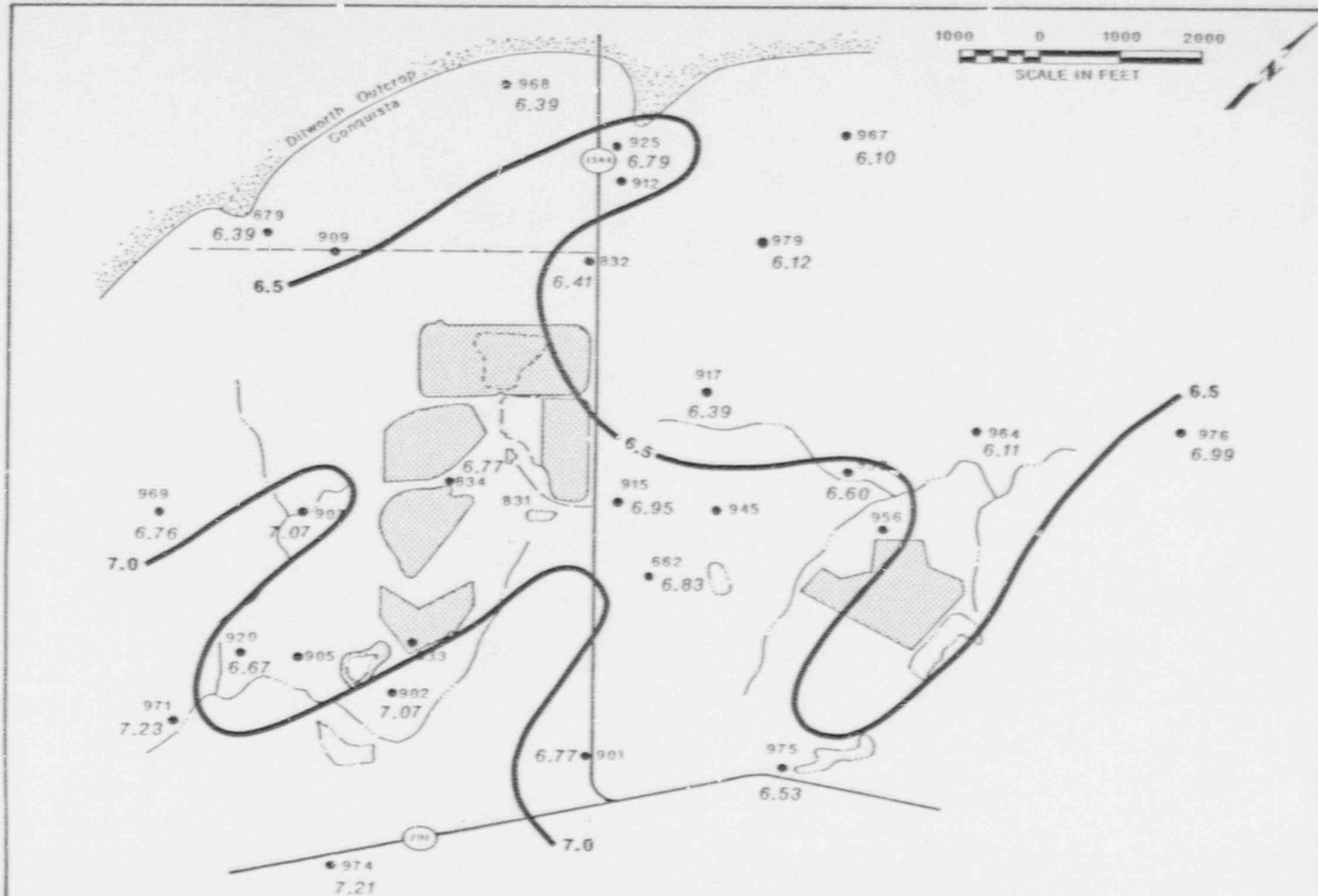


FIGURE 18.14
DISTRIBUTION OF pH WITHIN THE DILWORTH AQUIFER
FALLS CITY, TEXAS, SITE

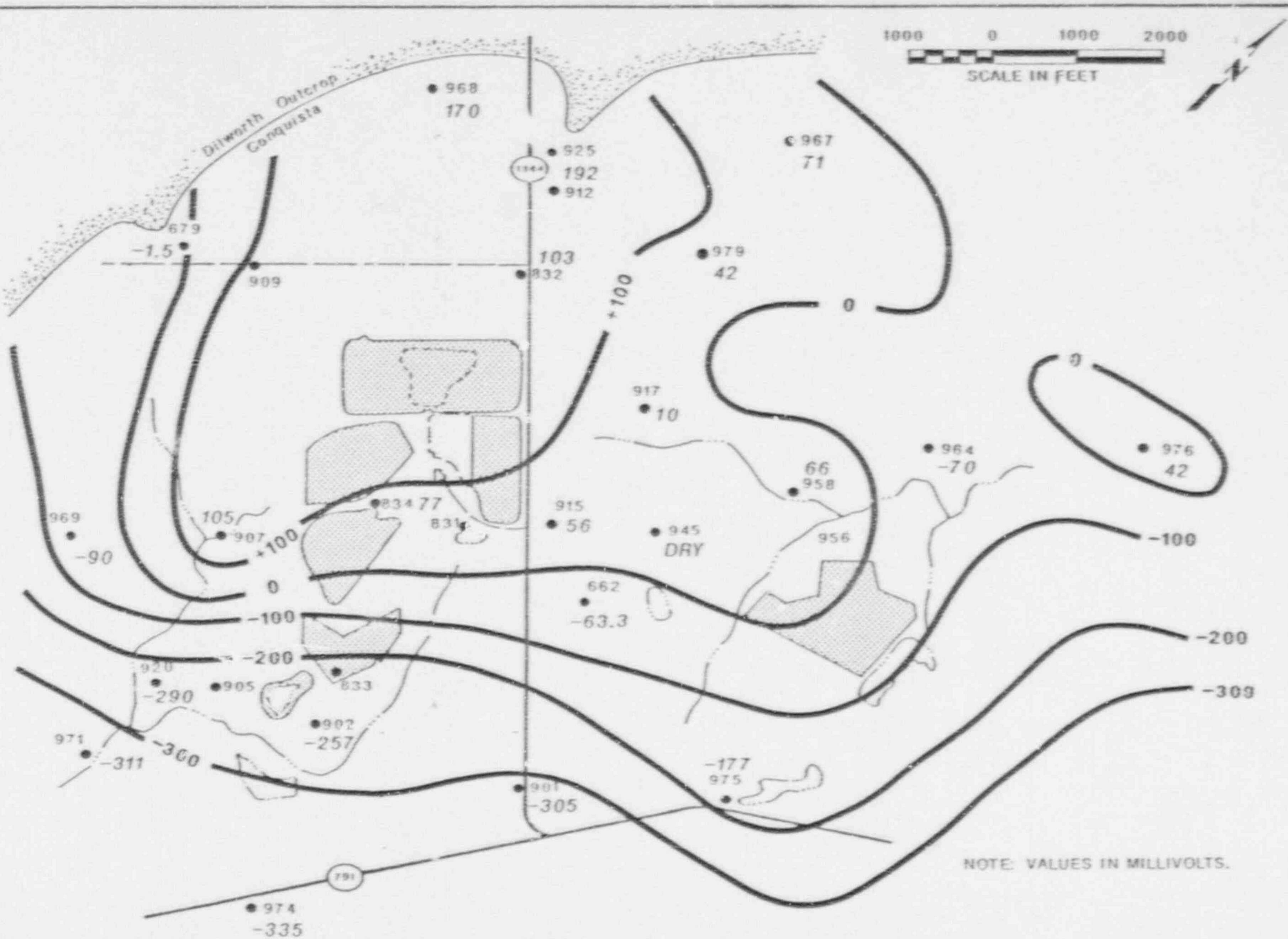


FIGURE 18.15
DISTRIBUTION OF OXIDATION REDUCTION POTENTIAL WITHIN THE DILWORTH AQUIFER
FALLS CITY, TEXAS, SITE

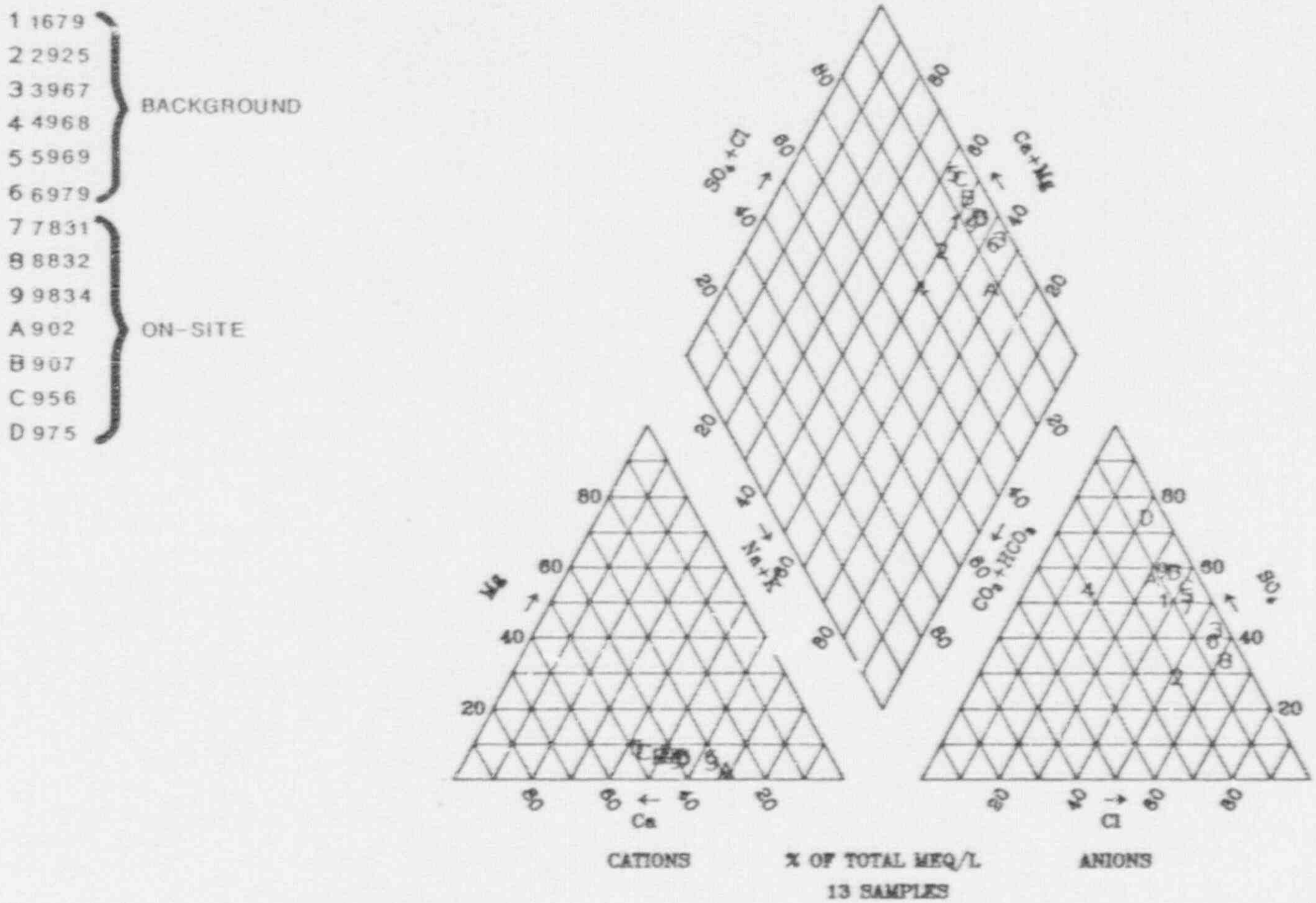


FIGURE 18.16

TRILINEAR DIAGRAM FOR THE DILWORTH FORMATION GROUNDWATERS

FALLS CITY, TEXAS, SITE

The Dilworth member has not been affected by mining and milling activities at the Falls City site; nevertheless, the quality of water from the aquifer can only be described as extremely poor. Because groundwater that requires little or no treatment is readily available from sources such as the Carrizo Formation, it is not economically viable to consider treating the Dilworth water for drinking water purposes. In addition, treating poor quality water from an extremely low yield aquifer cannot be considered a typical practice in the coastal plain region of Texas.

Based on the water quality, and available quantity, the Dilworth member is not treatable by methods reasonably employed by public water supply systems in this region of Texas. Therefore, the water in the Dilworth member meets the definition of Class III (limited use) groundwater based on widespread ambient contamination that cannot be cleaned up using methods reasonably employed by public water supply systems.

Plans for Implementation: Incorporate the above discussion into the final RAP and include the Deweesville/Conquista/Dilworth as the uppermost aquifer.

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________
Approved By: ______________________ Date: ______________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 19

Section: 5.2.1, 5.2.2, 5.2.3, 5.2.4, 5.4.2

The DOE needs to provide an analysis of the potential for downward migration of contaminants via abandoned boreholes in the site vicinity along with available data on the locations and construction details of the exploratory boreholes. These boreholes have the potential to vertically connect the Dilworth aquifer to the overlying Deweesville/Conquista aquifer, thereby providing paths for the downward migration of contaminants.

SECTION 2

Response: By: TSC
Date: April 30, 1991

The DOE has previously described the potential hydraulic connection between the Deweesville/Conquista members and the lower Dilworth member in the preliminary final RAP (DOE, 1990). To further define the potential for hydraulic connection, the DOE has obtained records of Susquehanna Western Inc. exploration boreholes that were drilled in 1960. Because this information is proprietary, it can not be published in this document but will be summarized briefly. Exploration boreholes cover the disposal site on 100 foot centers typically to a depth of 300 feet. In the northern and western portions of the site some of the boreholes penetrated the lower Dilworth and upper Manning Clay. Subsequent to this drilling, other shallower boreholes were drilled into the Conquista Clay to define the ore bodies that were mined in the vicinity of the UMTRA Project site.

Although these boreholes cover the site, they most likely do not significantly increase the present amount of recharge to the Dilworth member. During the 1991 Texas BEG/DOE field program, drillers had difficulty keeping coreholes open. It appears that the clays in the formation are self-sealing and close the boreholes naturally. While the permeability of these clays that seal the boreholes is probably from one to two orders of magnitude less than that of the naturally occurring materials, the cross-sectional area of the borehole available for vertical recharge is small relative to the area of the aquitard that separates the Deweesville/Conquista members from the lower Dilworth member. Thus, seepage down the boreholes is negligible compared to leakage across the aquitard. The suggested groundwater mound in the upper Dilworth to the southwest of pile 2, shown on Figure 3.8 in the preliminary final RAP, is more an artifact of leakage across the aquitard due to the large difference in head (40 ft) between the Deweesville/Conquista members and the upper Dilworth in that area. The calculation of the travel time of groundwater flow across the aquitard between the Deweesville/Conquista aquifer and the lower Dilworth is approximately two years using a vertical hydraulic conductivity of .02 ft/day, a gradient of 0.6 and an effective porosity of 0.1, as stated in the preliminary final RAP. However, this calculation is extremely conservative (the travel time is likely to be much greater than two years) as recent pumping tests have shown the vertical hydraulic conductivity to be much lower.

The DOE has attempted to define the potential hydraulic connection between the Deweesville/Conquista members and the lower Dilworth. In April 1991, the DOE conducted three aquifer pumping tests in monitor wells 901, 902, and 921 to quantitatively assess aquifer parameters and qualitatively assess the potential hydraulic connection. The pumping tests were performed at discharge rates ranging from 0.5 to 2.5 gpm. The tests typically lasted from four to 24 hours as the wells could not sustain even these very low pumping rates. Drawdown was measured in nearby observation wells completed in either the upper or lower unit, depending upon in which units the pumping well was completed in. Recovery was then measured in the pumping wells.

Aquifer test parameters from the April 1991 pumping tests are presented in Table 19.1. Analysis of the recent pumping test data confirms that the Deweesville/Conquista and Dilworth members are low yield water bearing units with transmissivities ranging from 1.3 to 37.9 ft^2/d (FCT Calculation No. 04-91-14-03-00). Storage coefficients ranged from 1×10^{-5} to 5×10^{-2} for the Deweesville/Conquista and the Dilworth members, respectively. During the pumping period of monitor well 902, completed in the lower Dilworth, drawdown stabilized due to vertical leakage. Vertical leakage was calculated to be 7.4×10^{-5} d^{-1}. Considering an aquitard thickness of 60 ft, this results in a vertical hydraulic conductivity of 4.4×10^{-3} ft/day, which is almost an order of magnitude less than the vertical permeability estimated from packer tests in the aquitard in the RAP.

No hydraulic connection was observed between the formations during the pumping tests. A measurable direct hydraulic connection between the lower Dilworth and the Deweesville/Conquista members would have resulted in some drawdown in nearby observation wells in the Deweesville/Conquista members. However, this was not observed.

Because there is a potential hydraulic interconnection between the Deweesville/Conquista members and the lower Dilworth, the Dilworth has been included as part of the uppermost aquifer. While the hydraulic interconnection cannot be disproved, the water qualities of the two units show significantly different distributions of indicator parameters. As discussed in the response to Open Issue 18, one of the parameters used to delineate contamination is oxidation/reduction potential (ORP). In the Deweesville/Conquista members, there are highly oxidizing areas associated with the areas covered with tailings and as one moves away from these areas, the environment becomes more reducing in all

TABLE 19.1.
SUMMARY OF AQUIFER PUMPING TEST PARAMETERS

	Pumped Well No.	Observation Well No.
	901	677
Depth (feet)	145	85
Screened Interval (feet)	123 - 143	49 - 80
Member	lower Conquista-upper Dilworth	lower Deweesville-upper Conquista
Static Water Level (feet)	56.45	60.86
Pumping Duration (minutes)	240	Not Applicable
Discharge Rate (gal/min)	0.5	Not Applicable
Maximum Drawdown	65.3	None Observed
Distance from pumped well to observation well (feet)	Not Applicable	9.0
Transmissivity (drawdown analysis)	1.30 ft^2/day	not analyzed
Storativity (drawdown analysis)	1.0×10^{-5}	not analyzed
Specific Leakage (drawdown analysis)	none	not analyzed
Transmissivity (recovery analysis)	1.35 ft^2/day	not analyzed
Storativity (recovery analysis)	1.0×10^{-5}	not analyzed
Specific Leakage (recovery analysis)	none	not analyzed

58 A,B,&C

TABLE 19.1. (continued)
SUMMARY OF AQUIFER PUMPING TEST PARAMETERS

	Pumped Well No.	Observation Well No.
	921	915
Depth (feet)	140	40
Screened Interval (feet)	118 - 132	10 - 40
Member	Fossiliferous Conquista-Sandstone	upper Dilworth
Static Water Level (feet)	25.18	57.22
Pumping Duration (minutes)	1400	Not Applicable
Discharge Rate (gal/min)	0.5 (0 - 160 min) 1.0 (160 - 350 min) 1.5 (350 - 600 min) 2.0 (600 - 900 min) 2.5 (900 - 1400 min)	Not Applicable
Maximum Drawdown	15.3	None Observed
Distance from pumped well to observation well (feet)	Not Applicable	17.0
Transmissivity (drawdown analysis)	36.6 ft^2/day	not analyzed
Storativity (drawdown analysis)	4.9×10^{-2}	not analyzed
Specific Leakage (drawdown analysis)	7.4×10^{-5} day^{-1}	not analyzed
Transmissivity (recovery analysis)	37.9 ft^2/day	not analyzed
Storativity (recovery analysis)	5.0×10^{-2}	not analyzed
Specific Leakage (recovery analysis)	1.1×10^{-5} day^{-1}	not analyzed

TABLE 19.1. (continued)
SUMMARY OF AQUIFER PUMPING TEST PARAMETERS

	Pumped Well No.	Observation Well No.
	902	676
Depth (feet)	140	40
Screened Interval (feet)	118 - 132	10 - 40
Member	upper Dilworth	lower Deweesville-upper Conquista
Static Water Level (feet)	53.90	8.82
Pumping Duration (minutes)	1400	Not Applicable
Discharge Rate (gal/min)	1.0	Not Applicable
Maximum Drawdown	42.69	None Observed
Distance from pumped well to observation well (feet)	Not Applicable	25.0
Transmissivity (drawdown analysis)	4.82 ft^{2}/day	not analyzed
Storativity (drawdown analysis)	1×10^{-5}	not analyzed
Specific Leakage (drawdown analysis)	none	not analyzed
Transmissivity (recovery analysis)	5.88 ft^{2}/day	not analyzed
Storativity (recovery analysis)	1×10^{-5}	not analyzed
Specific Leakage (recovery analysis)	none	not analyzed

directions. The distribution of ORP in the Dilworth member is roughly parallel to the outcrop and becomes very reducing downdip as the aquifer becomes confined. Numerical simulation of this system using the geochemical equilibrium code PHREEQE (Parkhurst et al., 1980) indicates that any hazardous constituents that reach the Dilworth will be removed via precipitation (FCT Calculation 05-91-14-13-00). The Dilworth groundwater will attain compositions below maximum concentration limits or at background even if there should be a significant contribution of fluids from the overlying Deweesville/Conquista members.

Reclassification of the Deweesville/Conquista/Dilworth members as the uppermost aquifer does not significantly affect the compliance strategy at the Falls City site because groundwater in the Dilworth aquifer is also limited use (see response to comment 18). Disposal of the tailings will not impact the water quality of the Dilworth and therefore, the existing or potential beneficial uses.

Plans for Implementation: The April 1991 aquifer test data will be added to the RAP and this discussion will also be included.

SECTION 3

Confirmation of Implementation:

Checked by: ____________________ Date: ____________________
Approved By: ____________________ Date: ____________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 20

Section: 5.2.2

The DOE needs to prepare a phreatic (water table) map to more accurately show groundwater flow directions and gradients in the uppermost, unconfined, water-bearing zones. This map should include the unconsolidated surficial deposits, Dubose Clay Member, Deweesville/Conquista Members, and the Dilworth Member within at least a 2-mile radius of the site. This would demonstrate the direction and gradient of groundwater flow in the aquifer.

SECTION 2

Response: ____________ By: TSC
Date: April 30, 1991

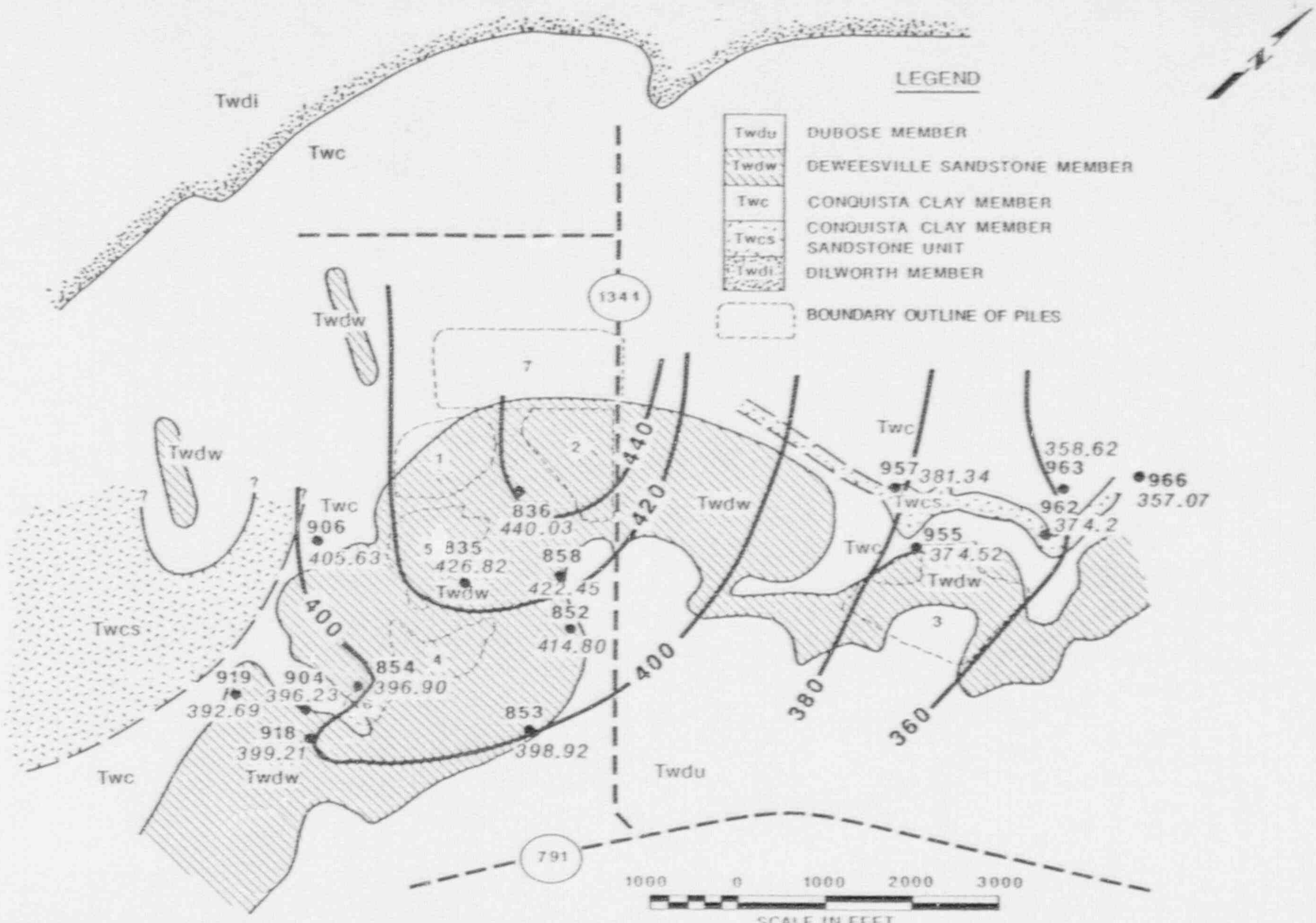
As requested by NRC, the DOE has prepared the phreatic surface map shown on Figure 20.1. The map was prepared using groundwater elevations obtained from DOE monitor wells screened in an unconfined interval within the outcrop area of the geologic member. No monitor wells are screened in unconfined conditions upgradient of the tailings piles in the Dilworth member. Similarly, no unconfined monitor wells have been completed downgradient of the tailings piles in the Dubose Clay. Therefore, most of the data are concentrated in the Deweesville/Conquista outcrop area. The groundwater elevations are a subdued reflection of topography.

Plans for Implementation: None

SECTION 3

Confirmation of Implementation:

Checked by: ____________ Date: ____________
Approved By: ____________ Date: ____________



MODIFIED FROM J.A. MacKallor et al., 1962.

FIGURE 20.1
PHREATIC SURFACE MAP
FALLS CITY, TEXAS, SITE

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 21

Section: 5.2.2, 5.2.3

Groundwater seepage velocities in the Deweesville/Conquista aquifer are more than an order of magnitude greater than the fastest seepage velocities calculated by the DOE based on hydrologic test values and an assumed value of effective porosity. This estimate is based on the extent of a molybdenum plume that originated from a disposal pit near the former mill foundation. The DOE should consider this hydrochemical evidence in revising estimates of seepage velocities at the site.

SECTION 2

Response: ______ By: TSC
Date: April 30, 1991

Hazardous constituents in groundwater in monitor well 677 (see Figure 3.23 in the preliminary final RAP) are not evidence of a much faster than anticipated average groundwater seepage velocity. The DOE maintains that molybdenum, the hazardous constituent used in the NRC's estimate of the velocity, is contributed along the flow path by other tailings piles and not just the molybdenum pit. Furthermore, simplifying the problem by considering flow along the centerline of the plume in one dimension, the 50th percentile concentration reduction arrives with the average seepage velocity (Freeze and Cherry, 1979). This means that if the source concentration is 61 mg/l, the distribution of the 30 mg/l contour should define the average seepage velocity. From Figure 3.23 in the preliminary final RAP, the 30 mg/l contour has not moved more than 900 feet from the molybdenum pit and not the 4500 feet suggested by the NRC. Thus, although average seepage velocity may have some relevance to the movement of conservative ions, it can not be used to interpret the distribution of hazardous constituents that are either precipitated or adsorbed along the flow path. The estimate of the groundwater seepage velocity in the preliminary final RAP (28 ft/year) is conservative considering that it is based on a hydraulic conductivity of 1.2 ft/day.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________
Approved By: ______________________ Date: ______________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 22

Section: 5.2.4

lne DOE needs to ensure that all deep wells located on Falls City site will be sealed in order tr protect potable water supplies in the units below the Manning clay.

SECTION 2

Response: By: DBierley
Date: April 30, 1991

In December 1990, the two deep on-site production wells were abandoned by the State of Texas, Bureau of Radiation Control. A log of one of the abandoned wells is on file in the UMTRA Project Office. The available data from the milling operation indicate that these were the only deep wells on the processing site.

Plans for Implementation: This information will be added to the final RAP.

SECTION 3

Confirmation of Implementation:

Checked by: ________ Date: ________
Approved By: ________ Date: ________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 23

Section: 5.4.3

The DOE should clarify whether the groundwater contained in tailings pile is perched water or actually represents mounding on the shallow water table surface and assess possible impacts on stability/settlement.

SECTION 2

Response: ______ By: TSC
Date: April 30, 1991

During the April 1991 field program, the DOE measured groundwater elevations and the phreatic surface in tailings piles. As shown in Table 23.1, there is almost a 30-foot difference in head elevation between tailings piezometers and nearby groundwater monitoring wells. The low hydraulic conductivity of the tailings (2.4×10^{-4} ft/day from the preliminary final RAP) prevents the tailings from draining rapidly into the groundwater system. Because the underlying hydraulic conductivity of the foundation materials is from two to three orders of magnitude higher, unsaturated flow will occur down to the water table. Furthermore, there is no evidence of seeps on the sides of the piles, suggesting that the foundation materials can accept all of the tailings drainage as unsaturated flow.

Plans for Implementation: This discussion will be added to the RAP

Table 23.1

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________
Approved By: ______________________ Date: ______________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 24

Section: 5.0

The predicted performance of the infiltration barrier will remain an open item pending NRC review of newly-received documentation (Calculation No. FCT-07-89-12-01-00 missing from RAP).

SECTION 2

Response: By: TSC/RAC
Date: April 30, 1991

The performance of the cover (infiltration barrier) will not impact the proposed groundwater compliance strategy. Calculation FCT-07-89-12-01-00 was provided to demonstrate that the topslope cover meets the as low as reasonable under the circumstances criterion for the application of supplemental standards.

Plans for Implementation: None.

SECTION 3

Confirmation of Implementation:

Checked by: ______ Date: ______
Approved By: ______ Date: ______

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 25

Section: 6.2.1

The following physical and radiological properties of the contaminated materials must be reevaluated.

(1) The in situ slime will undergo a significant volume reduction (50 to 60 inches of estimated settlement) and will result in a denser material. The effect of this increased density on the calculated radiological parameters should be evaluated or the conservatism of the values currently used should be demonstrated.

(2) The representatives of the composite samples of relocated tailings must be established or the conservatism of the proposed parameters be demonstrated.

(3) DOE needs to provide the location of the wind-blown sample 526.

(4) The calculated diffusion coefficient of the relocated tailings is significantly higher than the diffusion coefficient based on test results from three composite samples. As representativeness of the composite sample has already been questioned, DOE must address the large discrepancy and provide justification for not using the higher value in the radon attenuation modeling.

(5) The data presented to justify the emanation coefficient was inconclusive. The data that were evidently used to calculate the average values have no supporting documentation such as location, depth, etc. DOE must provide additional justification for the emanation values for all three material groups. If data from the November 1987 RAP is used, DOE should include the location of Pile E and an explanation of why it is appropriate to include the upper two feet of material in their analyses.

SECTION 2

Response: By: R. Cornish
Date: April 29, 1991

1) In-situ slime settlement will not significantly affect the calculated radiological parameters for the following reasons:

- The in situ slimes will not undergo 50 to 60 inches of settlement. The slime materials will be excavated and mixed with tailings or other windblown soil to produce a mixture which, when recompacted into the pile, will have settling characteristics similar to the rest of the in situ tailings material.

- The in situ tailings will typically be covered by 10 to 30 feet of other materials. They will be buried so deeply that their radiological parameters will not significantly affect the flux of radon from the surface.

- Compaction usually results in a reduction of the coefficient of diffusion (NUREG/CR-3533, Section 4.5) and the additional potential higher moisture content of the compacted sand-slime mixture would also produce a lower radon diffusion coefficient for this material relative to adjacent sand tailings.

2) The slime tailings will be excavated and mixed with sand tailings from Pile 3. The resulting mixture will contain a greater percentage of smaller particles than the sand tailings. The mixture will have a higher water content and a smaller coefficient of diffusion than the sand tailings. To be conservative, the mixture will be assumed to have the same coefficient of diffusion as the sand tailings.

3) The location of the windblown sample 526 is East 65600, North 56800.

4) The empirical formula used to calculate diffusion coefficients is given in NUREG/CR-3533, Section 4.2. This same reference, in Section 4.3, states that the calculated and measured diffusion coefficients may differ by as much as an order of magnitude, particularly at higher moisture saturation. Measured values are preferable to calculations.

5) There never was a pile 8. The locations listed as pile 8 in the November 1987 RAP are 6 locations between piles 2 and 5, plus one location north of pile 3. Samples from random depths were used to determine the emanation coefficient (1987 draft RAP, D-13). A representative sampling of the piles was made at the locations and depths given in Table D.2.7 of the 1987 RAP. This table has been included here for review.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: ______________________ Date: ______________________

Approved By: ______________________ Date: ______________________

Table D.2.7 Radon emanating fractions at the Falls City site

PILE	PARCEL	LOCATION NUMBER	DEPTH (ft.)	MOISTURE DRY WT. %	RADON EMANATION COEFF.	RADIUM (pCi/g)
1	A	84	9-11	45.6	0.26	552
1	A	86	12-14	49.4	0.26	655
1	A	89	14-16	56.3	0.27	558
1	A	90	16-18	47.8	0.24	490
1	A	90	2-4	94.3	0.27	642
1	A	91	0-2	31.0	0.08	11
1	A	95	11-13	52.1	0.36	656
1	A	95	13-15	38.1	0.28	475
1	A	97	2-4	24.2	0.18	16
1	A	105	6-8	62.7	0.28	698
1	A	105	4-6	58.0	0.23	568
1	A	107	6-8	174.3	0.13	943
1	A	107	0-2	29.1	0.12	11
1	A	108	6-7	156.2	0.34	934
2	A	59	8-10	28.9	0.19	274
2	A	59	10-12	28.9	0.17	281
2	A	60	10-12	31.6	0.23	21
2	A	63	4-6	28.2	0.13	524
2	A	64	6-8	54.7	0.21	384
2	A	64	10-12	26.6	0.17	265
2	A	65	8-10	129.3	0.14	1254
2	A	65	4-6	33.2	0.15	458
2	A	71	6-8	29.7	0.19	240
2	A	73	6-8	99.9	0.10	991
2	A	73	8-10	144.2	0.15	1561
2	A	78	0-2	26.0	0.15	16
2	A	78	2-4	48.8	0.19	20
4	A	9	16-18	24.9	0.16	317
4	A	9	8-10	27.4	0.16	637
4	A	9	30-32	29.8	0.22	165
4	A	9	22-24	31.0	0.18	481
4	A	9	12-14	24.2	0.16	413
4	A	10	4-6	12.7	0.18	486
4	A	10	10-12	7.6	0.16	240
4	A	10	14-16	11.0	0.17	297
4	A	11	2-4	9.7	0.15	272
4	A	11	8-10	73.1	0.17	1895
4	A	11	16-18	86.6	0.14	2046
4	A	11	26-28	32.9	0.14	564
5	A	7	12-14b	31.0	0.19	360
5	A	7	4-6	7.3	0.17	175
5	A	7	18-20	108.8	0.21	1733
5	A	7	12-14	31.7	0.19	363
5	A	7	6-8	10.6	0.17	251
5	A	7	10-12	12.1	0.17	257
5	A	8	14-16	13.4	0.21	292
5	A	8	26-28	39.8	0.19	483
5	A	8	10-12	11.3	0.23	227

Table D.2.7 Radon emanating fractions at the the Falls City site (concluded)

PILE	PARCEL	LOCATION NUMBER	DEPTH (ft.)	MOISTURE DRY WT. %	RADON EMANATION COEFF.	RADIUM (pCi/g)
7	A	24	10-12	25.7	0.19	223
7	A	24	2-4	11.2	0.25	92
7	A	24	6-8	27.6	0.23	290
7	A	25	19-21	27.4	0.20	165
7	A	25	12-14	24.6	0.19	200
7	A	25	2-4	9.3	0.18	180
7	A	31	26-28	24.9	0.13	164
7	A	31	10-12	24.6	0.18	162
7	A	31	22-24	28.0	0.19	166
7	A	31	20-22	31.8	0.20	268
7	A	31	24-26	31.9	0.19	290
7	A	31	16-18	25.9	0.19	149
7	A	31	12-14	29.5	0.21	212
7	A	31	14-16	27.3	0.19	168
7	A	31	18-20	27.2	0.18	136
7	A	38	6-8	10.0	0.20	104
7	A	39	6-8	36.2	0.24	89
7	A	44	10-12	21.5	0.20	251
7	A	44	8-10	10.3	0.26	109
7	A	48	14-16	9.8	0.23	221
7	A	49	4-6	19.6	0.27	95
7	A	49	0-2	34.7	0.14	14
7	A	50	10-12	23.4	0.20	295
7	A	53	12-14	12.4	0.18	238
8	A	TP6	2-3	17.1	[illegible]14	265
8	A	147	8-10	34.3	[illegible]6	18
8	A	153	8-10	29.1	[illegible]2	34
8	A	159	8-10	19.9	[illegible].20	38
8	A	190	8-10	57.1	0.16	15
8	A	192	8-10	26.1	0.09	11
8	A	193	8-10	38.9	0.17	17
3	B	TP4	9%	17.1	0.20	288
3	B	TP4	17%	15.9	0.19	301
3	B	TP4	--	15.8	0.18	323
3	B	1	18-20	62.8	0.17	674
3	B	1	8-10	88.6	0.25	1701
3	B	1	12-14	20.4	0.19	387
3	B	1	4-6	10.6	0.21	209
3	B	2	10-12	15.3	0.20	296
3	B	2	16-18	58.2	0.19	702
3	B	2	24-25	73.5	0.16	1026
3	B	4	20-22	42.4	0.17	476
3	B	4	12-14	15.9	0.22	263
3	B	4	6-8	18.0	0.21	294

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 26

Section: 6.2.1.2

The data used to characterize radon barrier material must be evaluated against the proposed material specifications.

SECTION 2

Response: ____________________ By: ____________________
Date: ____________________

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: ____________________ Date: ____________________
Approved By: ____________________ Date: ____________________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas   Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 27

Section: 6.2.2

The radon attenuation analysis must be revisited to determine if any changes in the computer model are required to accurately characterize the system after considering the above comments.

SECTION 2

Response: ____________   By: R. Cornish
Date: April 29, 1991

The radon attenuation parameters have not changed significantly. Therefore, a recalculation using the RAECOM computer model would not alter the initial results.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: ____________   Date: ____________
Approved By: ____________   Date: ____________

UMTRA DOCUMENT REVIEW FORM

SECTION 1

Site: Falls City, Texas Date: 4/1/91
Document: Draft TER
Commentor: NRC

Open Issue: Number 28

Section: 6.3.2

DOE must reevaluate the material that has been considered naturally occurring ore, and if warranted, address its remediation. Otherwise, DOE must establish acceptable identification procedures for this material for NRC concurrence.

SECTION 2

Response: ______________ By: ______________
Date: ______________

Naturally occurring uranium ore which has been moved from its point of origin will be remediated, if present at the Falls City site. The Spook, Wyoming UMTRA Project site also contains naturally occurring uranium ore, and a procedure for its identification has been developed. The Spook procedure, with specific modifications, will be used at the Falls City site. A site geologist will determine the interface between undisturbed strata and tailings.

Plans for Implementation:

SECTION 3

Confirmation of Implementation:

Checked by: ______________ Date: ______________

Approved By: ______________________ Date: ______________________