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SUBJECT: 2005 ANNUAL MOISTURE MONITORING REPORT FOR MATERIAL DISPOSAL AREA AB AT TECHNICAL AREA 49

Dear Mr. Bearzi:

Enclosed please find two hard copies with electronic files of the "2005 Annual Moisture Monitoring Report for Material Disposal Area AB at Technical Area 49."

If you have questions, please contact John McCann (505) 665-1091 (jmccann@lanl.gov) or Tony Trujillo at (505) 845-5987 (ltrujillo@doeal.gov).

Sincerely,

David McInroy, Deputy Program Director
Environmental Remediation & Surveillance
Los Alamos National Laboratory

Sincerely,

David Gregory, Federal Project Director
Department of Energy
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DM/DG/JM/jk

Enclosures: Two hard copies with electronic files – 2005 Annual Moisture Monitoring Report for Material Disposal Area AB at Technical Area 49 (ER2005-0785)

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December 2005
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2005 Annual Moisture Monitoring Report for Material Disposal Area AB at Technical Area 49

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Prepared by
Environmental Stewardship Division–
Environmental Remediation and Surveillance Program

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EXECUTIVE SUMMARY

Material Disposal Area (MDA) AB, located within Technical Area (TA) 49 at Los Alamos National Laboratory, consists of subsurface test shafts in Areas 1, 2, 2A, 2B, 3, and 4, and their surface soils. It is the location of hydronuclear safety, tracer, and containment test experiments that were conducted in deep shafts. Active operations at MDA AB were conducted between 1959 and 1961. TA-49 is an access-controlled area, and MDA AB is posted as an underground radioactive material area.

During fiscal year (FY) 2005, moisture monitoring was performed at MDA AB in December 2004, May 2005, and September 2005. In addition, moisture data were collected continuously from four buried time-domain reflectometry (TDR) probes, allowing the moisture content within the cover material to be measured. Data collected during this period reflected the above-average precipitation at the site during the winter of 2004–2005. However, by September the high subsurface moisture contents recorded in May had returned to levels near the long-term average. Statistical analysis of the moisture monitoring data over the past four years indicates stable and/or decreasing moisture trends in the subsurface of MDA AB.

Water within neutron access hole 2-AY, although always present, rose significantly during the wet winter months. The entire water column was bailed from this borehole in May 2005 and sampled for radiological contamination. The results did not indicate any radiological contaminants above drinking water standards in the samples.

Maintenance and best management practices completed at the site over the past year include repair of the biobarrier mesh after penetration by a gopher, repair of the TDR wiring, installation of steel conduit, installation of telemetry equipment for remote download of the datalogger, and abandonment of historical hydrogeologic investigation holes Alpha and Gamma A.

In FY2006, moisture monitoring of MDA AB will be conducted bimonthly.

CONTENTS

1.0 INTRODUCTION 1

2.0 1998–1999 INTERIM MEASURE 1

3.0 MOISTURE MONITORING RESULTS 3

3.1 Neutron Logging 3

3.2 TDR and Precipitation Measurements 6

4.0 MOISTURE MONITORING RESULTS AND DATA ANALYSIS 7

4.1 Correlation between TDR Measurements and Precipitation Events 8

4.2 TDR and Neutron Comparisons 8

4.3 Student's T-test of Neutron Data 8

5.0 BEST MANAGEMENT PRACTICES AND SITE MAINTENANCE 9

5.1 Water Sampling 9

5.2 Biobarrier Repair 10

5.3 Borehole Abandonment 10

6.0 CONCLUSIONS 11

7.0 SUMMARY 12

8.0 SITE RECOMMENDATIONS 12

9.0 REFERENCES 13

Appendixes

Appendix A Neutron Moisture Measurements

Appendix B Time Versus Moisture Content Plots

Appendix C Condition of Evapotranspiration (ET) Cover

Appendix D 2005 Borehole Abandonment Constructions

Figures

Figure 1.0-1 Location of TA-49 with respect to Laboratory TAs and surrounding land holdings 2

Figure 2.0-1 Location of instrumentation and neutron access holes on *XY* plane at TA-49, MDA AB Area 2 4

Figure 3.1-1 Locations of neutron access holes at TA-49 5

Figure 3.2-1 TDR measurements compared with neutron measurements at neutron access hole 49-10046, which is in close proximity and at the same corresponding depth as TDR 16

Figure 3.2-2 TDR measurements compared with neutron measurements at neutron access hole 49-10048, which is in close proximity and at the same corresponding depth as TDR 3 7

Figure A-1 Neutron probe moisture measurements for neutron access holes TH-1 and TH-2 ..... A-1
Figure A-2 Neutron probe moisture measurements for neutron access holes TH-3 and TH-4 ..... A-2
Figure A-3 Neutron probe moisture measurements for neutron access holes TH-5 and 2-A0 ..... A-3
Figure A-4 Neutron probe moisture measurements for neutron access holes 2-AY and 2-BY A-4
Figure A-5 Neutron probe moisture measurements for neutron access holes 49-10046 and 49-10047 ..... A-5
Figure A-6 Neutron probe moisture measurements for neutron access holes 49-10048 and 1M-3 .... A-6
Figure A-7 Neutron probe moisture measurements for neutron access holes 1M-3A and 2M-3 ..... A-7
Figure A-8 Neutron probe moisture measurements for neutron access holes 4M-4 and 5M-1 ..... A-8
Figure A-9 Neutron probe moisture measurements for neutron access holes 4M-3 and 49-2901 using geophysics A-9
Figure A-10 Neutron probe moisture measurements for neutron access hole 49-2901 utilizing ENV-ECR geophysical acquisition package A-10
Figure B-1 Trend plot of neutron moisture measurements, neutron access hole TH-1 ..... B-1
Figure B-2 Trend plot of neutron moisture measurements, neutron access hole TH-2 ..... B-1
Figure B-3 Trend plot of neutron moisture measurements, neutron access hole TH-3 ..... B-2
Figure B-4 Trend plot of neutron moisture measurements, neutron access hole TH-4 ..... B-2
Figure B-5 Trend plot of neutron moisture measurements, neutron access hole TH-5 ..... B-3
Figure B-6 Trend plot of neutron moisture measurements, neutron access hole 2-AO B-3
Figure B-7 Trend plot of neutron moisture measurements, neutron access hole 2-AY B-4
Figure B-8 Trend plot of neutron moisture measurements, neutron access hole 2-BY B-4
Figure B-9 Trend plot of neutron moisture measurements, neutron access hole 49-10046 ..... B-5
Figure B-10 Trend plot of neutron moisture measurements, neutron access hole 49-10047 ..... B-5
Figure B-11 Trend plot of neutron moisture measurements, neutron access hole 49-10048 ..... B-6
Figure B-12 Trend plot of neutron moisture measurements, neutron access hole 1M-3 ..... B-6
Figure B-13 Trend plot of neutron moisture measurements, neutron access hole 1M-3A B-7
Figure B-14 Trend plot of neutron moisture measurements, neutron access hole 2M-3 ..... B-7
Figure B-15 Trend plot of neutron moisture measurements, neutron access hole 4M-4 ..... B-8
Figure B-16 Trend plot of neutron moisture measurements, neutron access hole 5M-1 ..... B-8
Figure B-17 Trend plot of neutron moisture measurements, neutron access hole 4M-3 ..... B-9
Figure D-1 ET cover from outside Area 2 showing the new steel conduit D-1
Figure D-2 ET cover from inside fence of Area 2 showing the new steel conduit D-1

Tables

Table 2.0-1 TDR Array Descriptions 4
Table 4.3-1 Results of the Student T-test Analysis, Based on a 95% Confidence Interval 9
Table 5.1-1 Summary of Analytical Results for Water Sample from Neutron Access Hole 2A-Y 10

1.0 INTRODUCTION

Material Disposal Area (MDA) AB, located within Technical Area (TA) 49 at Los Alamos National Laboratory (the Laboratory), consists of subsurface test shafts in Areas 1, 2, 2A, 2B, 3, and 4, and their surface soils. Figure 1.0-1 shows the location of TA-49 with respect to Laboratory TAs and surrounding land holdings. TA-49 is the location of hydronuclear safety, tracer, and containment test experiments historically conducted in deep shafts. TA-49 is an access-controlled area, and MDA AB is posted as an underground radioactive material area.

An evapotranspiration (ET) cover was installed after an asphalt pad was removed during the interim measure (IM) implemented in 1998 at the direction of New Mexico Environment Department–Hazardous and Radioactive Materials Bureau (NMED-HRMB). The area was covered with soil, gravel, biobarrier, and seeded as part of stabilization activities. The IM was conducted to address concerns about moisture accumulation beneath the asphalt pad. Moisture monitoring at MDA AB is conducted every two months to measure subsurface moisture levels and assess the performance of the ET cover.

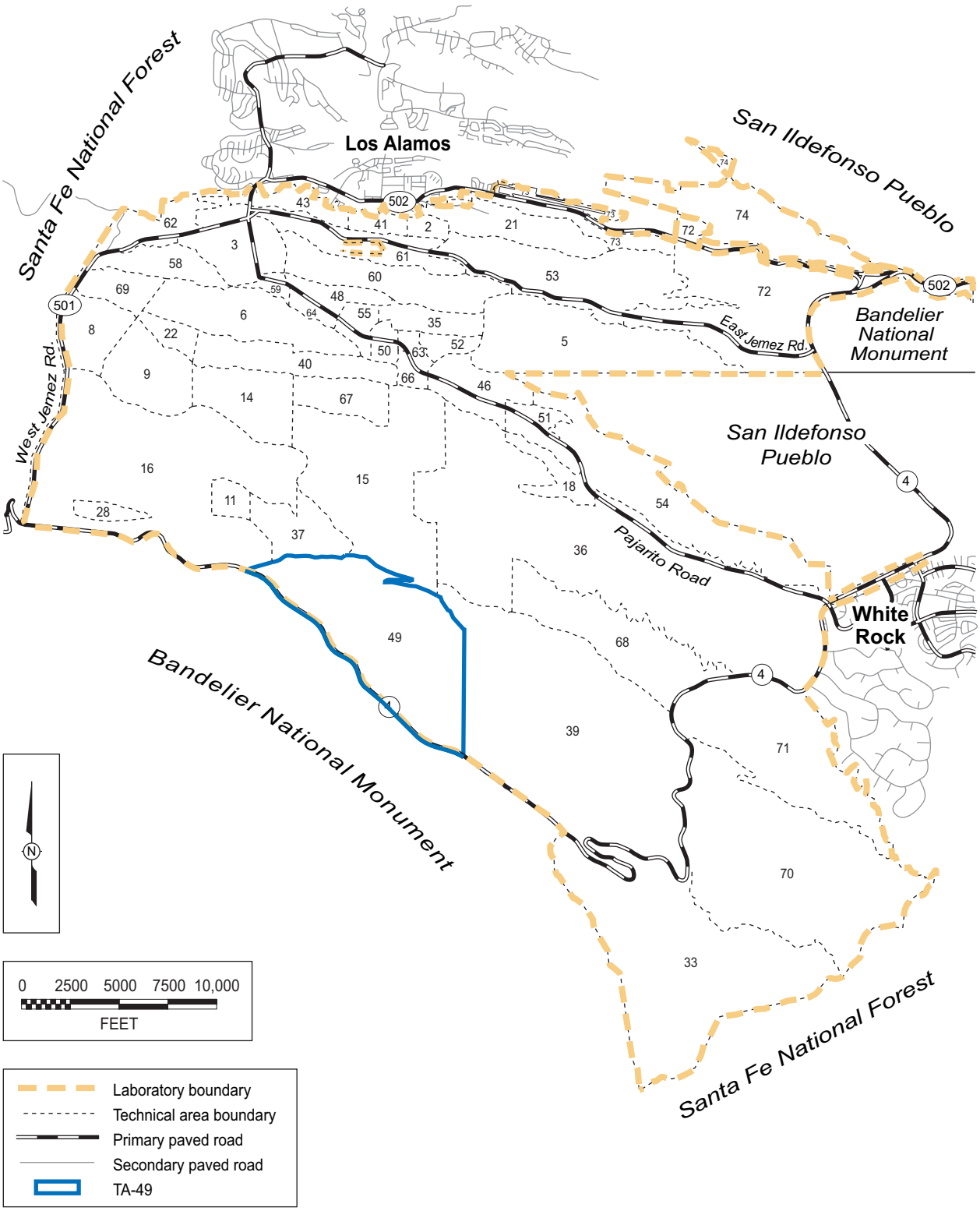
The moisture monitoring program at MDA AB is required by the NMED-approved stabilization plan Solid Waste Management Units 49-001 (b,c,d, and g) (LANL 1998, 59166). This annual moisture monitoring report describes the activities that occurred during fiscal year (FY) 2005 in support of the performance monitoring of the Area 2 cover and the maintenance of the completed IM.

2.0 1998–1999 INTERIM MEASURE

In 1998–1999, the IM and associated best management practice (BMP) activities conducted at Area 2 included the following:

- installation of a run-on diversion channel to the west of Area 2;
- removal of the asphalt cover over Area 2;
- regrading of the Area 2 surface to eliminate surface-water ponding;
- grouting and abandonment of CH-2 and the two 150-ft-deep Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) neutron access holes;
- installation of an ET cover composed of crushed tuff monofill with topsoil and covered with a steel mesh biobarrier;
- installation of a silt fence surrounding the ET cover to control both erosion and contaminant transport; and
- seeding the ET cover with shallow-rooting grasses.

For details on the 1998–1999 BMP at Area 2, refer to documents produced by the former Environmental Restoration Project (LANL 1998, 59166; LANL 1998, 63041; and LANL 1999, 63919).



F1.0-1, 2005 Annual Moist. Mon. Rpt. for MDA AB, 102605, ptm

Figure 1.0-1. Location of TA-49 with respect to Laboratory TAs and surrounding land holdings

In February 2000, a moisture-monitoring system was installed to monitor the ET cover at Area 2. Three shallow neutron logging access tubes were installed through the ET cover, and time-domain reflectometry (TDR) probes were installed at two depths and at two locations in the ET cover. The TDR probes were wired into a Campbell Scientific, Inc., datalogger for automated measurements. The moisture-monitoring system uses three neutron access holes, four TDR probes, and a rain gauge to evaluate the moisture content and relative changes within and beneath the new cover material. Additionally, eight neutron access holes located in the surrounding area are monitored for moisture content every two months. (Monitoring had been conducted monthly until the first quarter of FY2002.) These neutron access holes characterize the moisture content of undisturbed areas immediately adjacent to the cover area. It is anticipated that the new cover material will behave much like the native undisturbed areas, thus restoring the semiarid, moisture-limited, near-surface environment. Monitoring began at six newly located access holes in the fourth quarter of FY2003. These locations provide additional subsurface moisture data from outside of Area 2, allowing for further comparison and investigation of moisture infiltration and ET across TA-49.

Moisture monitoring began in March 2000 in accordance with Standard Operating Procedure (SOP) 07.05, Rev. 2, “Subsurface Moisture Measurements Using a Neutron Probe.” Neutron logging is performed with a dedicated CPN 503DR probe. The TDR probes record moisture-content measurements twice a day. The two TDR arrays are located adjacent to neutron access holes 49-10046 and 49-10048 for data comparison and confirmation. The arrays consist of a shallow TDR probe positioned horizontally beneath the surface soil (approximately 6 in.) and another positioned vertically beneath the cover materials at 10 ft and 6 ft, respectively. The shallow probes are positioned to detect infiltration through the topsoil. A rain gauge located at the surface of the cover near neutron access hole 49-10046 monitors the levels of precipitation at the site. Continuous measurement of site precipitation and the 12-hr TDR data characterize infiltration response of the cover to rain events. Figure 2.0-1 shows the locations of neutron access holes, TDR probes, the cover, and the gopher barrier boundary. Table 2.0-1 gives the corresponding depths of the TDR probes.

3.0 MOISTURE MONITORING RESULTS

3.1 Neutron Logging

Neutron-logging took place in December 2004 and in May and September 2005 using a dedicated CPN 503DR. Logging could not be completed during the past year because the neutron probe required repairs. In addition, only a subset of all boreholes was sampled in December 2004 because the neutron probe malfunctioned during the monitoring event. The neutron counts from each of the monitoring holes were recorded on a spreadsheet, and the corresponding volumetric moisture content was calculated. Moisture data from the access holes sampled in 2005 were compared to the average from April 2000 to September 2004. The plots of volumetric moisture content for each sampling period and all of the access holes are presented in Appendix A.

Neutron access hole 49-2901, located near TH-1 (Figure 3.1-1), is 700 ft deep. During the second quarter of 2004, unused instrumentation was removed from this borehole, leaving it open for neutron measurements. For three quarters, this borehole was neutron logged to a depth of 130 ft, the maximum cable length available at the time. However, the Environmental Stewardship Division–Environmental Characterization and Remediation (ENV-ECR) geophysics system (manufactured by Mount Sopris) was used in the fourth quarter of 2005 to neutron log this hole over its total available depth.

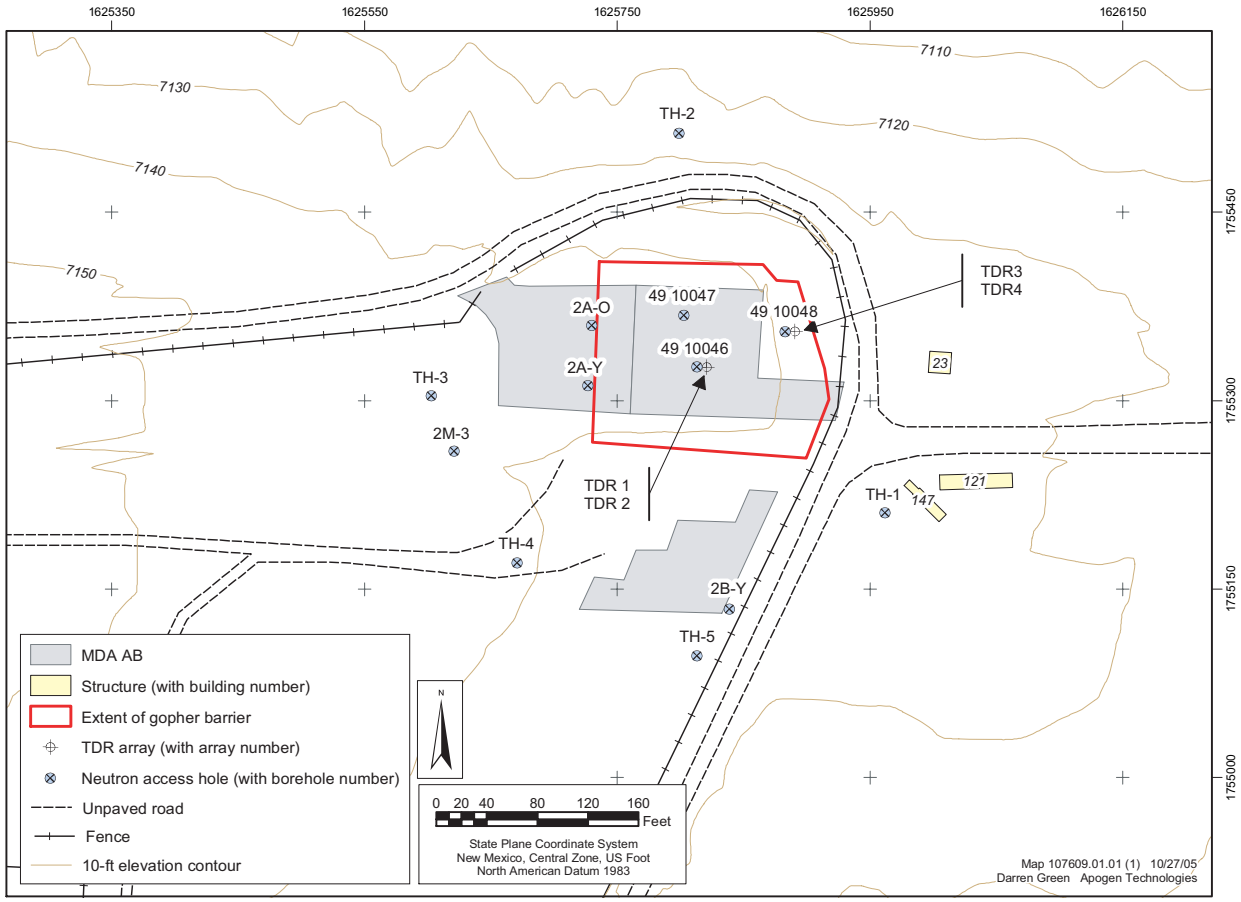


Figure 2.0-1. Location of instrumentation and neutron access holes on *XY* plane at TA-49, MDA AB Area 2

Table 2.0-1
TDR Array Descriptions

TDR Number	Array Type	Depth (ft)
TDR1	Vertical, within soil overlaying Bandelier Tuff	6
TDR2	Horizontal, at bottom of topsoil	0.5
TDR3	Vertical, within El Cajete pumice formation	10
TDR4	Horizontal, at bottom of topsoil	0.5

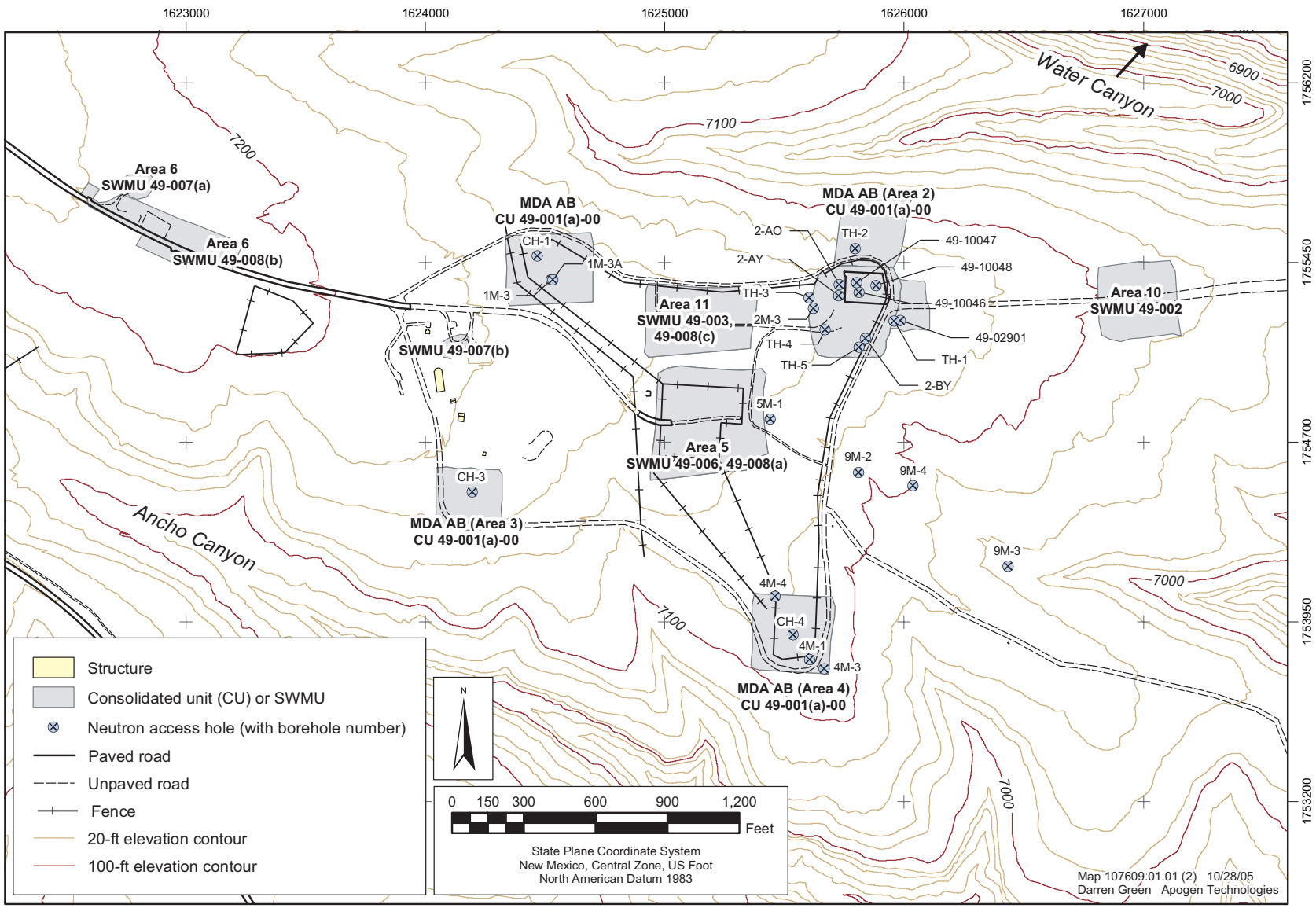


Figure 3.1-1. Locations of neutron access holes at TA-49

Data from this neutron access hole are presented in a combination of three plots in Appendix A. Figure A-9 shows the volumetric moisture, calculated from neutron probe measurements, from March 2004 to May 2005. Figure A-10 shows neutron data in counts per second, as acquired from the ENV-ECR geophysics system, over the interval of 0–130 ft below ground surface (bgs), and 0–689 ft bgs. These data cannot be correlated with volumetric moisture content data at this time because of a lag in counts in the geophysics system. Since no laboratory results for moisture content are available from this borehole to create a borehole-specific calibration, further investigation into the programming of the Mount Sopris data acquisition system is necessary. However, the counts per second recorded by the geophysics system show trends similar to the historical volumetric moisture contents derived from data collected by the CPN 503DR.

3.2 TDR and Precipitation Measurements

TDR measurements and precipitation quantities were collected twice a day and recorded to a Campbell Scientific datalogger programmed to record a timestamp, temperature, TDR raw frequencies, and precipitation in inches. The program converts raw frequency to volumetric moisture content and then records the data (both raw and converted) to a *.dat file. Figures 3.2-1 and 3.2-2 present the moisture content within the ET cover and precipitation measurements from April 2000 through September 2005. The precipitation data were obtained from the Laboratory's TA-49 weather station.

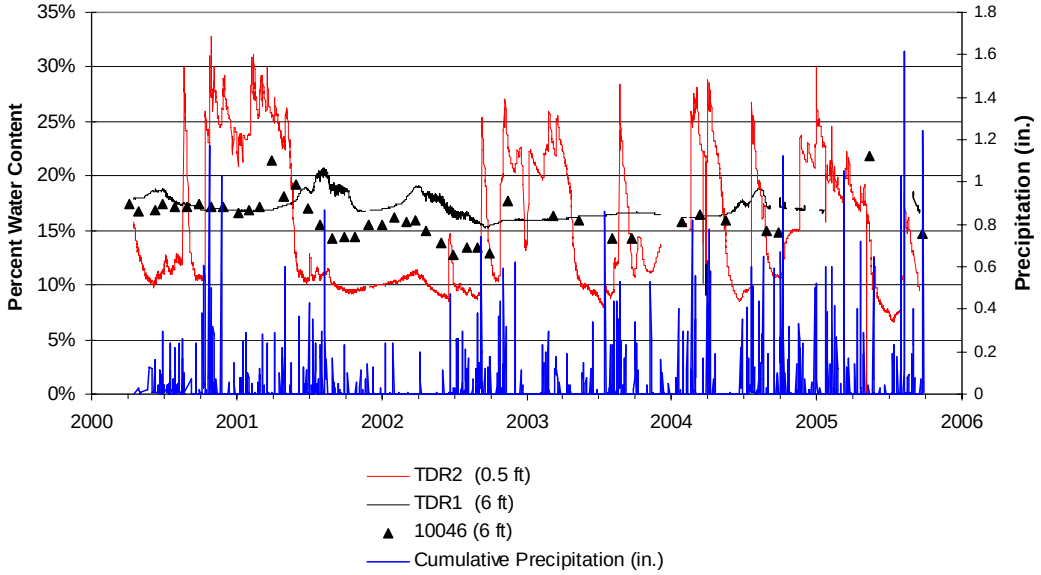


Figure 3.2-1. TDR measurements compared with neutron measurements at neutron access hole 49-10046, which is in close proximity and at the same corresponding depth as TDR 1

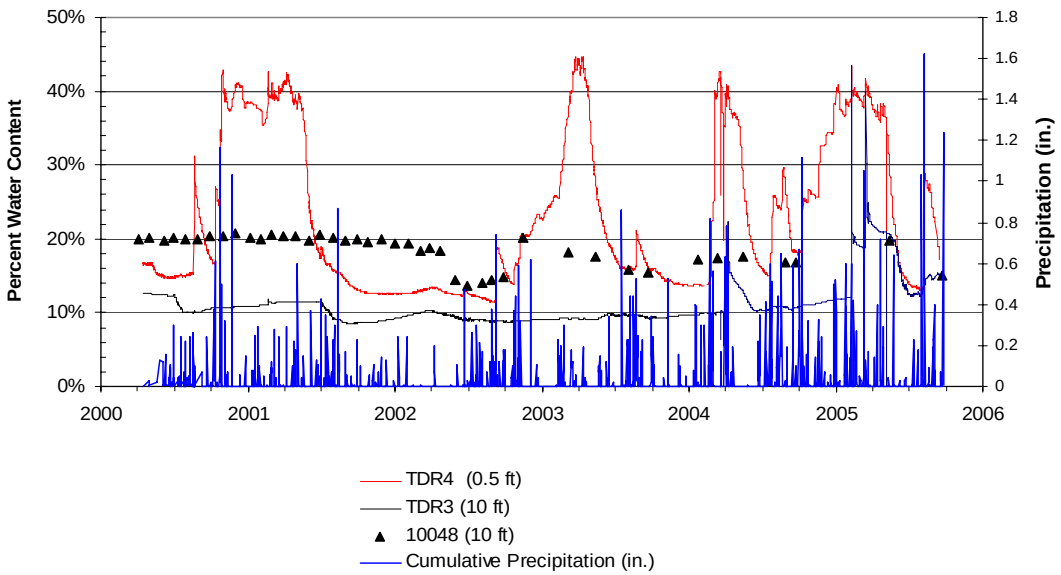


Figure 3.2-2. TDR measurements compared with neutron measurements at neutron access hole 49-10048, which is in close proximity and at the same corresponding depth as TDR 3

On September 3, 2004, TDR 1 shorted out as a result of damage by gophers. This damage, along with the deterioration of the polyvinyl chloride (PVC) conduit from solar radiation, led to the removal of the existing 4-in. PVC conduit, which was replaced with 2-in.-diameter electric metallic tubing (EMT) conduit (thin-walled, galvanized steel piping). At this time, all the wiring was removed and replaced with heavy duty multiconductor shielded cables. The signal from TDR 1 was restored as a result of this rewiring, and the likelihood of further gopher damage has decreased significantly.

Additional maintenance of the TDR system and datalogger included the installation of a cell phone and modem-based telemetry system in May 2005 to provide remote access of the datalogger.

4.0 MOISTURE MONITORING RESULTS AND DATA ANALYSIS

Data from TDR and neutron logging collected from April 2000 to September 2005 show fluctuations in volumetric moisture content in the near surface of all neutron access holes affected by shallow infiltration of precipitation. Deeper measurements indicate the moisture trends are relatively steady, while a few trends have decreased (Appendix A). Trend plots of time versus moisture content were created for specific depth intervals (Appendix B).

During the neutron logging event on May 16, 2005, three neutron access holes (TH-3, 2-AO, and 2-AY) showed abnormally high counts per second. The results of logging compared to the average readings are shown in Figures A-2, A-3, and A-4, respectively. The abnormally wet winter may have affected the May readings. The total precipitation at TA-49 (as recorded by the ENV–Meteorology and Air Quality Group weather station) during the second quarter of FY2005 was 6.61 in.; the total reported for Los Alamos was 2.99 in. (source: www.weather.com). Neutron logging of these access holes in September 2005 resulted in moisture contents near the historical average.

4.1 Correlation between TDR Measurements and Precipitation Events

During FY2005, the results of the shallow TDR probes at 0.5 ft ranged from between 8% and 30% (TDR 2) and 15% to 40% (TDR 4) volumetric moisture content from moisture infiltrating the first few feet of soil during and after precipitation events. By contrast, with two exceptions, the results of deeper TDR probes have remained constant through the year, ranging from between 15% and 20% for TDR 1 (6 ft) and 8% to 15% for TDR 3 (10 ft). The two exceptions are shown in Figure 3.2-2 when TDR 3 spiked to 42% on February 12, 2005, and 40% on March 20, 2005. TDR 1 did not show this same spike on February 12, 2005, and it was not operating on March 20, 2005. The high moisture content at TDR 3 on February 12, 2005, may be attributed to a 0.97 in. rainfall event on February 11 and 12, 2005. The high moisture content at TDR 3 on March 20, 2005, may be attributed to a snowfall event from March 13 through 15, 2005, which deposited an equivalent of 1.31 in. of water at the site. This snowfall did not begin to melt until March 17, 2005, when temperatures finally rose above freezing.

4.2 TDR and Neutron Comparisons

The moisture-monitoring system is performing as expected with consistent results between TDR arrays and neutron logging. Figures 3.2-1 and 3.2-2 show the deep TDR data associated with neutron access holes 49-10046 and 49-10048, respectively, for comparison with data from the collocated TDR instrumentation. The neutron probe data from the same depth as the deep TDR probes are also presented. The measurements are largely in agreement, differing by less than 2%.

4.3 Student’s T-test of Neutron Data

A Student’s t-test analysis was performed to statistically track trends in moisture over time for each of the neutron access holes. This test evaluates the significance of an apparent trend based on a selected confidence interval. For the purpose of this analysis, a 95% confidence interval was selected. Table 4.3-1 shows the results of the Student t-test analyses.

As of September 2005, approximately 45 months of data events were available for statistical analysis for monitoring holes in Area 2. Table 4.3-1 presents the results of the Student’s t-test analyses for each of these neutron access holes. The trending analysis results show that moisture levels have decreased since measurements began in April 2000. The five “M” neutron access holes spread across TA-49, for which logging began in the fourth quarter of 2003 and 4M-3 for which logging began in third quarter of 2004, are included in this table. Between six and ten months of data were available for statistical analysis for the M-holes, depending upon the hole.

In addition to the Student’s t-test analyses, trend plots of time versus moisture content for specific depth intervals in neutron access holes are shown in Figures B-1 through B-16 in Appendix B.

Table 4.3-1
Results of the Student T-test Analysis, Based on a 95% Confidence Interval

Neutron Access Hole Number	Moisture Trending Results
TH-1	Analysis shows a decreasing moisture trend from 1 to 111 ft
TH-2	Analysis shows a decreasing moisture trend from 6 to 104 ft
TH-3	Analysis shows a decreasing moisture trend from 61 to 85 ft, 96 to 105 ft
TH-4	Analysis shows a decreasing moisture trend from 1 to 10 ft, and 21 to 90 ft
TH-5	Analysis shows a decreasing moisture trend from 6 to 114 ft
2B-Y	Analysis shows no significant change in moisture trends
2A-Y	Analysis shows an increasing moisture trend from 6 to 27 ft
2A-O	Analysis shows an increasing moisture trend from 26 to 59 ft
49-10046	Analysis shows a decreasing moisture trend from 7 to 13 ft
49-10047	Analysis shows a decreasing moisture trend from 7 to 12 ft
49-10048	Analysis shows a decreasing moisture trend from 5 to 12 ft
1M-3	Analysis shows a decreasing moisture trend from 16 to 18 ft
1M-3A	Analysis shows an increasing moisture trend from 6 to 10 ft and a decreasing moisture trend from 21 to 30 ft
2M-3	Analysis shows no significant change in moisture trends
4M-3	Analysis shows an increasing moisture trend from 11 to 15 ft
4M-4	Analysis shows no significant change in moisture trends
5M-1	Analysis shows an increasing moisture trend from 6 to 10 ft

5.0 BEST MANAGEMENT PRACTICES AND SITE MAINTENANCE

5.1 Water Sampling

Neutron access hole 2A-Y was installed at test shaft location 2A-Y. This access hole was drilled in 1980 to a depth of 80 ft, is cased with 2-in.-diameter PVC to a depth of 31.75 ft, and has collapsed below the casing. Neutron access hole 2A-Y has had a small quantity of standing water in the bottom since neutron logging began in 2000. As a result of the wet winter in 2004–2005, the water column in this hole rose to a depth of nearly 2 ft. The water was bailed on June 27, 2005, and submitted to the Sample Management Office (SMO) for radionuclide analysis (gross alpha, gross beta, gamma spectroscopy). The water sample was unfiltered and contained a large amount of clay-rich sediment. Analysis of the water sample showed a gross beta concentration of 37.01 pCi/L, with no other analytes detected (Table 5.1-1). The gross beta level may represent in part naturally occurring radionuclides, such as potassium-40; however, beta-only emitters such as strontium-90 or tritium cannot be excluded. The detectable level of gross beta activity in the water is below the U.S. Environmental Protection Agency (EPA) limit for drinking water of 4 mrem/yr, where an activity (excluding potassium-40) of 50 pCi/L gross beta is the lowest level of concern set in 40 CFR Parts 9, 141, and 142. When 2A-Y was neutron logged on September 28, 2005, a 1-ft water column was present. This amount of water column is consistent with historical measurements.

Table 5.1-1
Summary of Analytical Results for Water Sample from Neutron Access Hole 2A-Y

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (pCi/L)	Frequency of Detects above Background Value
Americium-241	Groundwater, intermediate depth, perched	1	0	[5.813707 to 5.813707]	0/1
Cesium-134	Groundwater, intermediate depth, perched	1	0	[-3.288532 to -3.288532]	0/1
Cesium-137	Groundwater, intermediate depth, perched	1	0	[-3.160709 to -3.160709]	0/1
Cobalt-60	Groundwater, intermediate depth, perched	1	0	[1.48568 to 1.48568]	0/1
Europium-152	Groundwater, intermediate depth, perched	1	0	[-4.195175 to -4.195175]	0/1
Sodium-22	Groundwater, intermediate depth, perched	1	0	[8.693627 to 8.693627]	0/1
Uranium-235	Groundwater, intermediate depth, perched	1	0	[0.7775123 to 0.7775123]	0/1
Gross alpha	Groundwater, intermediate depth, perched	1	0	[5.98 to 5.98]	0/1
Gross beta	Groundwater, intermediate depth, perched	1	1	37.01 to 37.01	1/1

5.2 Biobarrier Repair

On September 28, 2004, it was discovered that a gopher had penetrated the biobarrier adjacent to the concrete pad surrounding neutron access hole 49-10046. An inadequate number of clips between bio-barrier sheets had allowed the gopher to slip through and dig into the ET cover. Following this discovery, the gopher's spoil pile was screened by a Health, Safety, and Radiation Protection Group radiation control technician and deemed to be at or below instrument background for the surface of the site. The soil was then spread across the cover and the biobarrier repaired. No further signs of gopher intrusion have been observed since the barrier was repaired.

5.3 Borehole Abandonment

Boreholes Alpha and Gamma A were abandoned during the fourth quarter of FY2005. These boreholes were advanced in 1960 as hydrogeological test holes. Alpha was located west of Areas 2 and 4, with a diameter of 2 ft and a depth of 189 ft. Gamma A was located in Ancho Canyon to the south of Area 4, with a diameter of 4 in. and a depth of 56 ft. The borehole locations are shown in Figure 3.2-1. These boreholes were not used for periodic testing or monitoring; nor were there any foreseeable future uses for these boreholes. The exploratory boreholes were abandoned for the following reasons:

- The exploratory boreholes provided a potential rapid conduit for moisture or other unwanted constituents into the subsurface.
- No construction diagrams or records exist.

- Large diameter boreholes cannot be utilized for vadose zone monitoring.
- Gamma A was located in a canyon-bottom flood plain.
- Neither borehole encountered saturated intervals at time of drilling, nor did any contain water at the time of abandonment.
- These boreholes are not required for future remediation projects.

Borehole abandonment activities began on September 26, 2005, and were completed on October 3, 2005. Boreholes Alpha and Gamma A, drilled for a hydrogeologic investigation in 1960, were abandoned per SOP-5.03, Rev. 3, "Monitor Well and RFI Borehole Abandonment." The constructions are described below.

Alpha

The corrugated steel casing was cut flush at ground surface, with 7.5 ft left in the borehole. This borehole was sealed in three stages.

- *Stage 1:* A cement/sand slurry was placed from total depth to a level of 10.5 ft bgs. The slurry consisted of water, cement, and sand at a ratio of approximately 1:2:8 by weight that had been prepared and delivered by Los Alamos Transit Mix.
- *Stage 2:* A soft bentonite grout was placed on top of the cement/sand slurry over the interval of 10.5 ft bgs to 2 ft bgs. The soft bentonite grout consisted of water, cement, and bentonite at a ratio of 10:3:1 by weight. Type I/II Portland cement and Baroid Aquagel Gold Seal (200 mesh bentonite powder) were used.
- *Stage 3:* A concrete cap constructed of standard 4000 pounds per square inch concrete was placed over the soft bentonite grout and domed over the former borehole. A brass cap was placed in the center of this dome for future identification and geographic reference.

Gamma A

The 4-in.-diameter steel casing was removed, and the borehole was sealed in two stages.

- *Stage 1:* Bentonite pellets (1/4 in.) were placed from total depth to 1 ft bgs and hydrated in 5-ft lifts.
- *Stage 2:* A cement seal consisting of Type I/II Portland cement was placed from 1 ft bgs to the surface.

Appendix C, "2005 Borehole Abandonment Constructions," presents diagrams of the construction described above.

6.0 CONCLUSIONS

Analysis of the moisture monitoring data collected over the past year leads to the following conclusions:

- The neutron log and TDR data indicate that subsurface moisture levels fluctuate in the near surface (<10 ft) and remain constant at greater depth, as expected in a moisture-limited, semiarid climate.

- Total precipitation at TA-49 was above average during the first and second quarters (5.21 in. and 6.61 in., respectively) and below average during the third and fourth quarters (2.7 in. and 7.84 in., respectively) of FY2005 (source: www.weather.com).
- The moisture levels within the cover at the majority of the locations have decreased when compared to the average moisture levels from third quarter FY2000 to fourth quarter FY2005. The shallow TDR probes have shown moisture-content responses to relatively small rainfall events, while the deeper probes (>6 ft) have remained constant. This finding can be attributed to precipitation detected in the near-surface with no deep infiltration.
- The data from neutron access holes 49-10046, 49-10047 and 49-10048 show that the moisture content of the ET cover has decreased.
- In access holes adjacent to the ET cover (TH-3, TH-4, and TH-5), the moisture levels have decreased to depths up to 114 ft.
- The data from moderate depth (<60 ft) neutron access hole 2A-Y, which borders the ET cover, has not yielded a significant change in moisture content.
- The cover over Area 2 has shown substantial growth of vegetation. Photographs of the Area 2 cover during the fourth quarter of FY2005 are included in Appendix D.
- Damage to the TDR data collection system indicates that gophers were present and active within Area 2; thus, new steel conduit was installed and the instrumentation rewired. As a result, the TDRs were not operating for approximately one week in the fourth quarter of FY2004.

7.0 SUMMARY

Routine moisture monitoring and site inspections conducted since March 2000 have shown the ET cover, and additional installations part of the 1998 IM, to be successful in eliminating run-on, reducing surface-water ponding, promoting ET, and stabilizing subsurface moisture contents. This finding is supported by the reduction and/or stabilization of the subsurface moisture content within the covered area. The increased vegetation, site BMPs, and steel-mesh biobarrier have controlled runoff, erosion, and biointrusion (with the exception of the recent gopher activity at neutron access hole 49-10046 during fourth quarter FY2004), thus reducing the potential for contaminant migration and cover degradation. However, because of the increasing age of the cover and the erosion control measures at Area 2, the physical condition should be carefully monitored, and small maintenance projects implemented to avoid significant deterioration.

Statistical analysis of the moisture monitoring data over the past four years indicates stable and decreasing moisture trends in the deep boreholes surrounding the Area 2 cover. Significant variability in subsurface moisture content has been observed only in the TDR data and reflects neutron measurements at shallow depths in boreholes through, or directly adjacent to, the cover. These results indicate that the cover's performance is best monitored through continuous TDR data collection, coupled with periodic collection of neutron probe data to provide a correlation for TDR data, and allow for analysis of the deep hydrogeological stability of Area 2.

8.0 SITE RECOMMENDATIONS

It is recommended that Laboratory personnel meet with the NMED staff to discuss and present data that has shown continuously declining subsurface moisture contents at Area 2, with the intent of further reducing or modifying the current monitoring frequency. Also, in addition to the required moisture

monitoring activities, the presence of water in neutron access hole 2A-Y should be further investigated to determine reasons for the variability in volume. At a minimum, the work should include gamma logging and additional water sampling.

9.0 REFERENCES

LANL (Los Alamos National Laboratory), June 1998. “Stabilization Plan for Implementing Interim Measures and Best Management Practices at Potential Release Sites 49-001(b, c, d, and g),” Los Alamos National Laboratory document LA-UR-98-1534, Los Alamos, New Mexico. (LANL 1998, 59166)

LANL (Los Alamos National Laboratory), September 1998. “Best Management Practices Report for Installation of Stabilization Measures at Potential Release Sites 49-001(b, c, d, and g),” Los Alamos National Laboratory document LA-UR-98-4170, Los Alamos, New Mexico. (LANL 1998, 63041)

LANL (Los Alamos National Laboratory), August 1999. “Interim Measures Report for Potential Release Sites 49-001(b), 49-001(c), 49-001(d), 49-001(g),” Los Alamos National Laboratory document LA-UR-99-2169, Los Alamos, New Mexico. (LANL 1999, 63919)

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Appendix A

Neutron Moisture Measurements

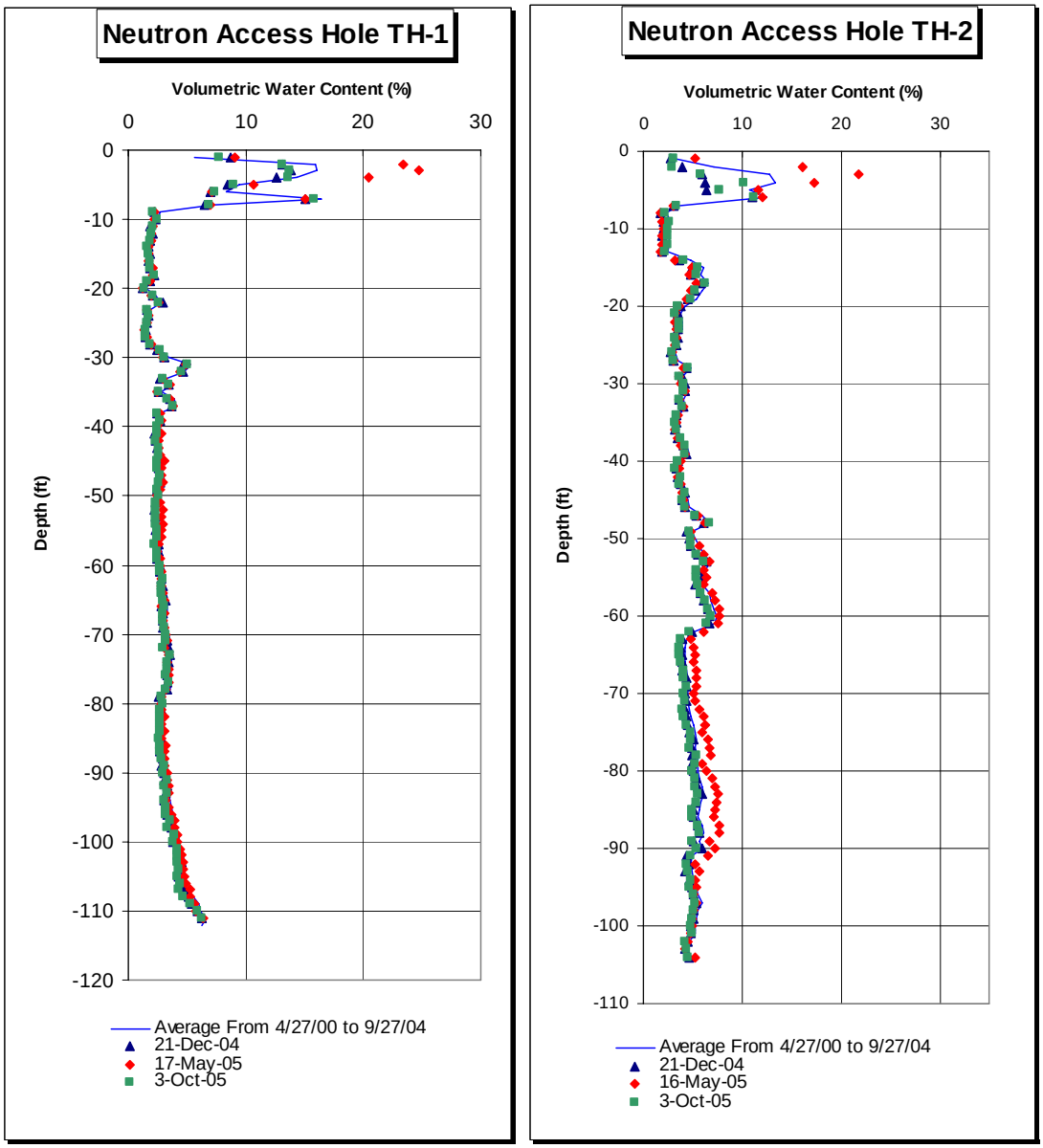

Figure A-1. Neutron probe moisture measurements for neutron access holes TH-1 and TH-2

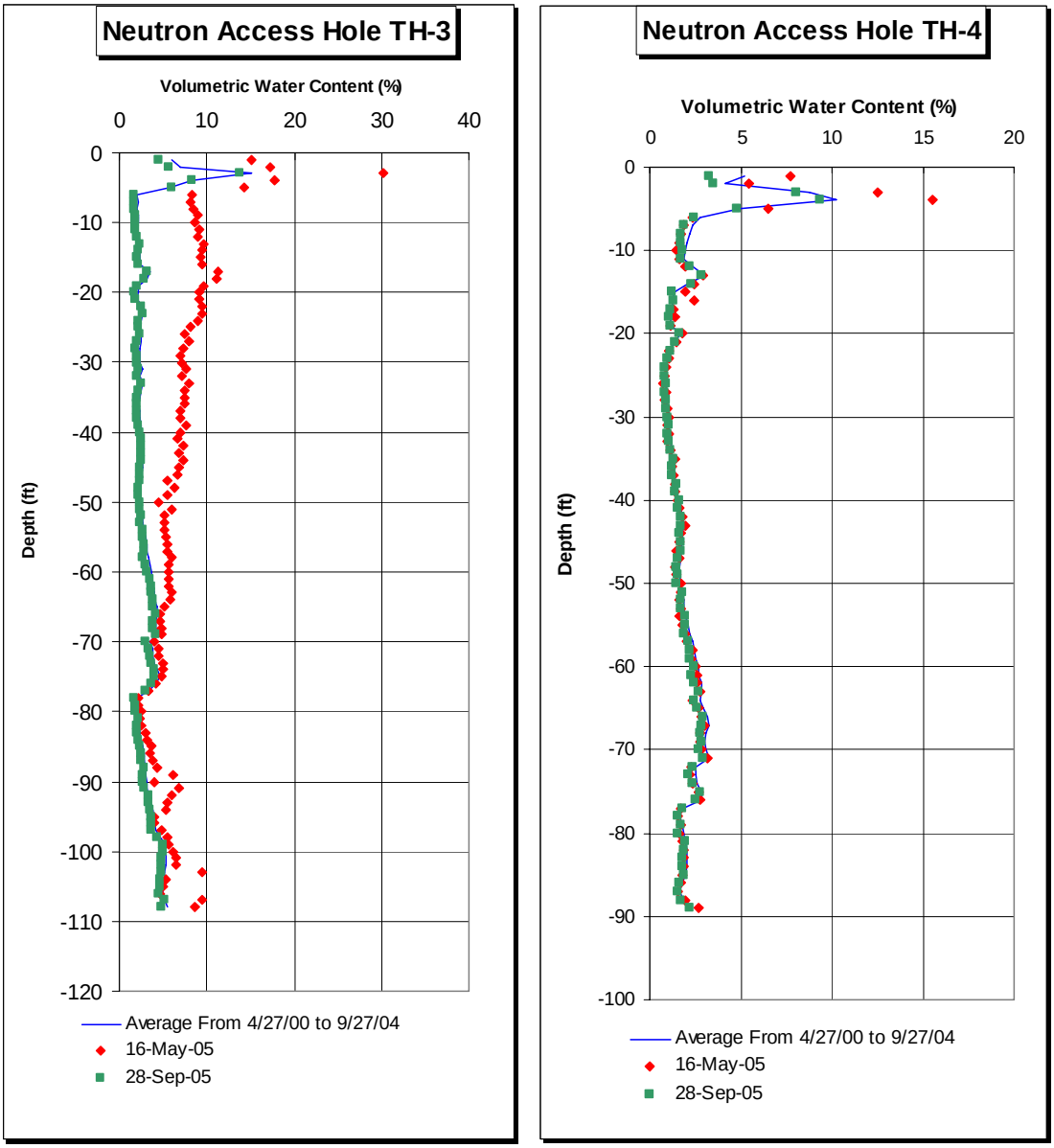

Figure A-2. Neutron probe moisture measurements for neutron access holes TH-3 and TH-4

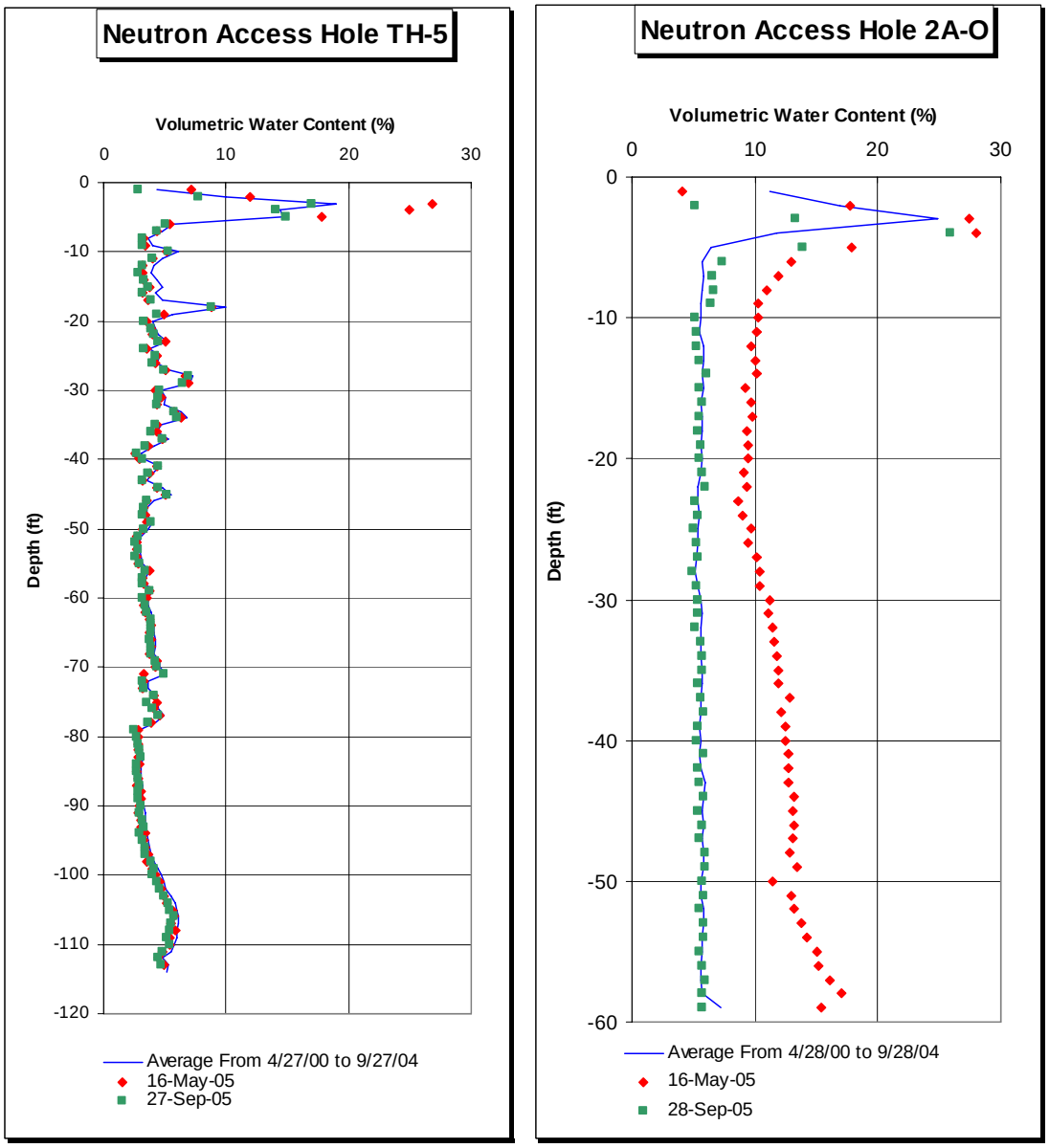

Figure A-3. Neutron probe moisture measurements for neutron access holes TH-5 and 2-A0

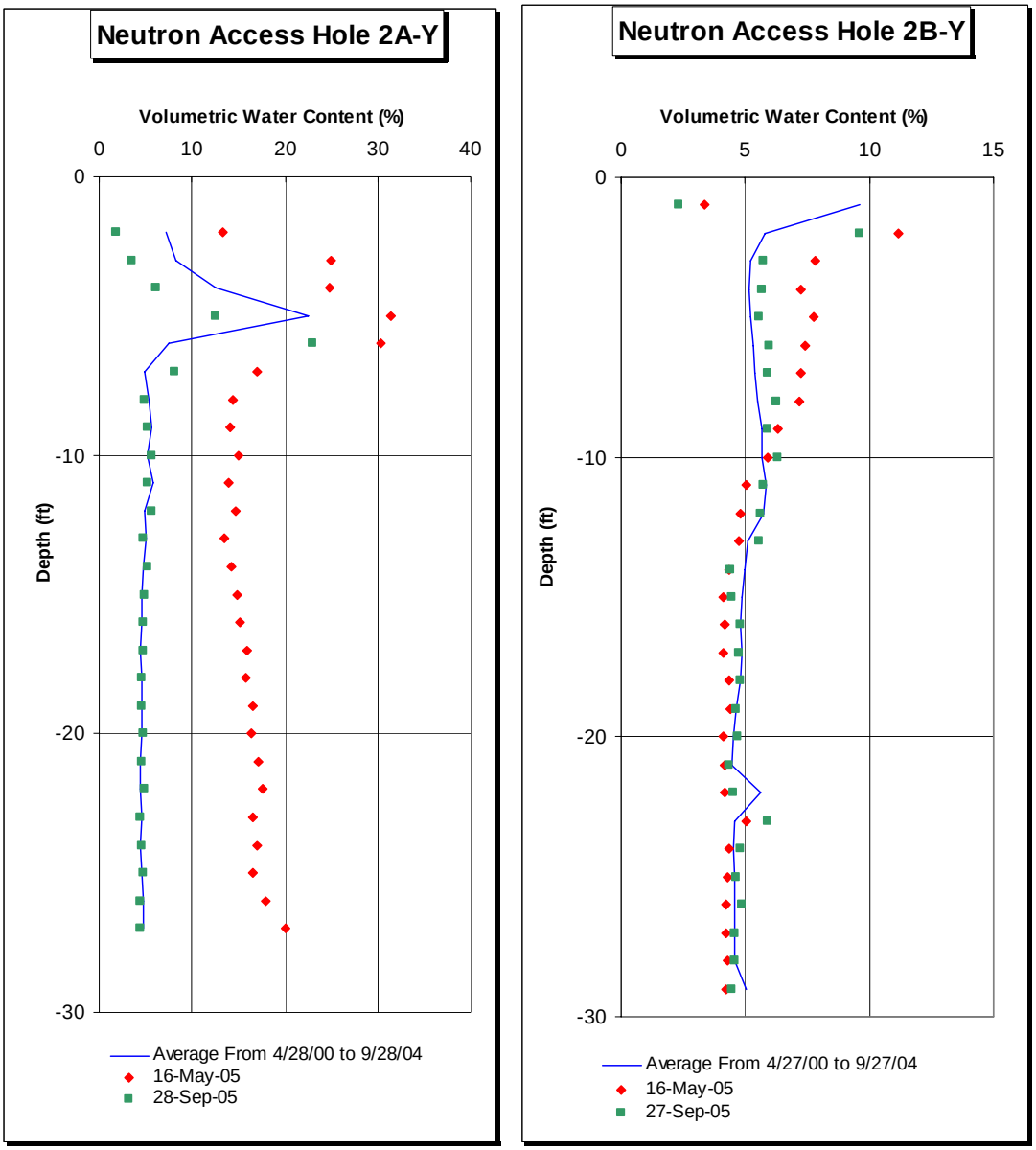

Figure A-4. Neutron probe moisture measurements for neutron access holes 2-AY and 2-BY

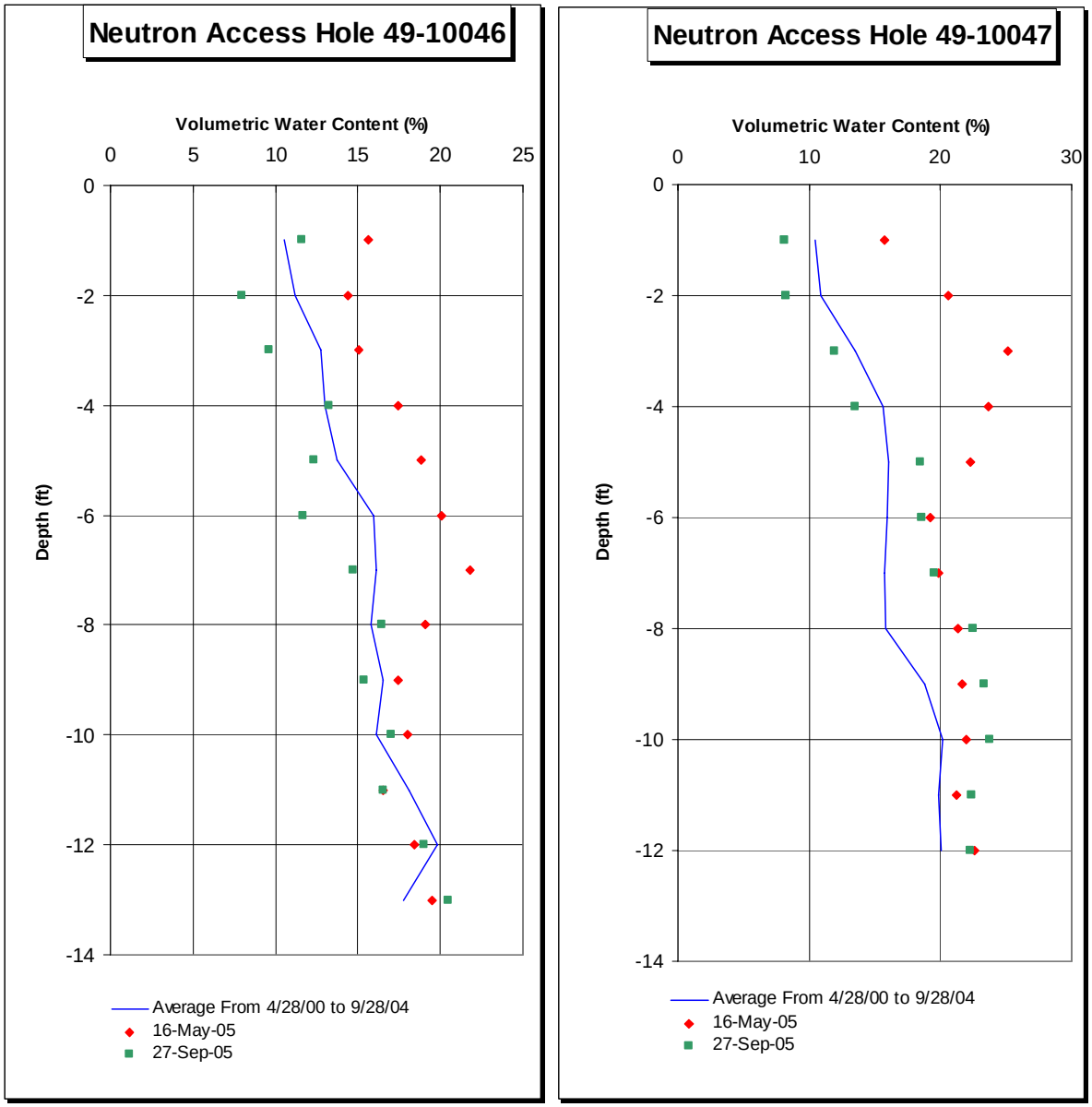

Figure A-5. Neutron probe moisture measurements for neutron access holes 49-10046 and 49-10047

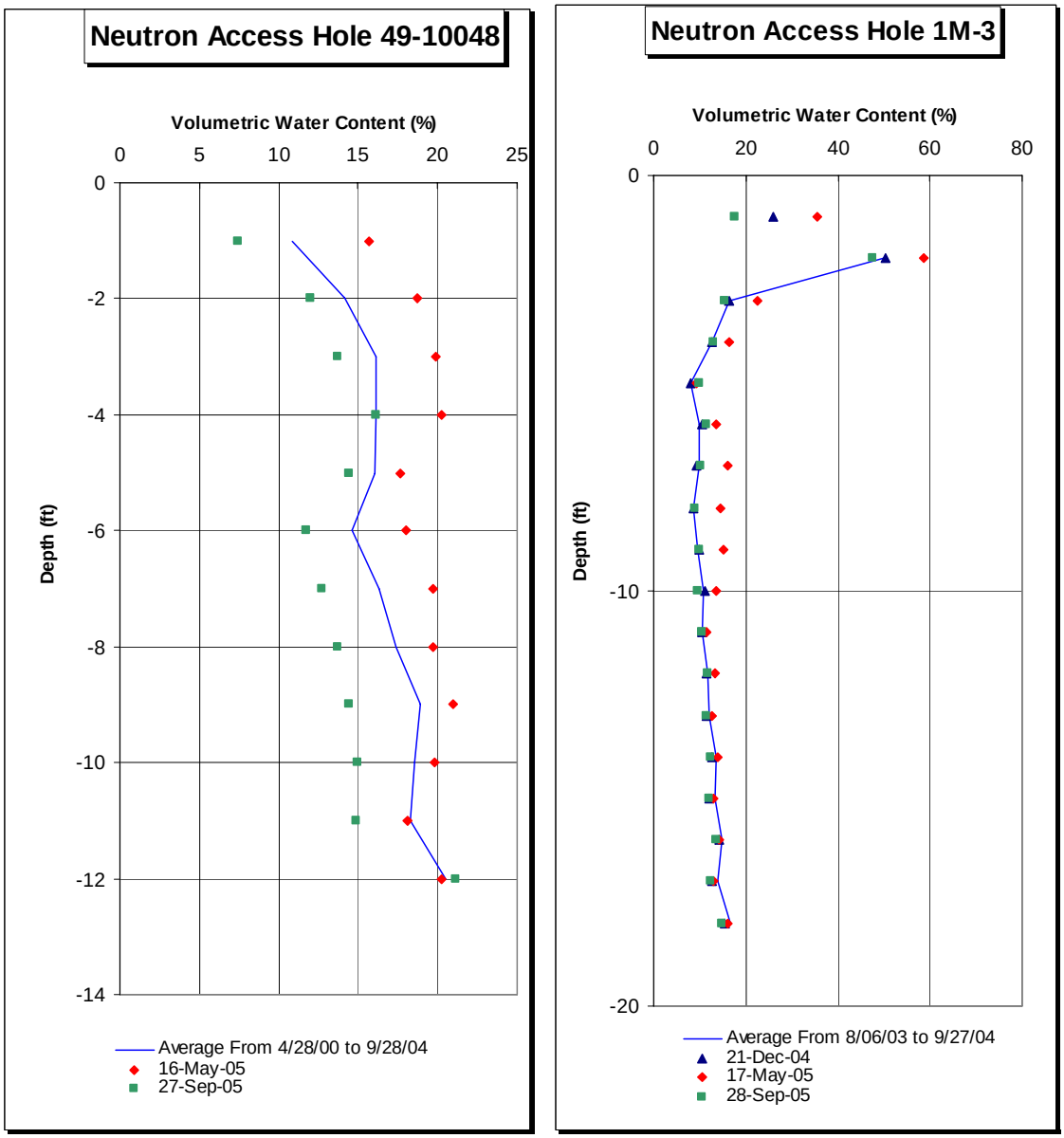

Figure A-6. Neutron probe moisture measurements for neutron access holes 49-10048 and 1M-3

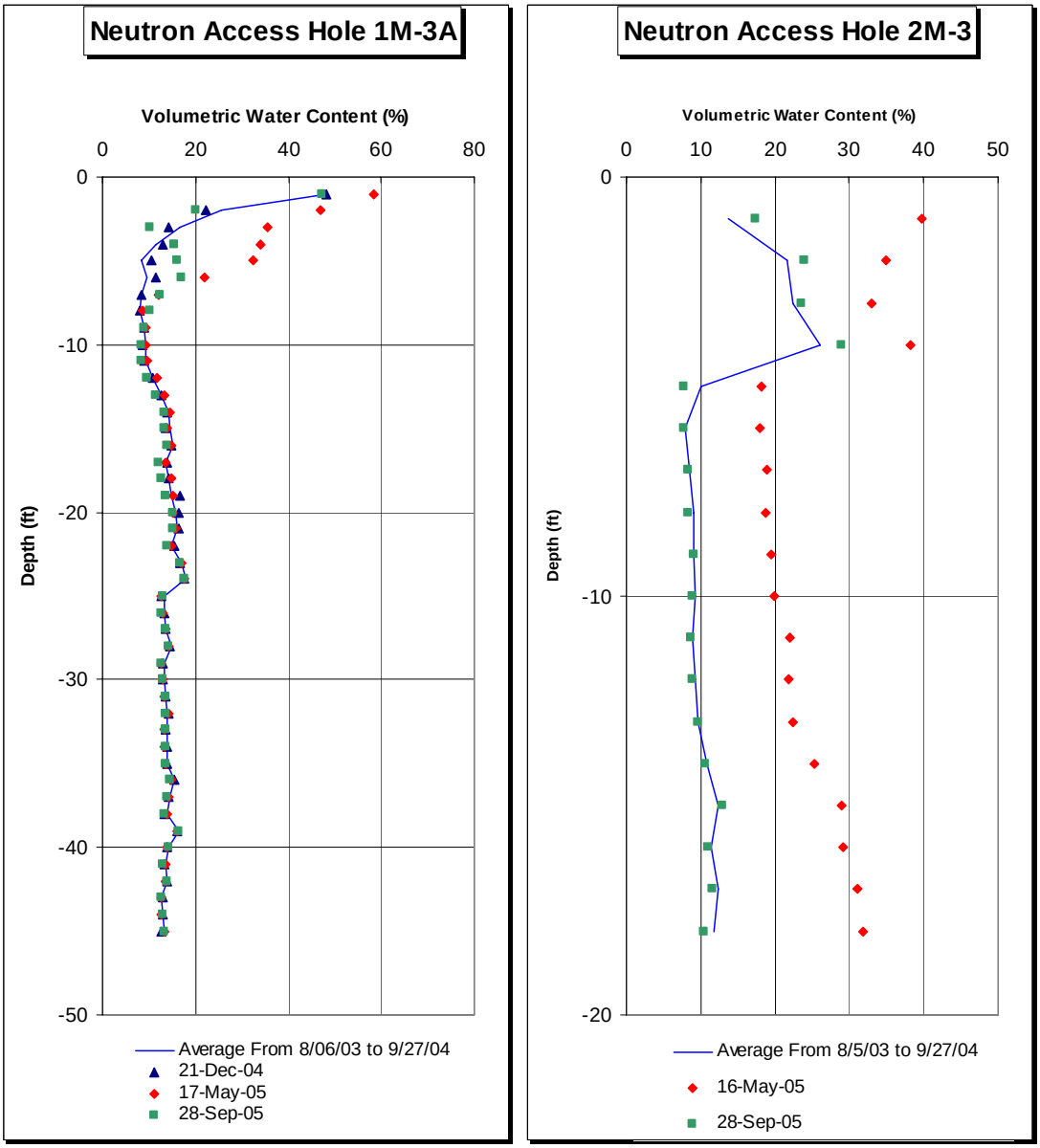

Figure A-7. Neutron probe moisture measurements for neutron access holes 1M-3A and 2M-3

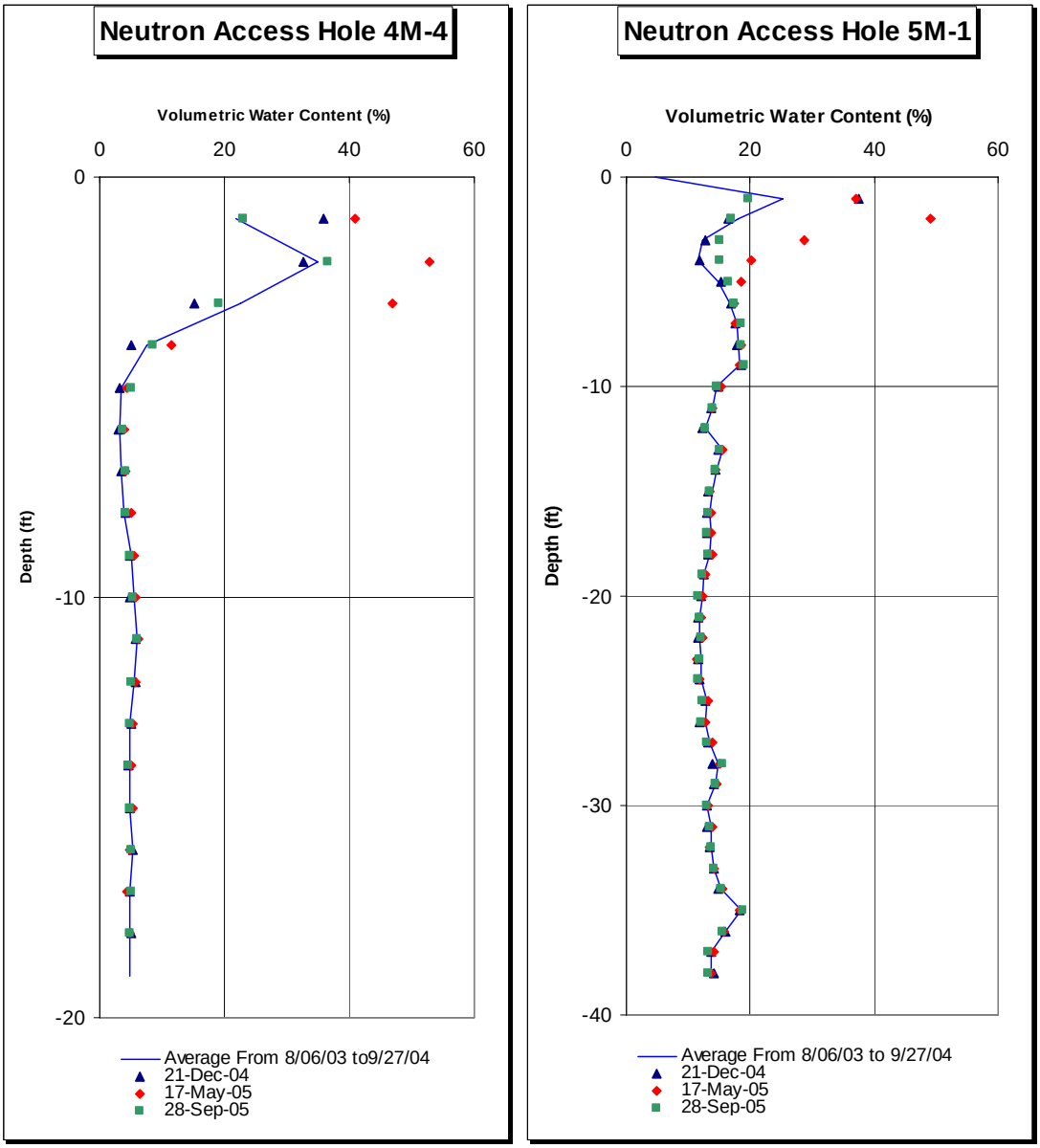

Figure A-8. Neutron probe moisture measurements for neutron access holes 4M-4 and 5M-1

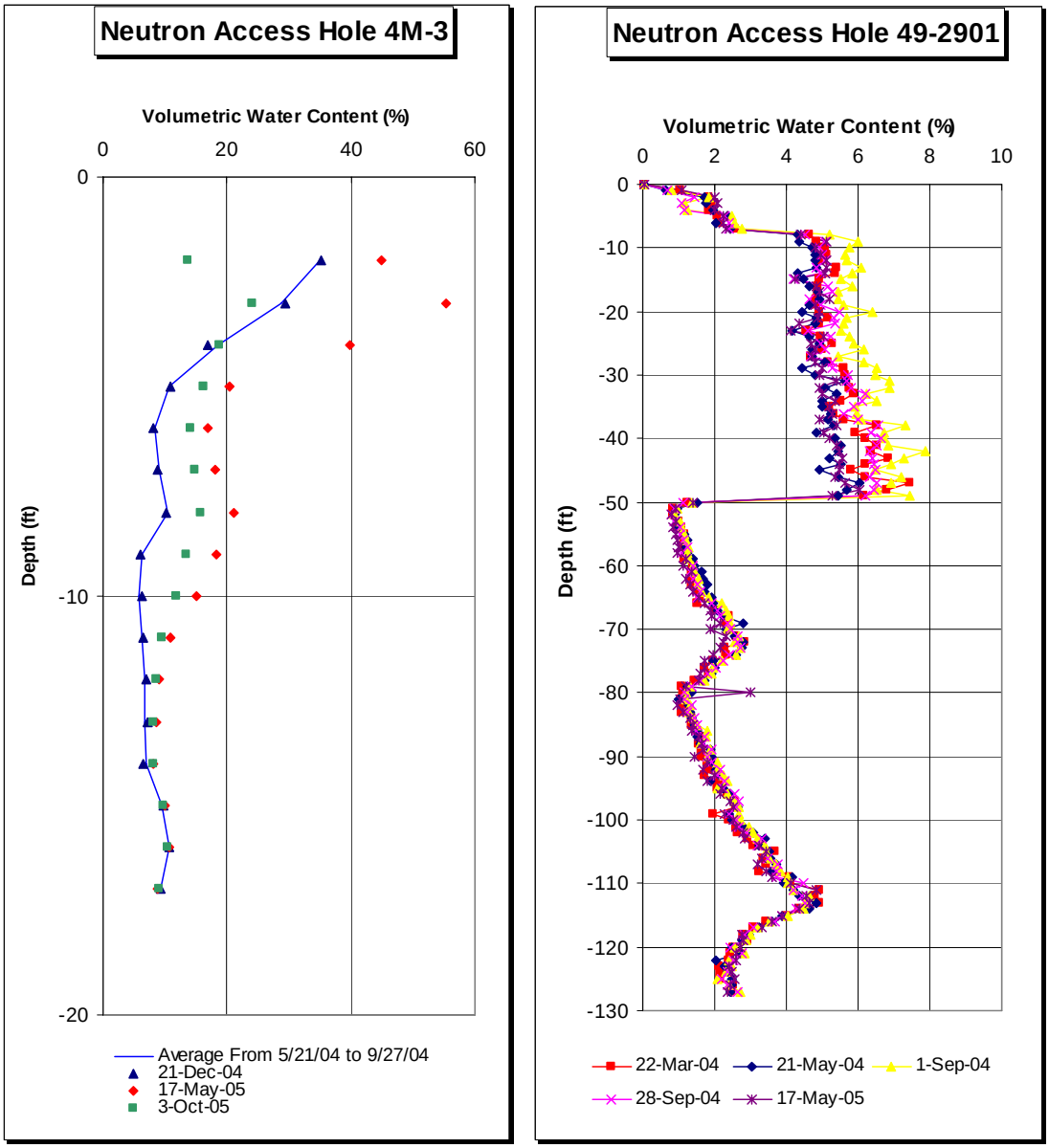

Figure A-9. Neutron probe moisture measurements for neutron access holes 4M-3 and 49-2901 using geophysics

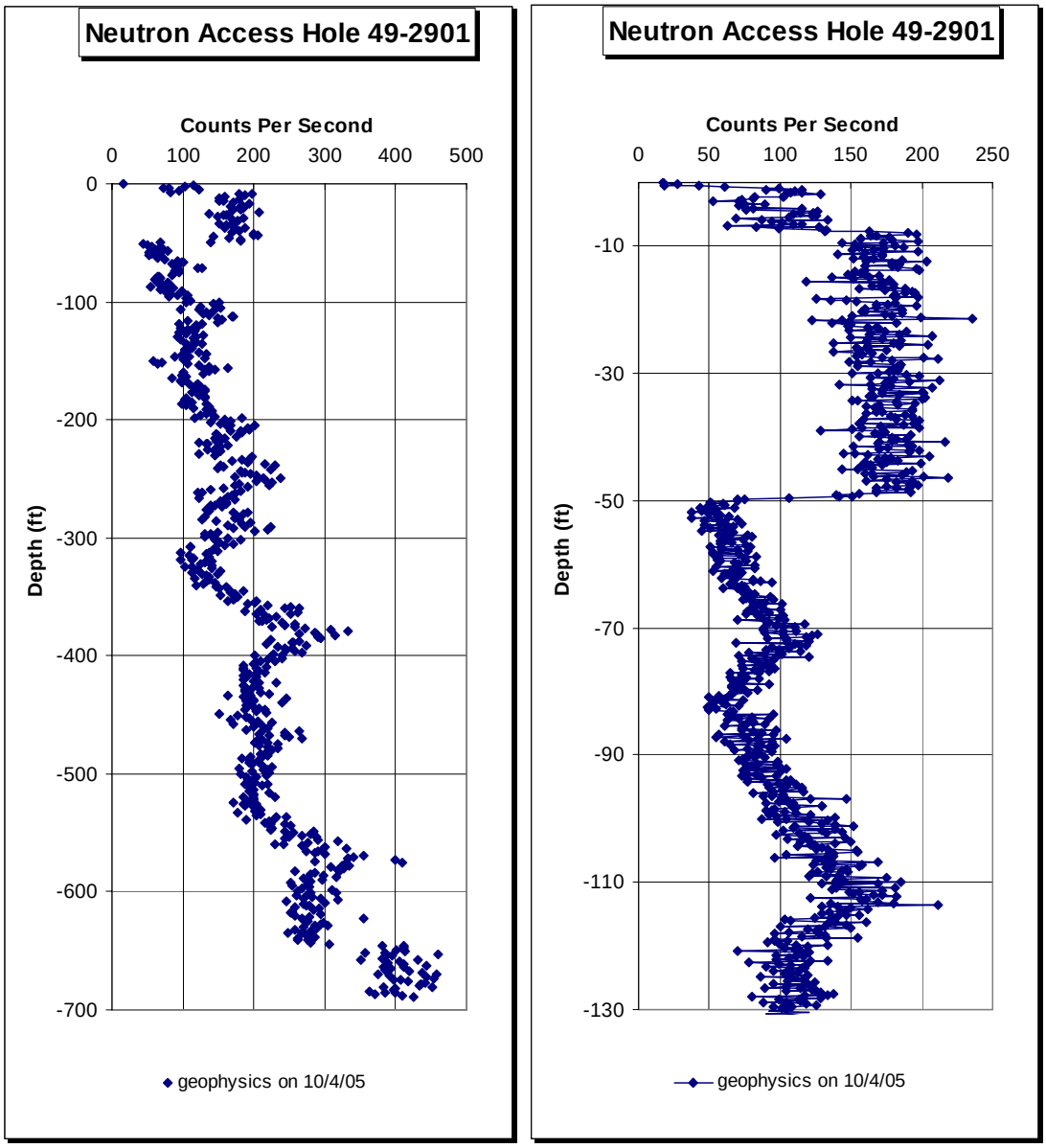

Figure A-10. Neutron probe moisture measurements for neutron access hole 49-2901 utilizing ENV-ECR geophysical acquisition package

Appendix B

Time Versus Moisture Content Plots

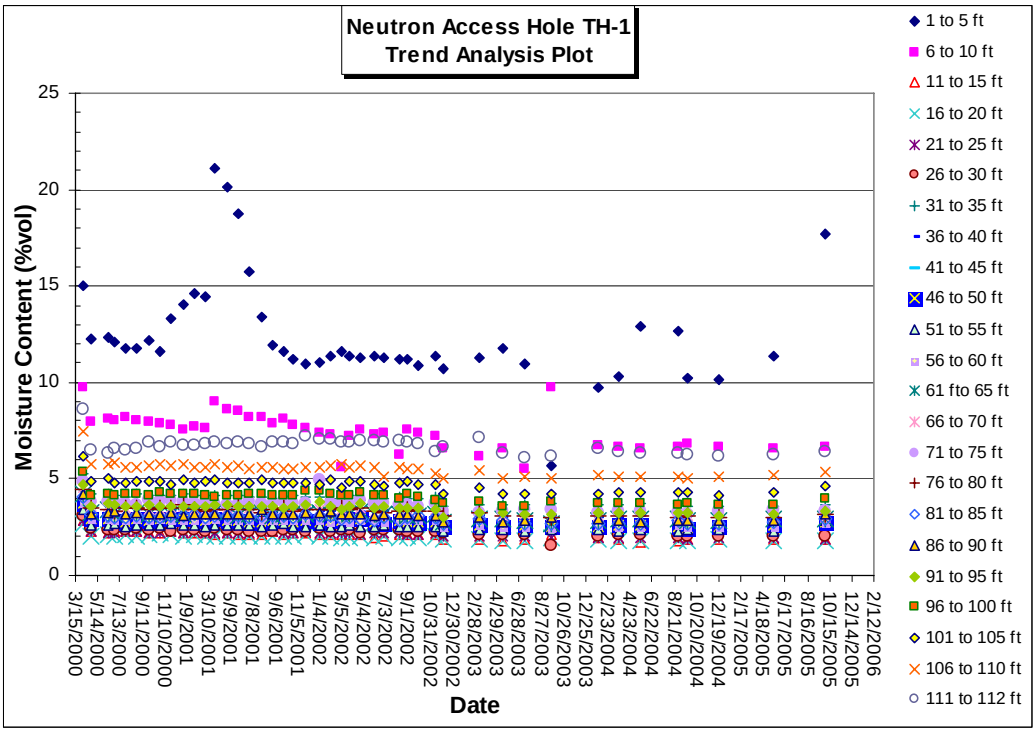

Figure B-1. Trend plot of neutron moisture measurements, neutron access hole TH-1

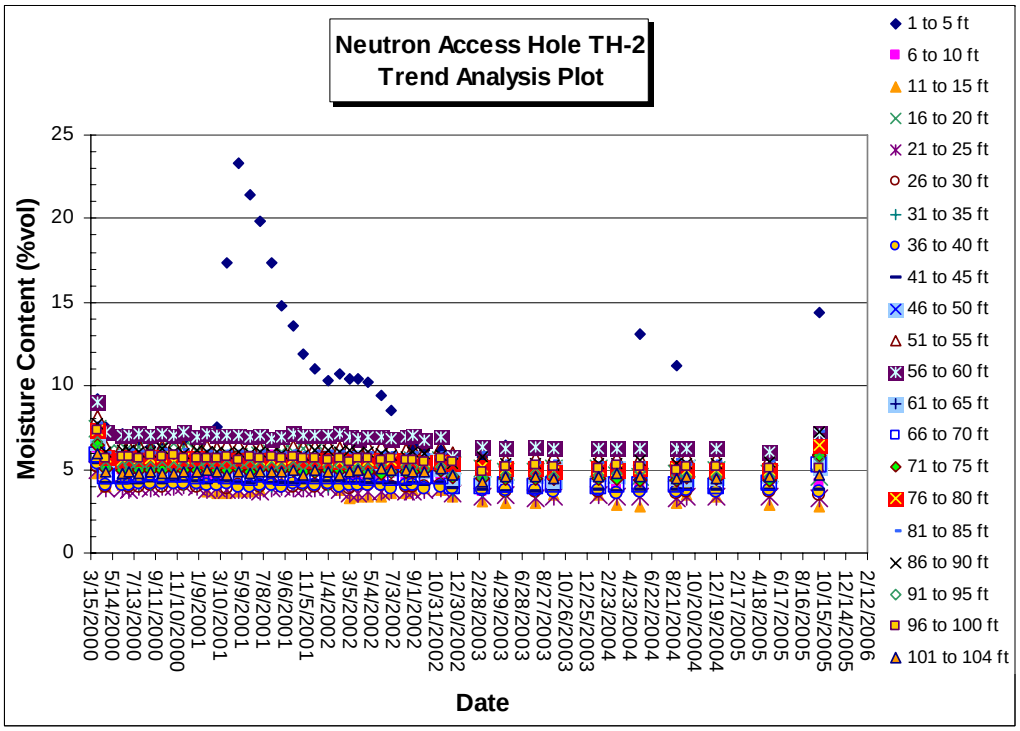

Figure B-2. Trend plot of neutron moisture measurements, neutron access hole TH-2

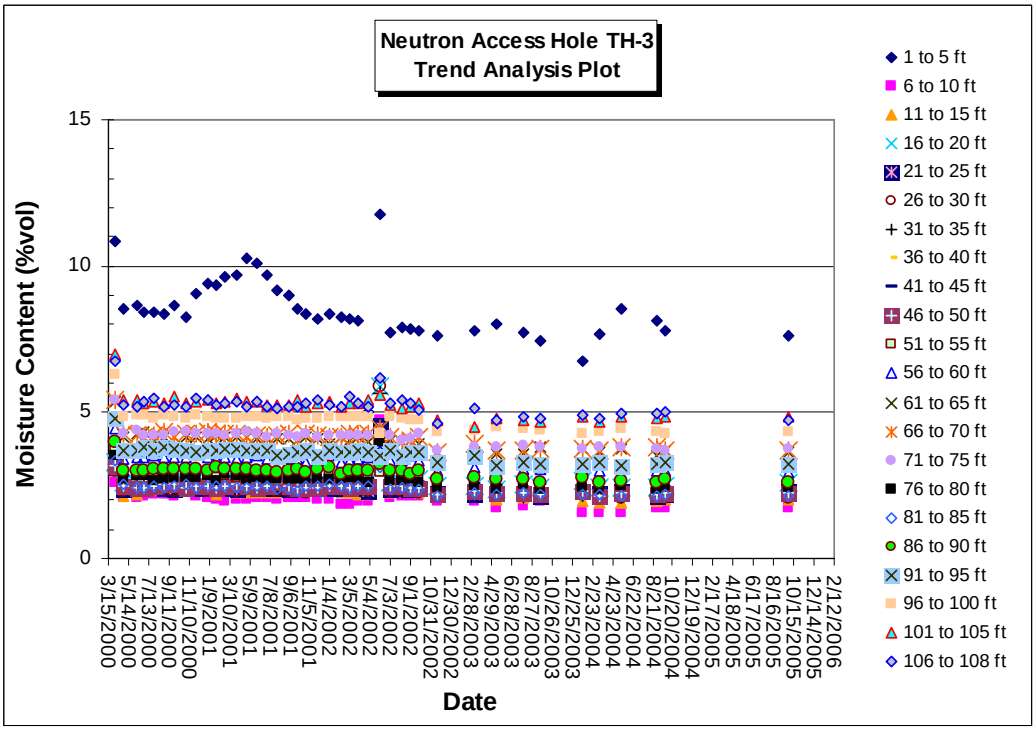

Figure B-3. Trend plot of neutron moisture measurements, neutron access hole TH-3

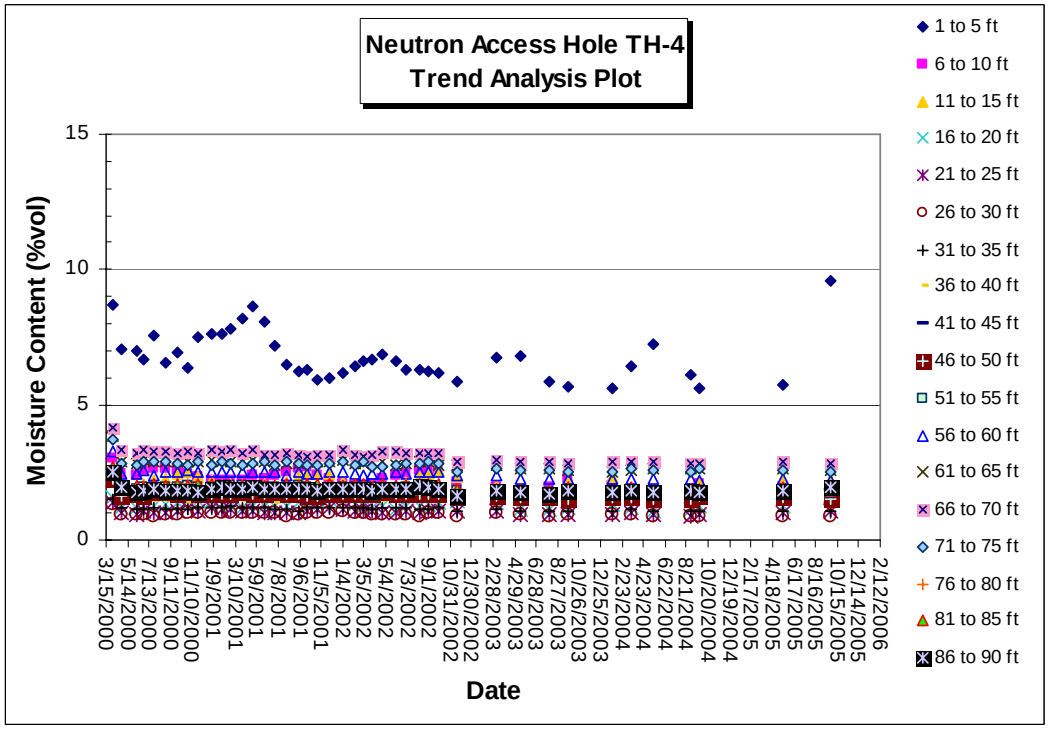

Figure B-4. Trend plot of neutron moisture measurements, neutron access hole TH-4

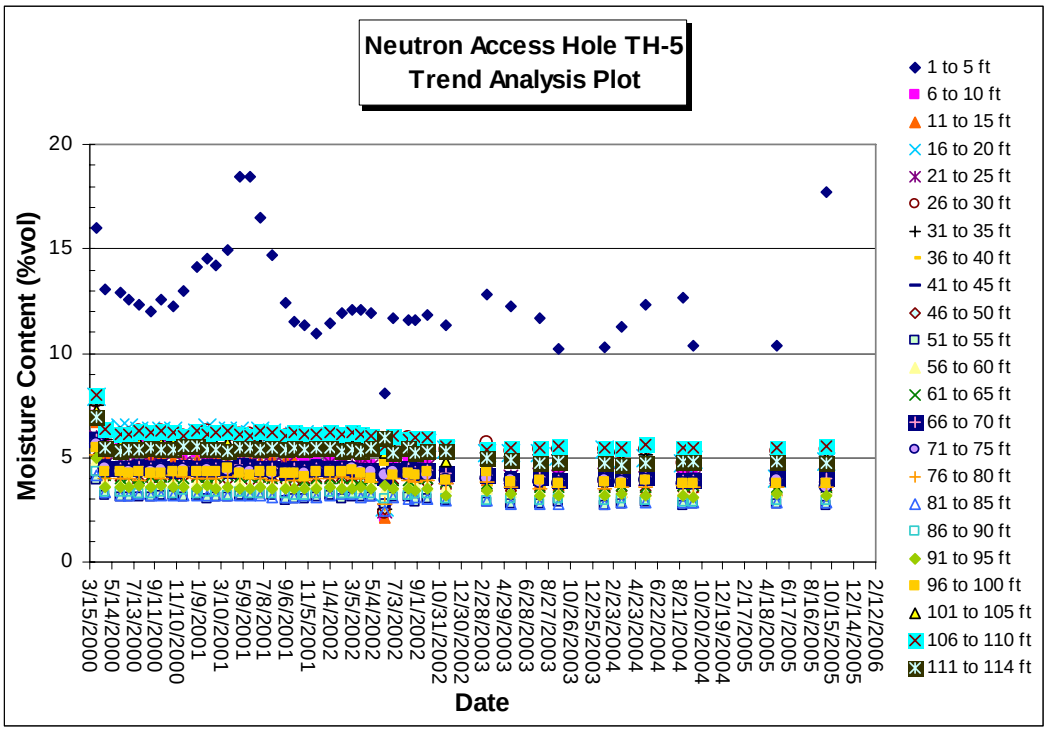

Figure B-5. Trend plot of neutron moisture measurements, neutron access hole TH-5

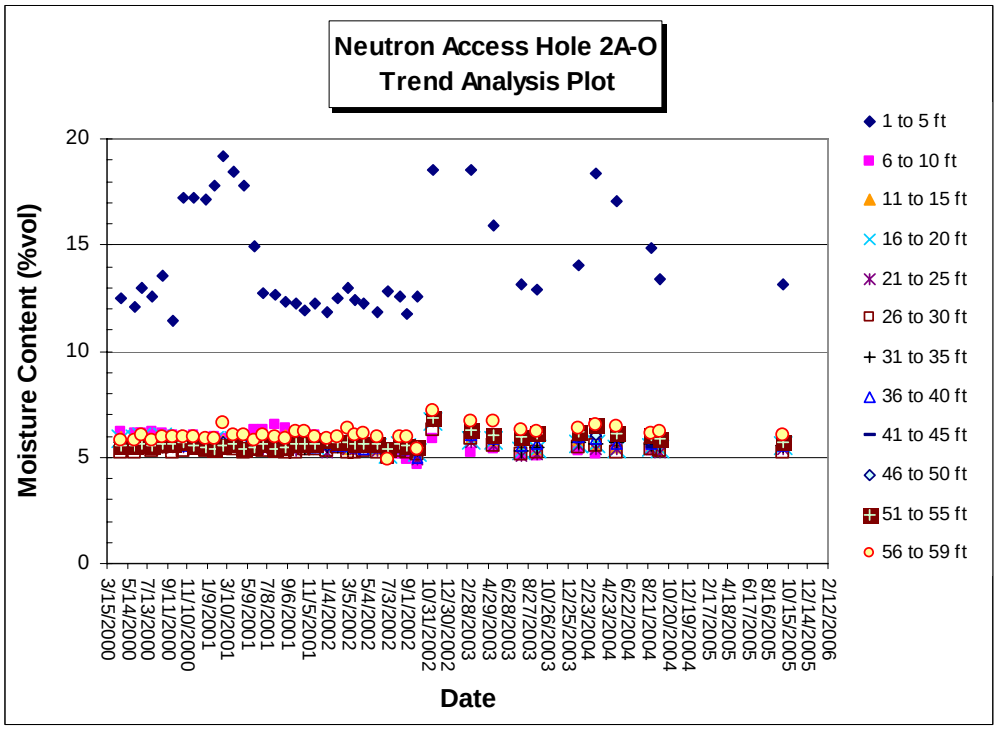

Figure B-6. Trend plot of neutron moisture measurements, neutron access hole 2-AO

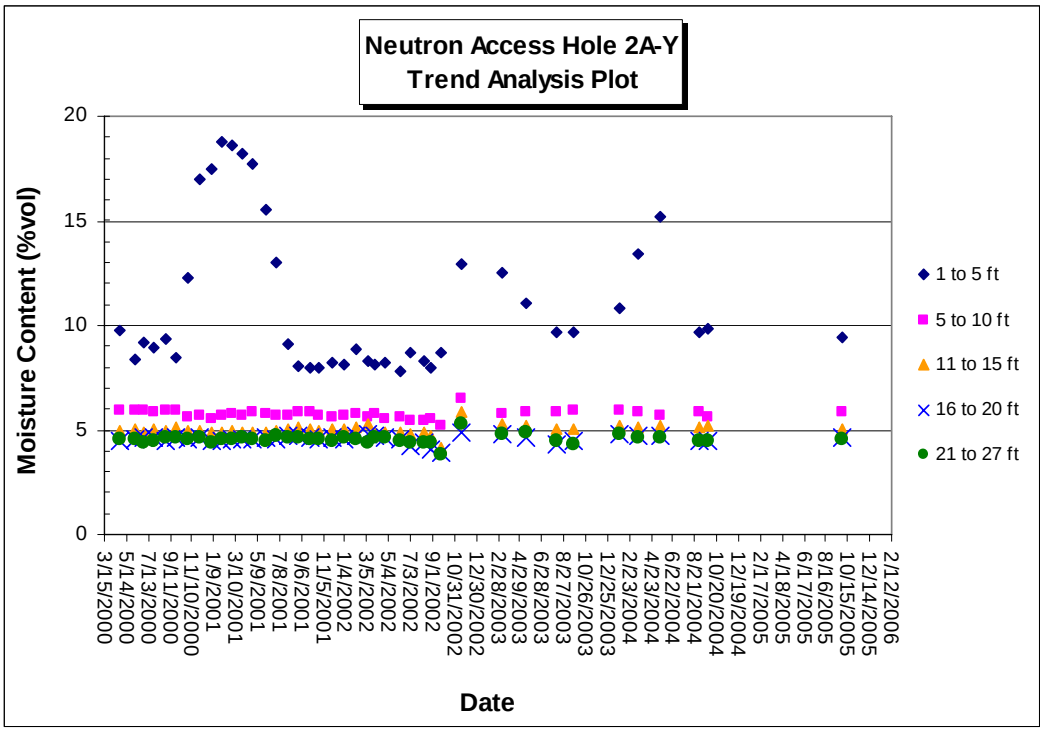

Figure B-7. Trend plot of neutron moisture measurements, neutron access hole 2-AY

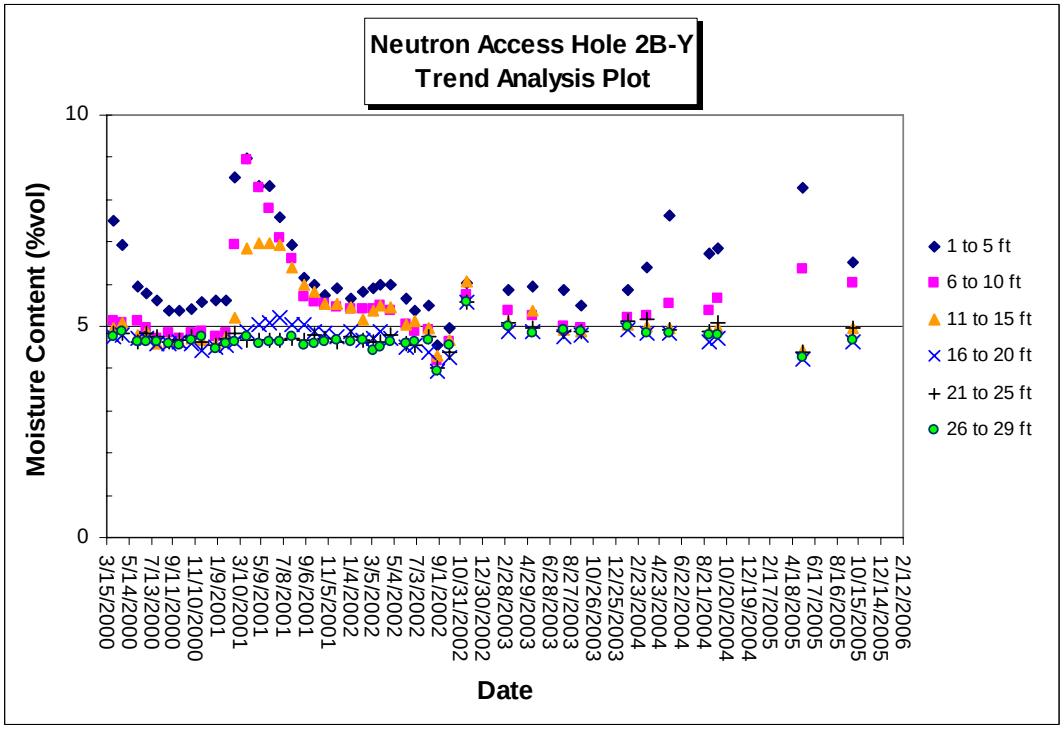

Figure B-8. Trend plot of neutron moisture measurements, neutron access hole 2-BY

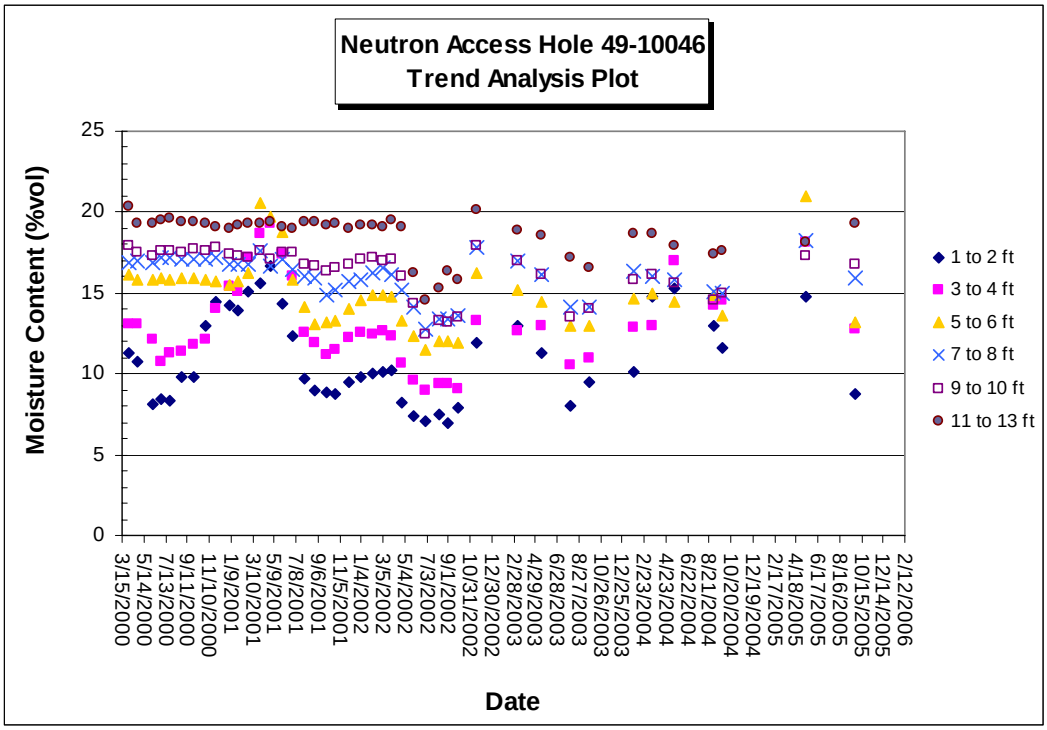

Figure B-9. Trend plot of neutron moisture measurements, neutron access hole 49-10046

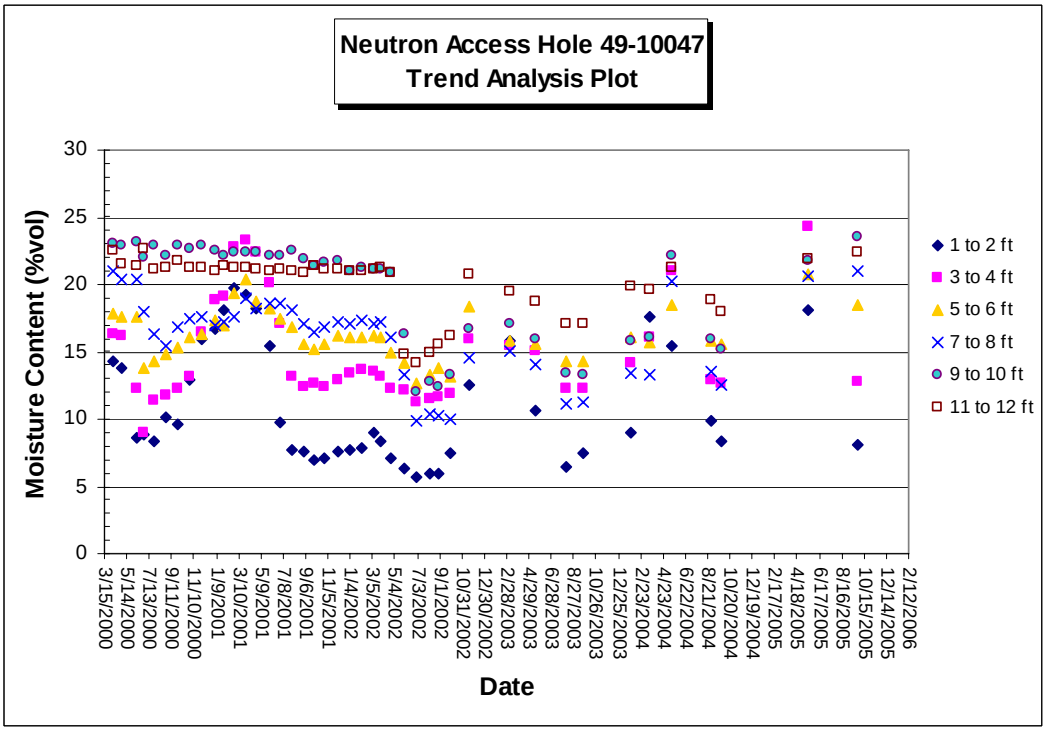

Figure B-10. Trend plot of neutron moisture measurements, neutron access hole 49-10047

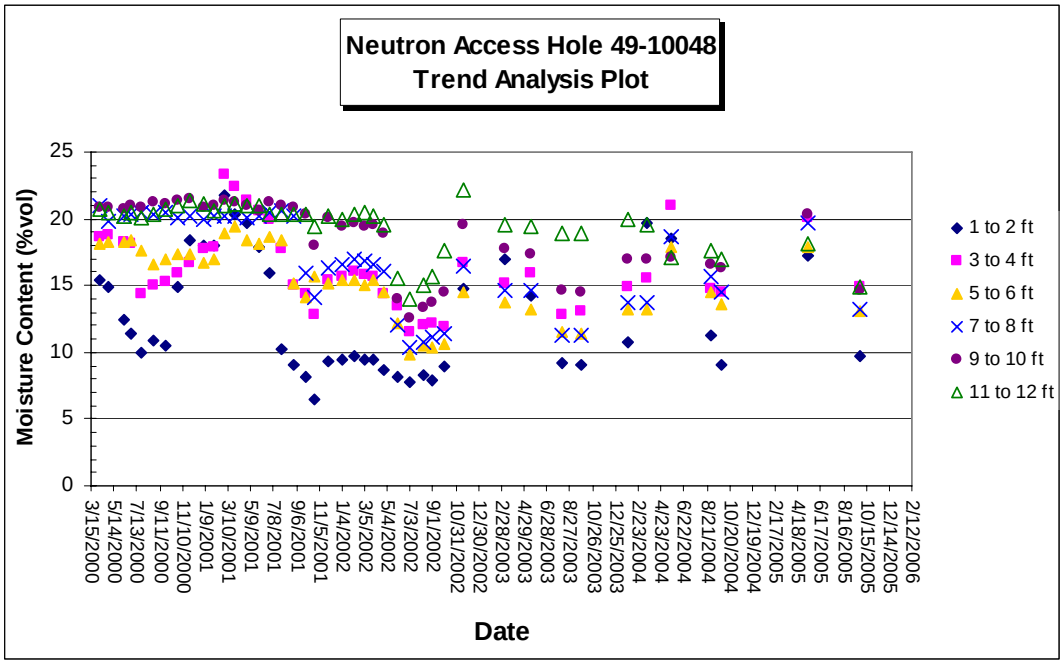

Figure B-11. Trend plot of neutron moisture measurements, neutron access hole 49-10048

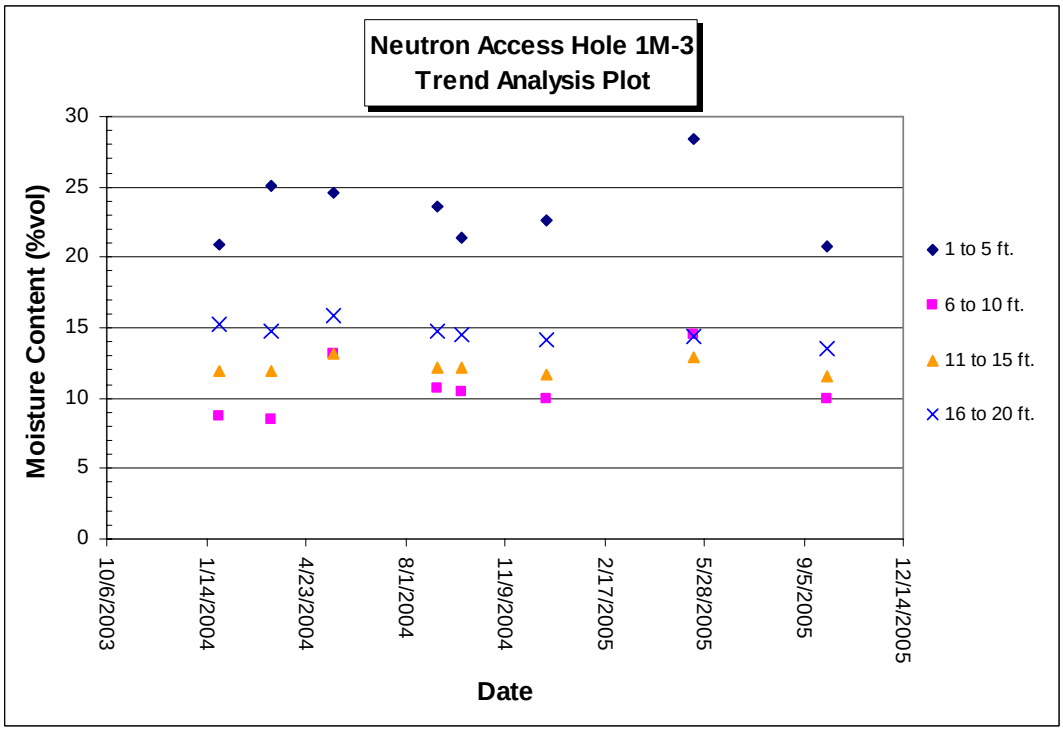

Figure B-12. Trend plot of neutron moisture measurements, neutron access hole 1M-3

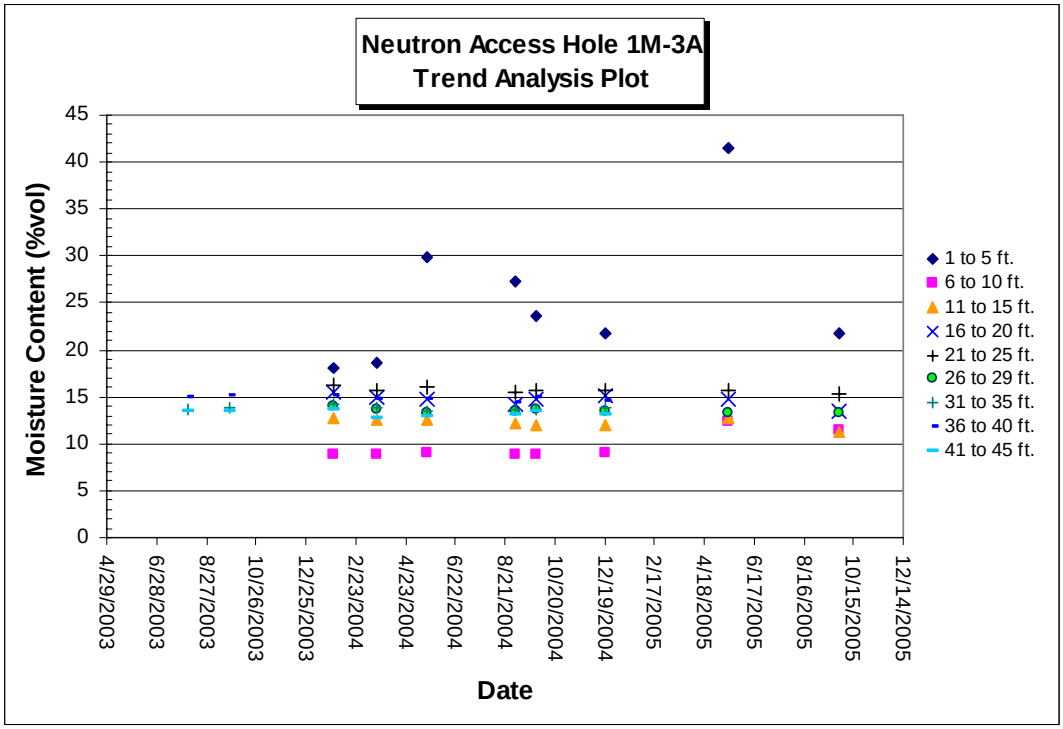

Figure B-13. Trend plot of neutron moisture measurements, neutron access hole 1M-3A

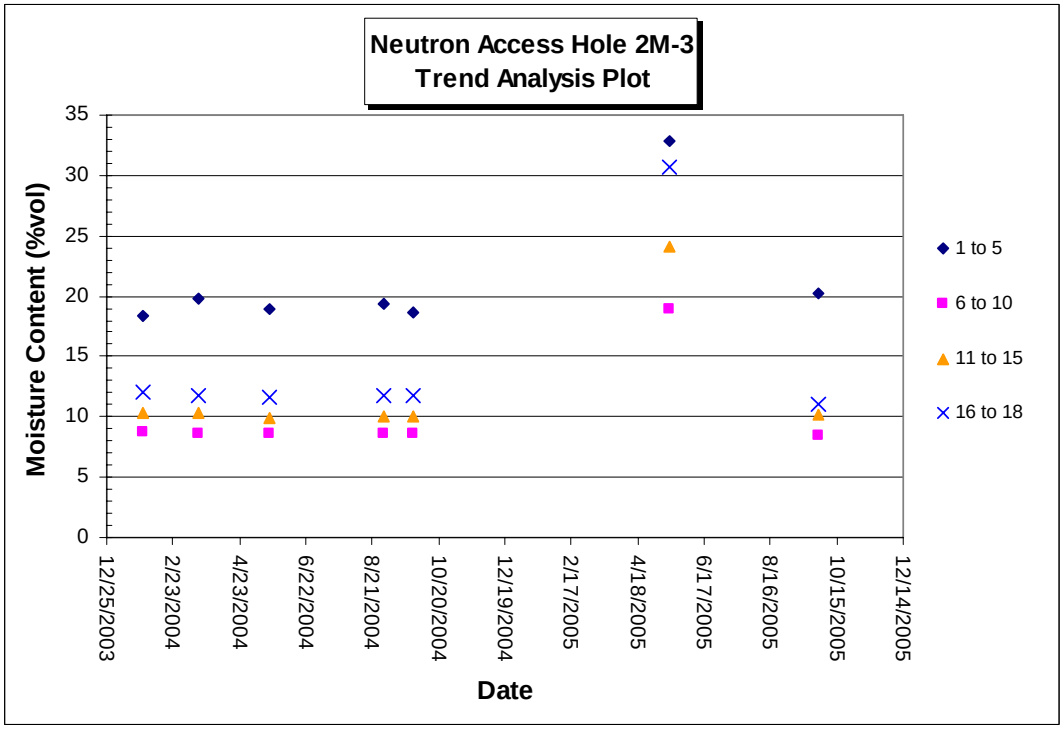

Figure B-14. Trend plot of neutron moisture measurements, neutron access hole 2M-3

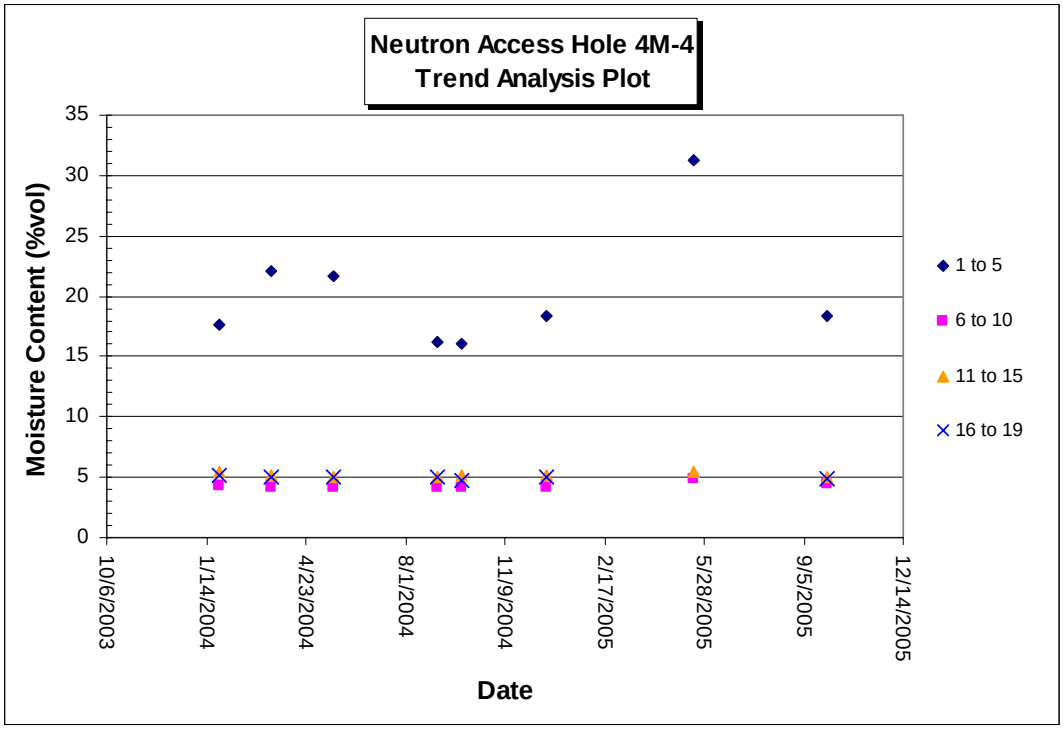

Figure B-15. Trend plot of neutron moisture measurements, neutron access hole 4M-4

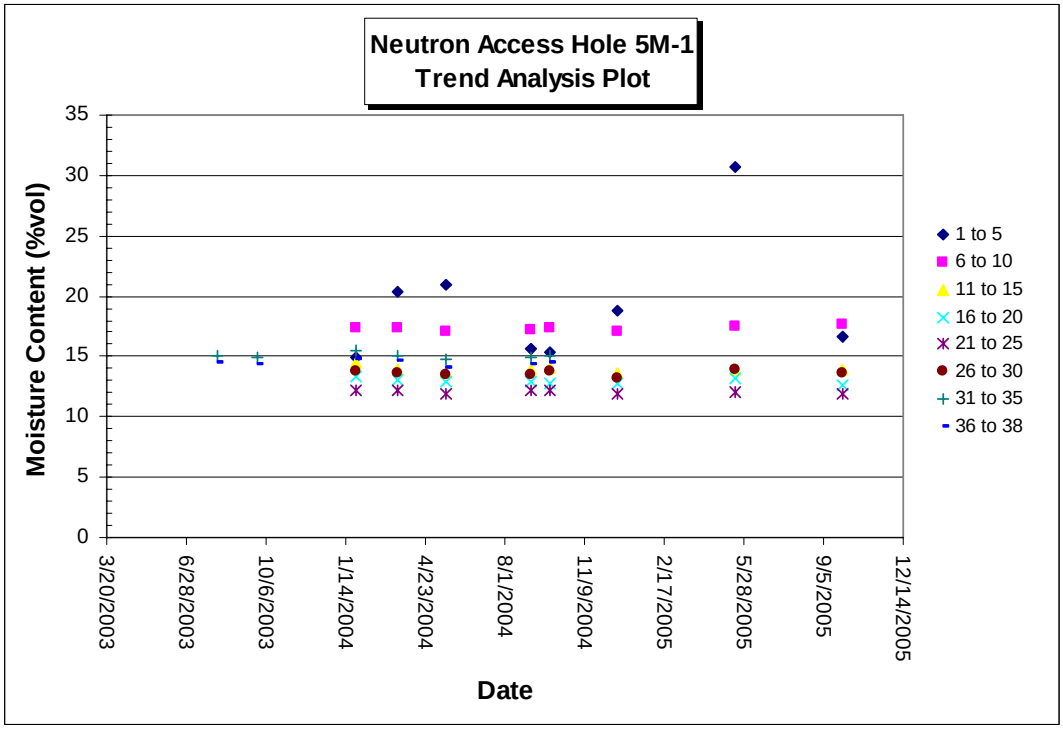

Figure B-16. Trend plot of neutron moisture measurements, neutron access hole 5M-1

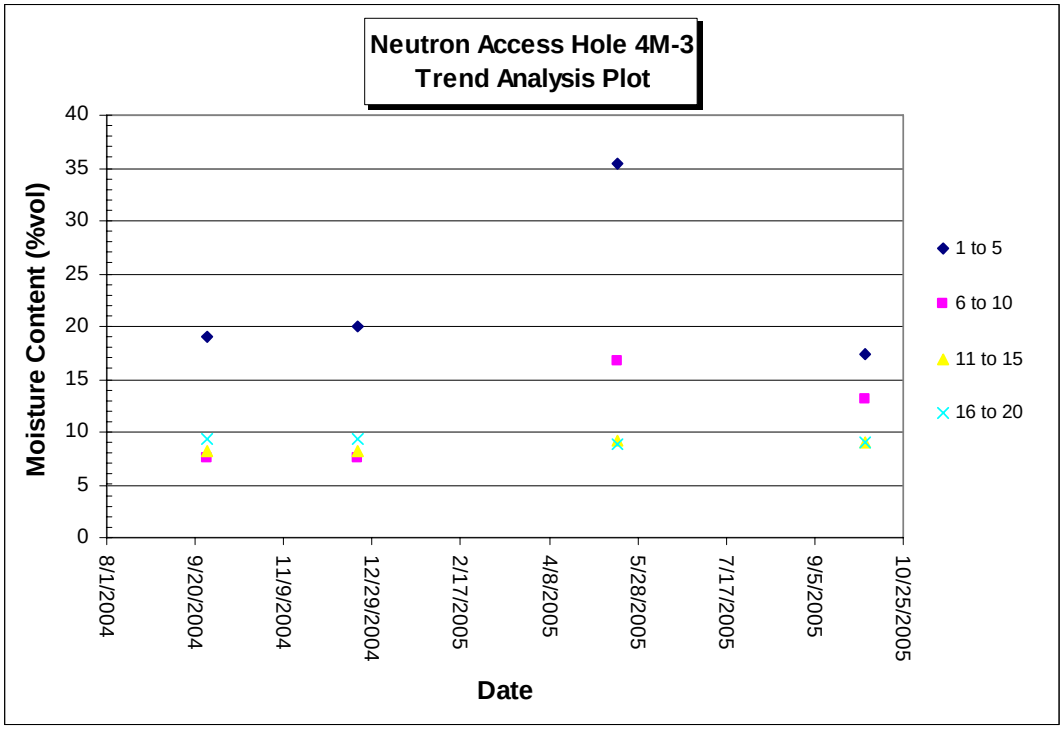

Figure B-17. Trend plot of neutron moisture measurements, neutron access hole 4M-3

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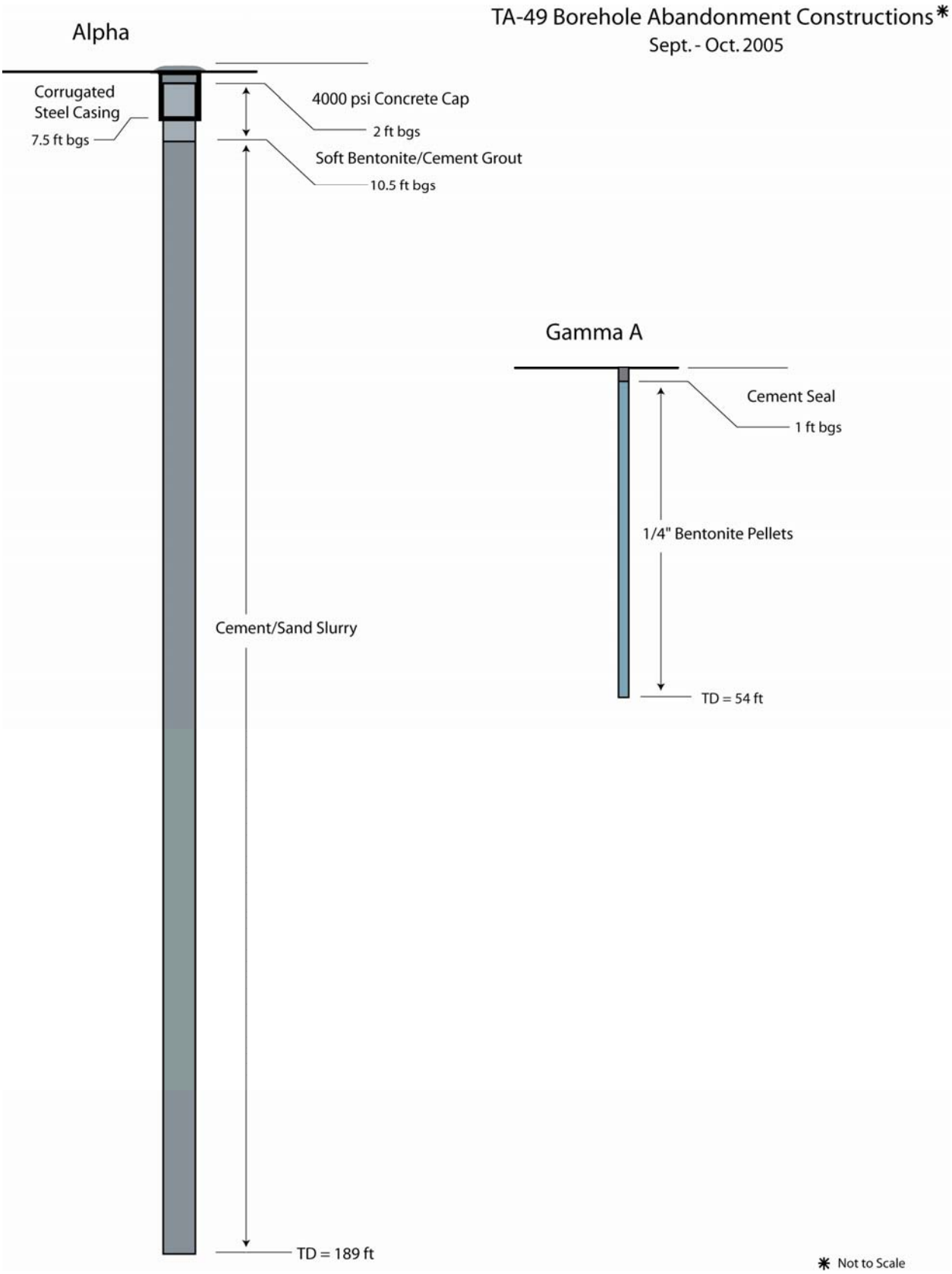
Appendix C

2005 Borehole Abandonment Constructions


TA-49 Borehole Abandonment Constructions*
Sept. - Oct. 2005
Alpha
Corrugated
Steel Casing
7.5 ft bgs
4000 psi Concrete Cap
2 ft bgs
Soft Bentonite/Cement Grout
10.5 ft bgs
Cement/Sand Slurry
TD = 189 ft
Gamma A
Cement Seal
1 ft bgs
1/4" Bentonite Pellets
TD = 54 ft
* Not to Scale

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Appendix D

Current Condition of Evapotranspiration (ET) Cover

Figure D-1. ET cover from outside Area 2 showing the new steel conduit

Figure D-2. ET cover from inside fence of Area 2 showing the new steel conduit

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