Appendix A

Soil Moisture Plots from the Soil, Moisture, and Resistivity Sensors for Fiscal Year 2004

Appendix A

Soil Moisture Plots from the Soil, Moisture, and Resistivity Sensors for Fiscal Year 2004

The following are soil moisture plots of the raw FY 2004 SMR data, from January 2004 through September 2004. Generally, the data are displayed only if they have value (e.g., the data are of sufficient quality to permit interpretation of moisture events). Those SMRs that have either produced no data, their data were not available for analysis, or produced data that was out of range over the entire FY-2004 time period are not included in this appendix. Those plots showing data that was corrected for temperature are labeled "TC" after the probe name and depth. Data from two sensors, 275 and 272, are not included in this appendix, but are shown in Figure 6-3.

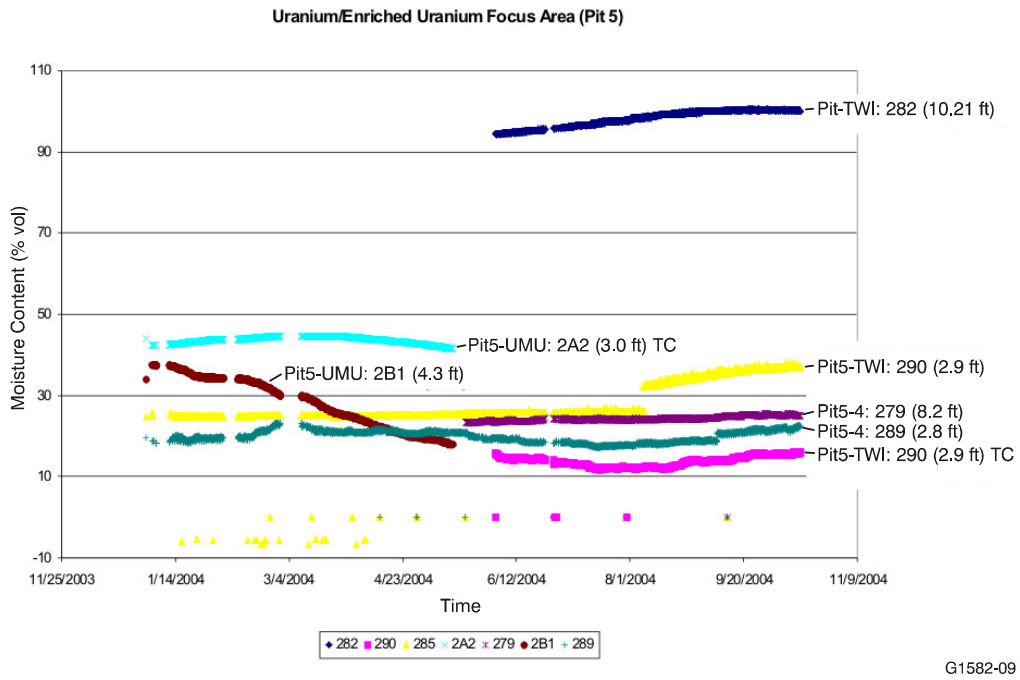


Figure A-1. Moisture measurements from the probes deployed in the Uranium/Enriched Uranium Focus Area (Pit 5).

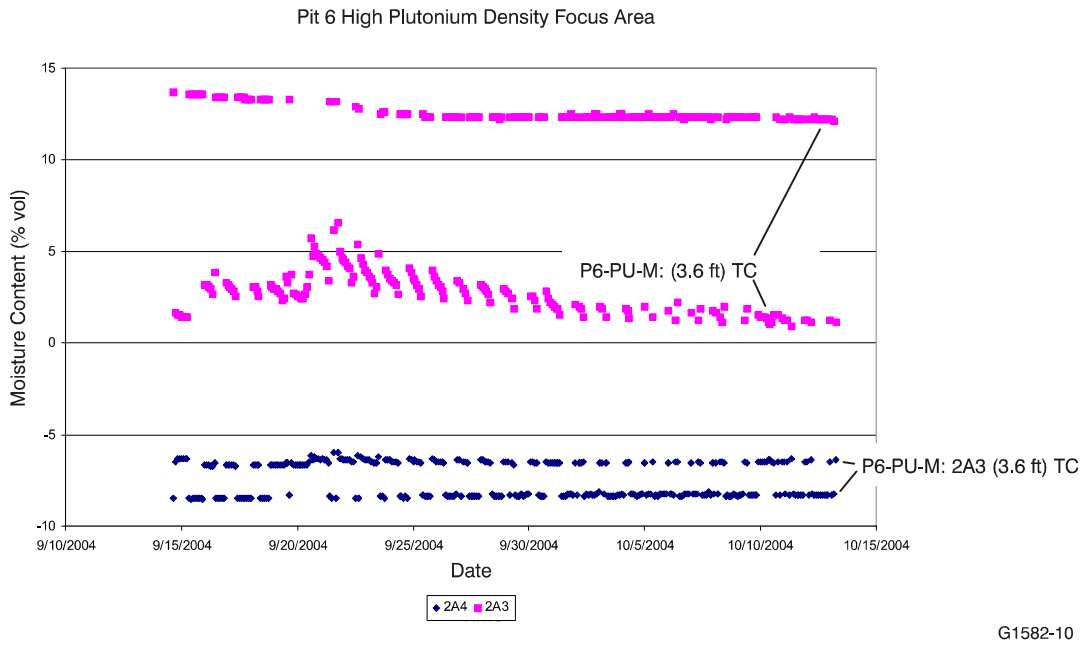


Figure A-2. Moisture measurements from the probes deployed in the Pit 6 High Plutonium Density Focus Area.

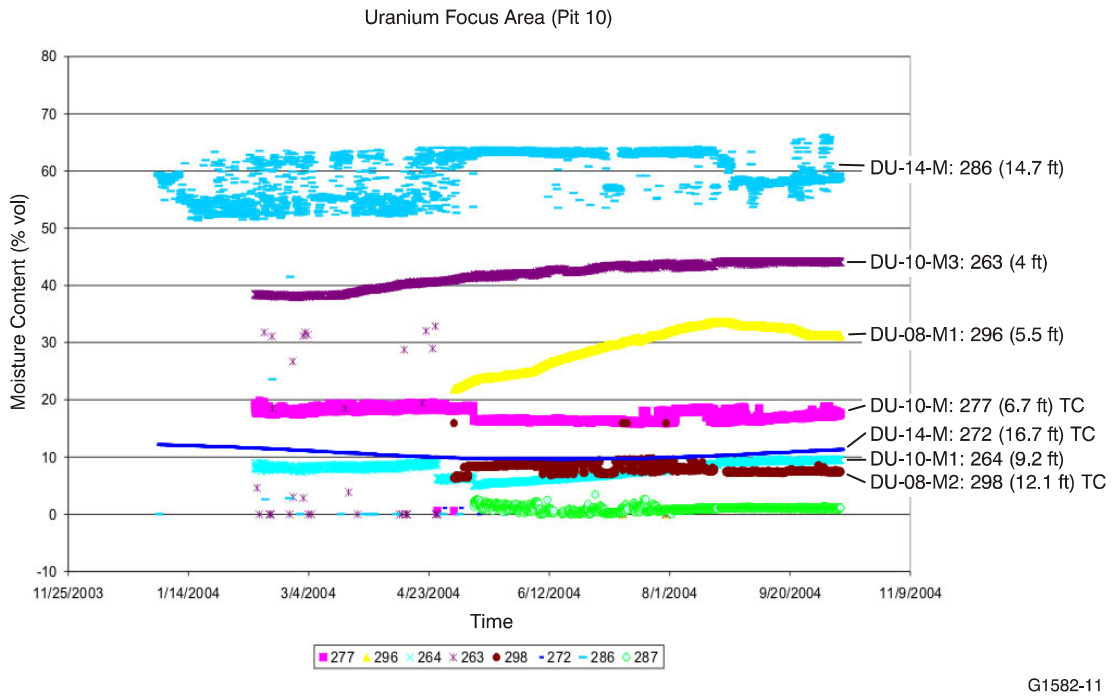


Figure A-3. Moisture measurements from probes deployed in the Depleted Uranium Focus Area (Pit 10).

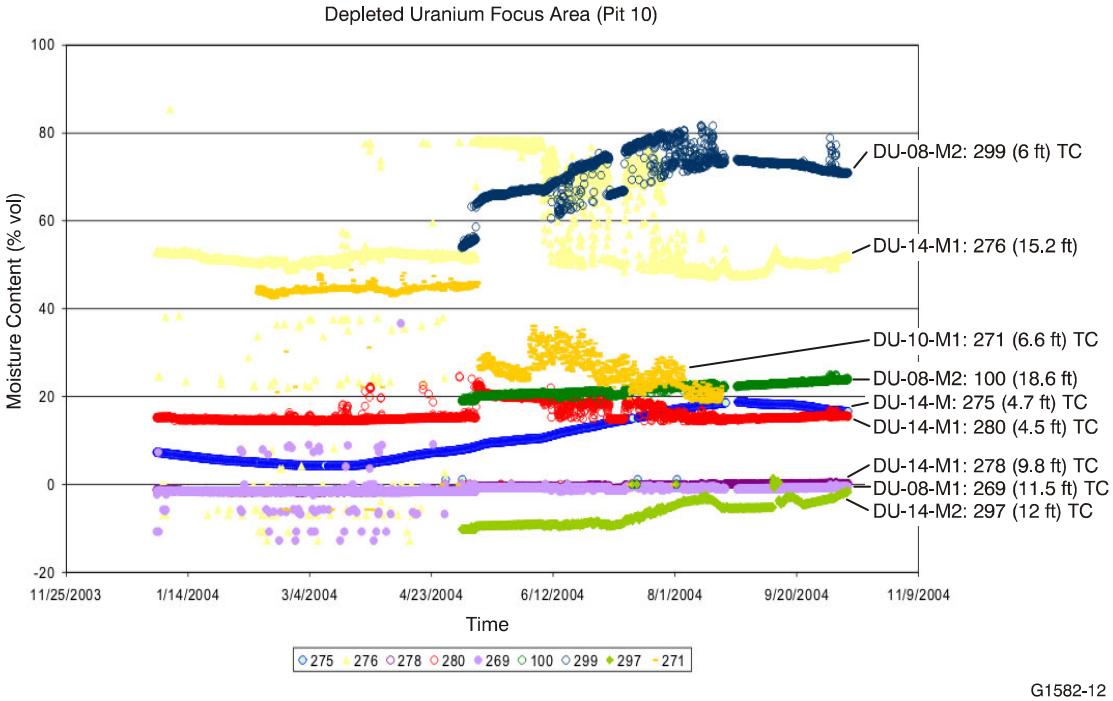


Figure A-4. Moisture measurements from probes deployed in the Depleted Uranium Focus Area (Pit 10).

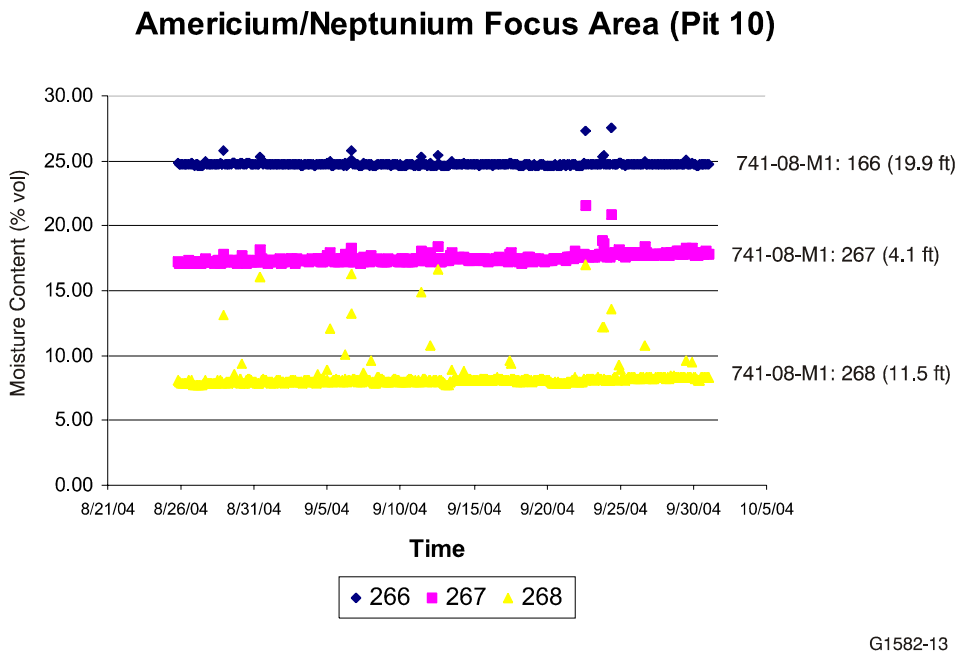


Figure A-5. Moisture measurements from probes deployed in the Americium/Neptunium Focus Area (Pit 10).

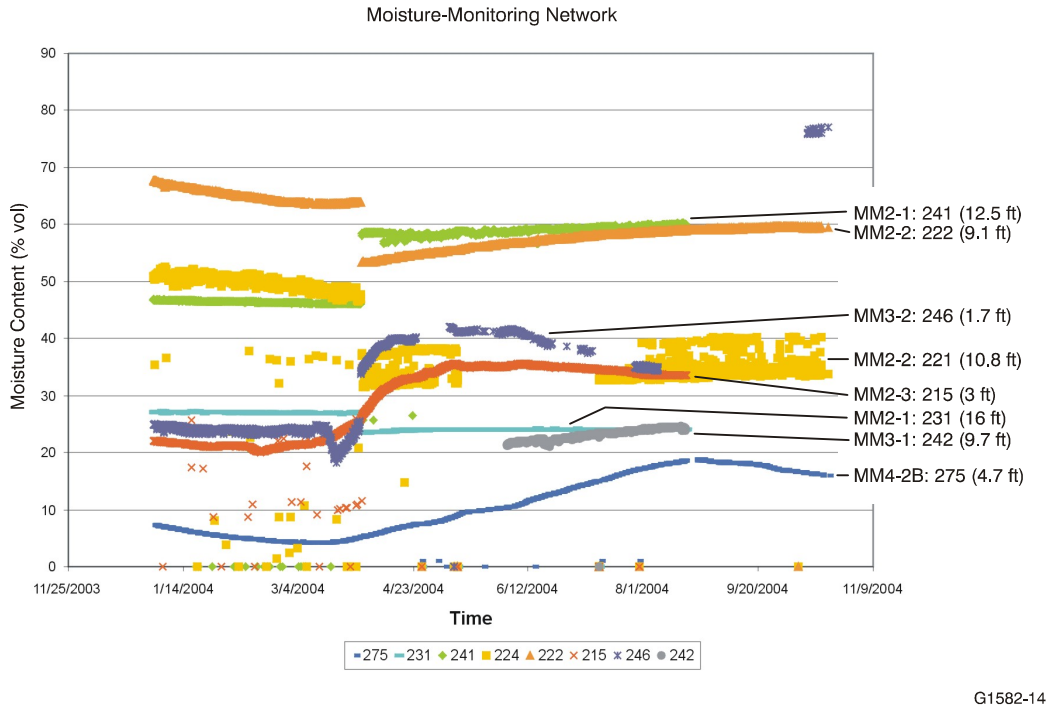


Figure A-6. Moisture measurements from probes deployed in the Moisture-Monitoring Networks.

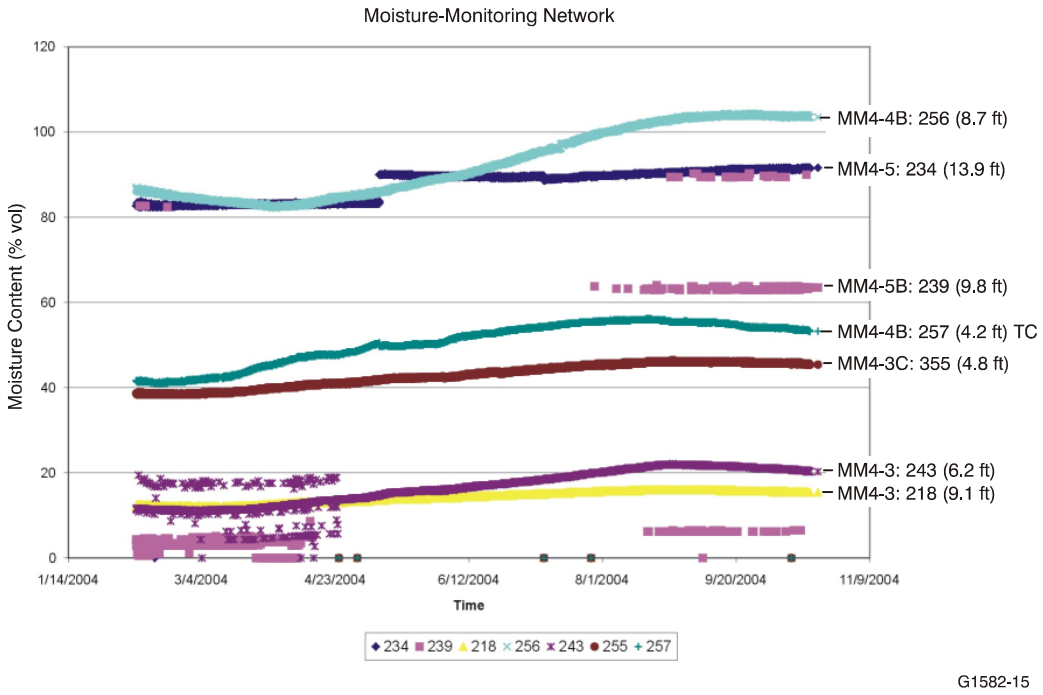


Figure A-7. Moisture measurements from probes deployed in the Moisture-Monitoring Networks.

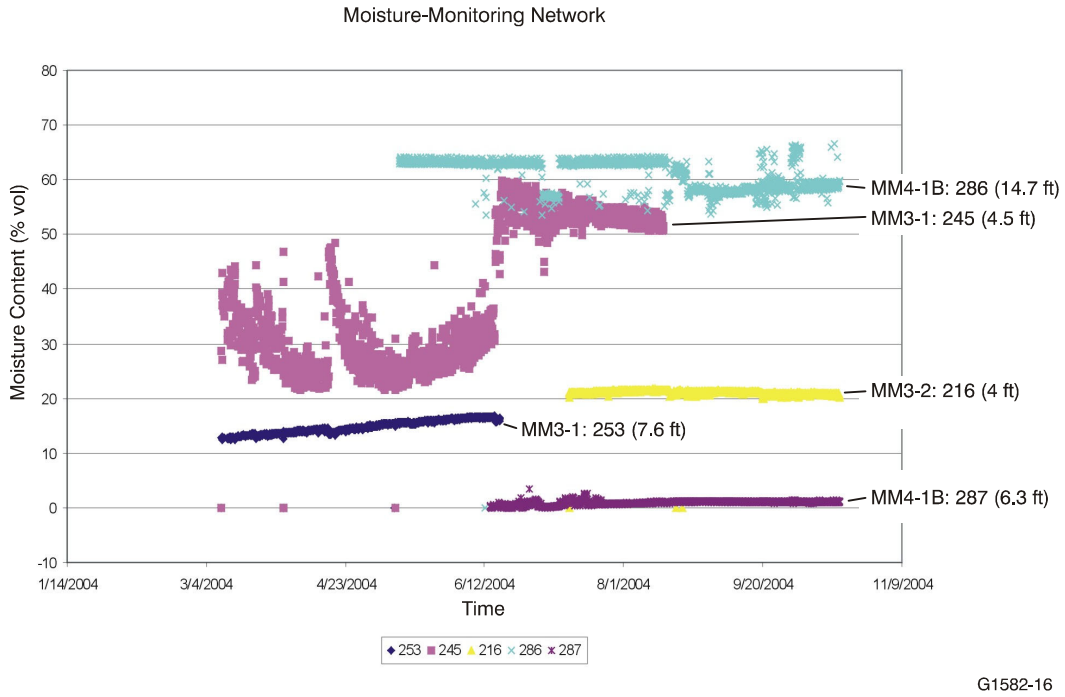


Figure A-8. Moisture measurements from probes deployed in the Moisture-Monitoring Networks.

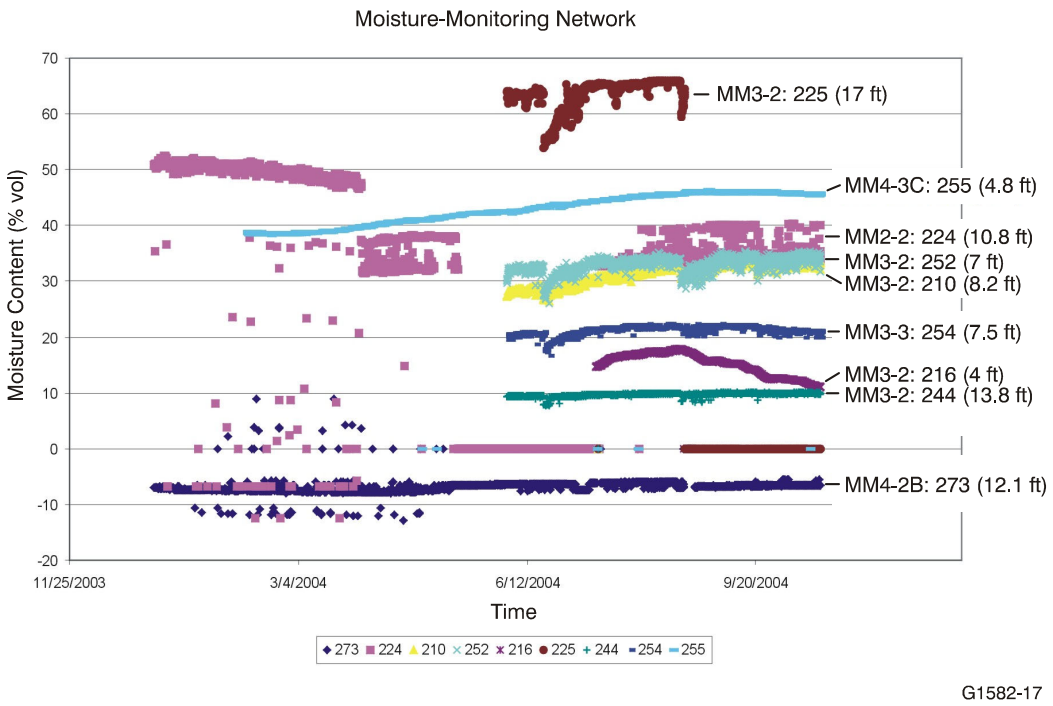


Figure A-9. Moisture measurements from probes deployed in the Moisture-Monitoring Networks.

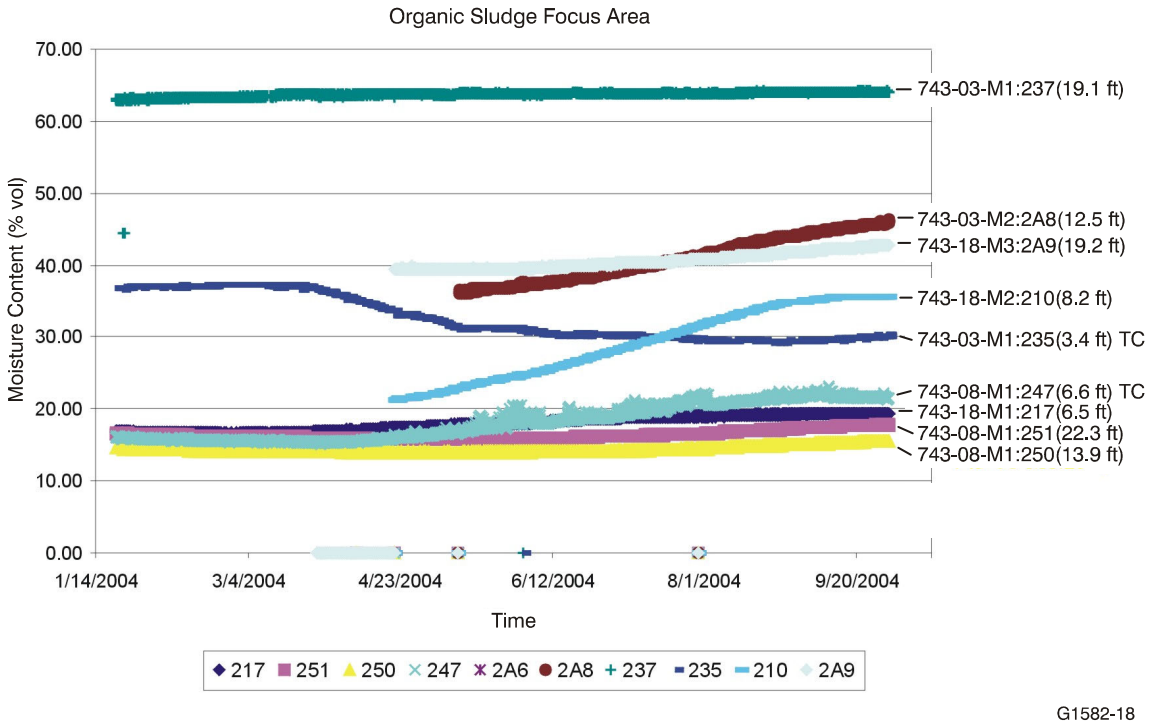


Figure A-10. Moisture measurements from probes deployed in the Organic Sludge Focus Area.

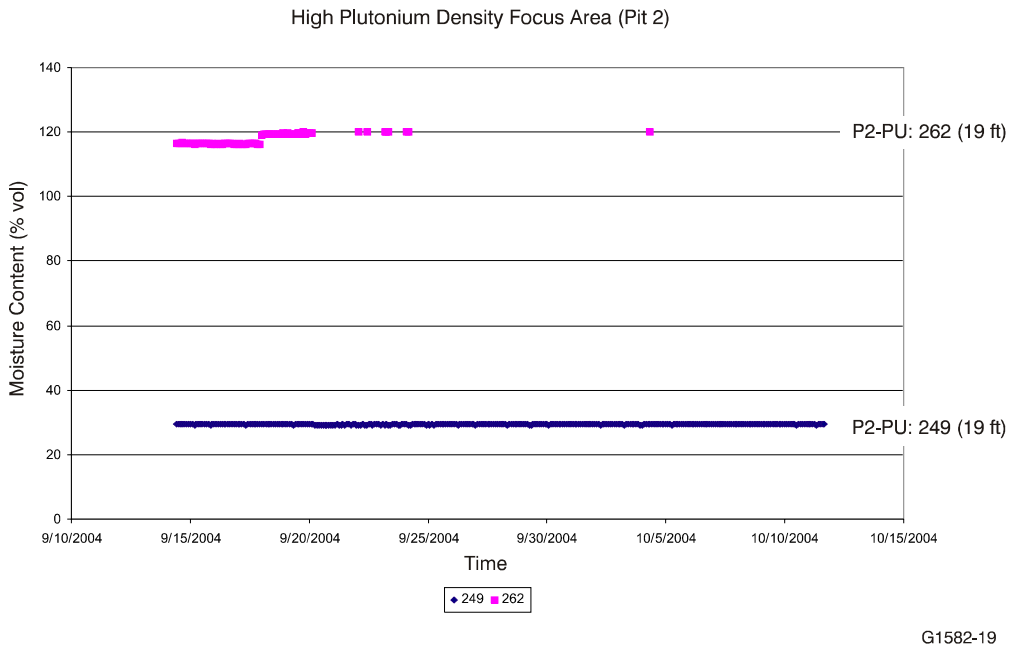


Figure A-11. Moisture measurements from probes deployed in the High Plutonium Density Focus Area (Pit 2).

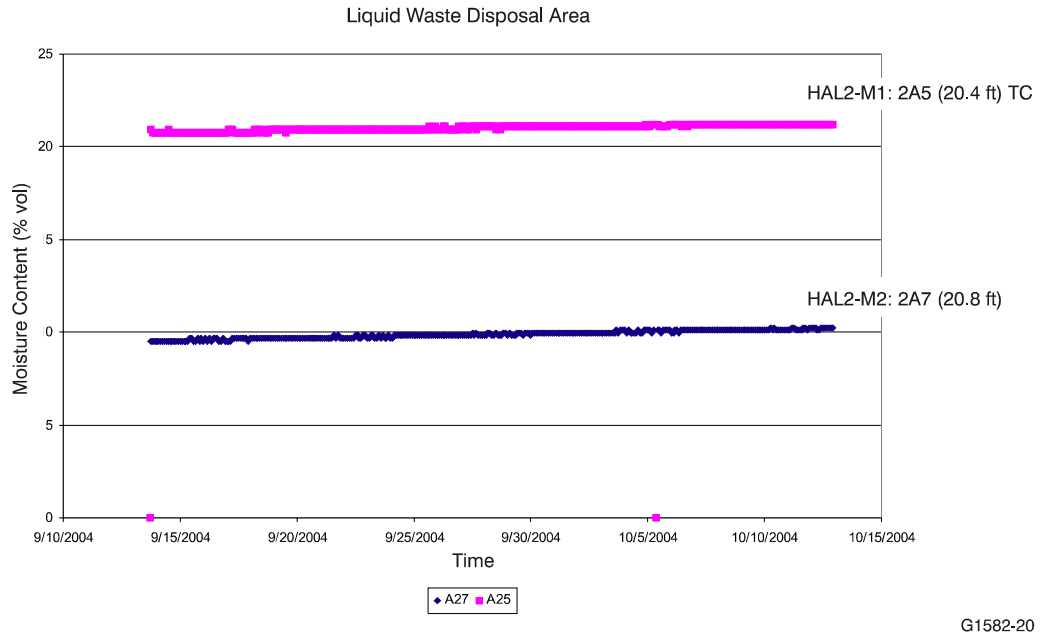


Figure A-12. Moisture measurements from probes deployed in the Liquid Waste Disposal Area.

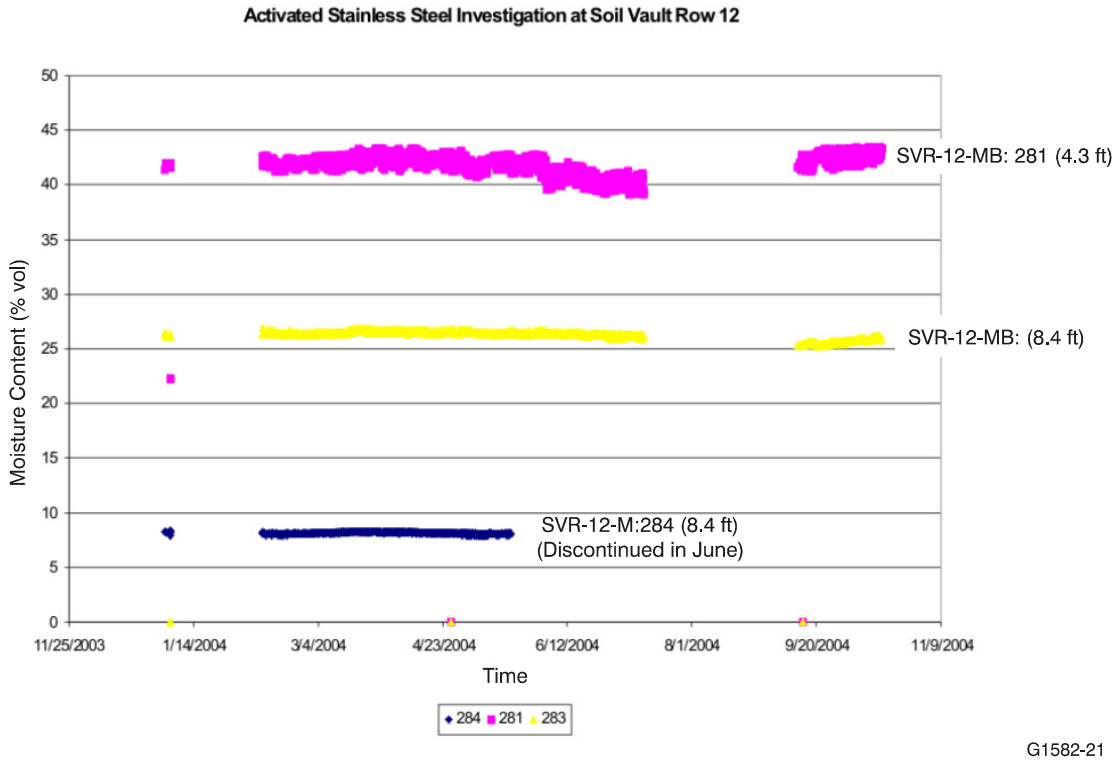


Figure A-13. Moisture measurements from probes deployed in the Activated Stainless Steel Investigation at Soil Vault Row 12.

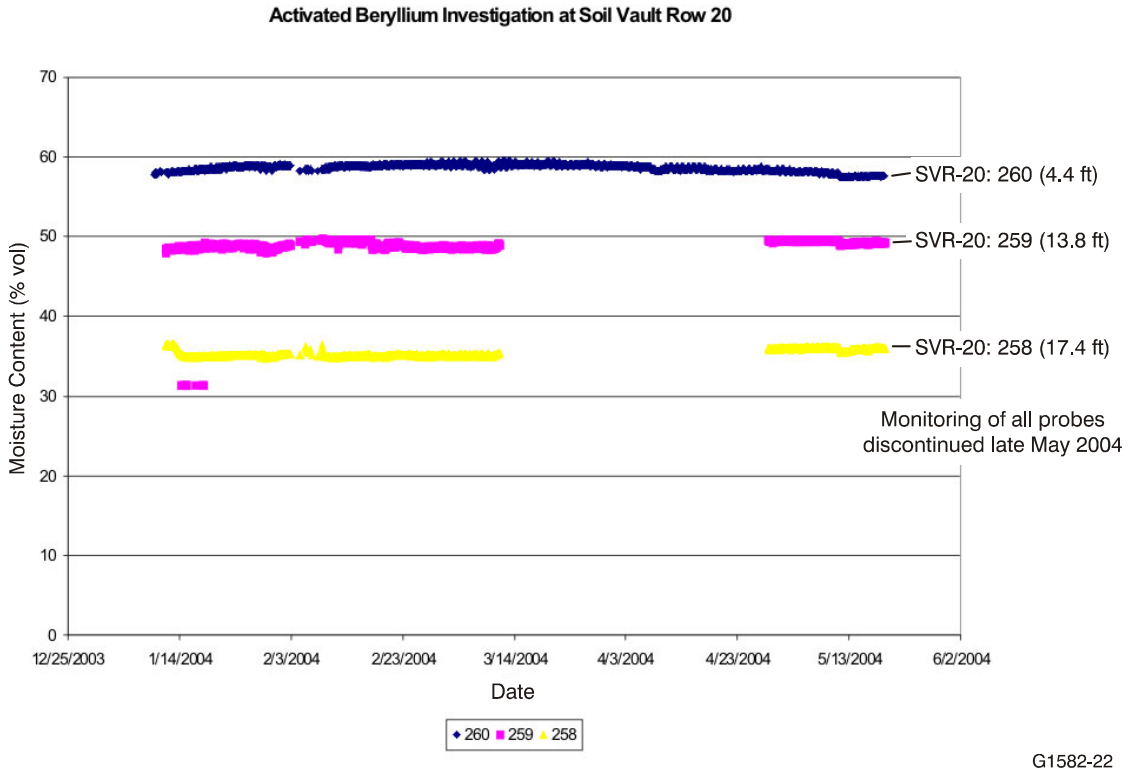


Figure A-14. Moisture measurements from probes deployed in the Activated Beryllium Investigation at Soil Vault Row 20.

Appendix B

Data for the Direct-Push Type B Tensiometers Deployed at the Subsurface Disposal Area during Fiscal Year 2004

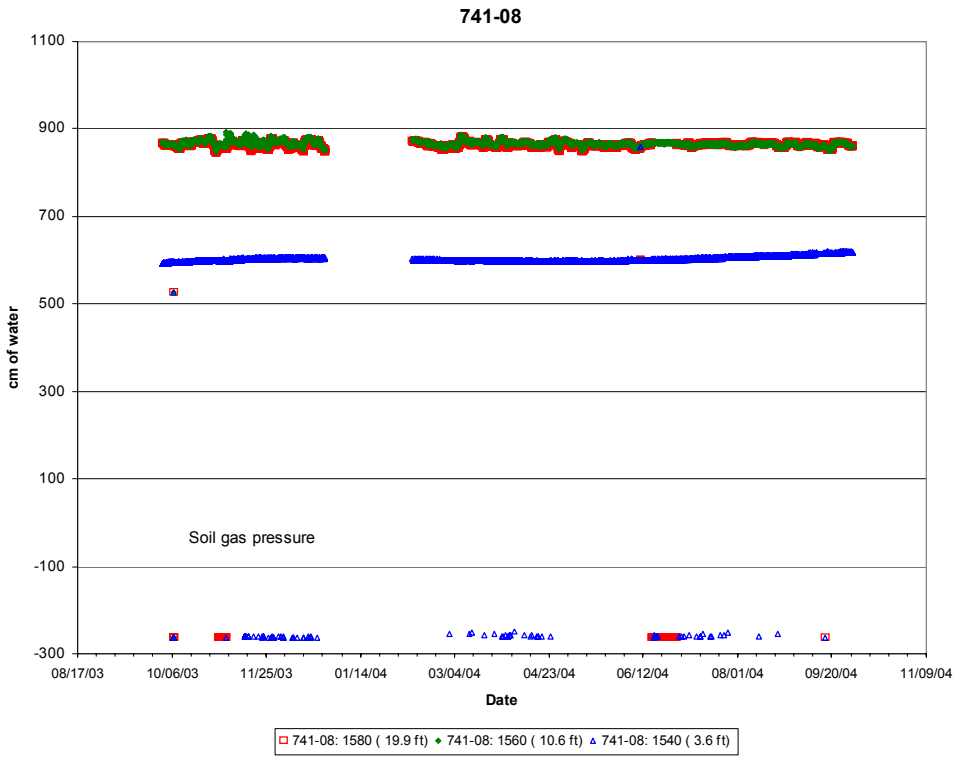
Appendix B

Data for the Direct-Push Type B Tensiometers Deployed at the Subsurface Disposal Area during Fiscal Year 2004

This appendix contains charts of plotted data from direct-push Type B tensiometers. The following plots show the raw soil gas and soil-water potential data.

- Soil gas pressure—The top graph is the raw soil-water pressure from the upper sensor and is presented as recorded with no modification. The sensor is referenced to absolute pressure.

- Soil-water potential (absolute)—The bottom graph is the raw (absolute) soil-water pressure as recorded by the lower transducer, with no modification.



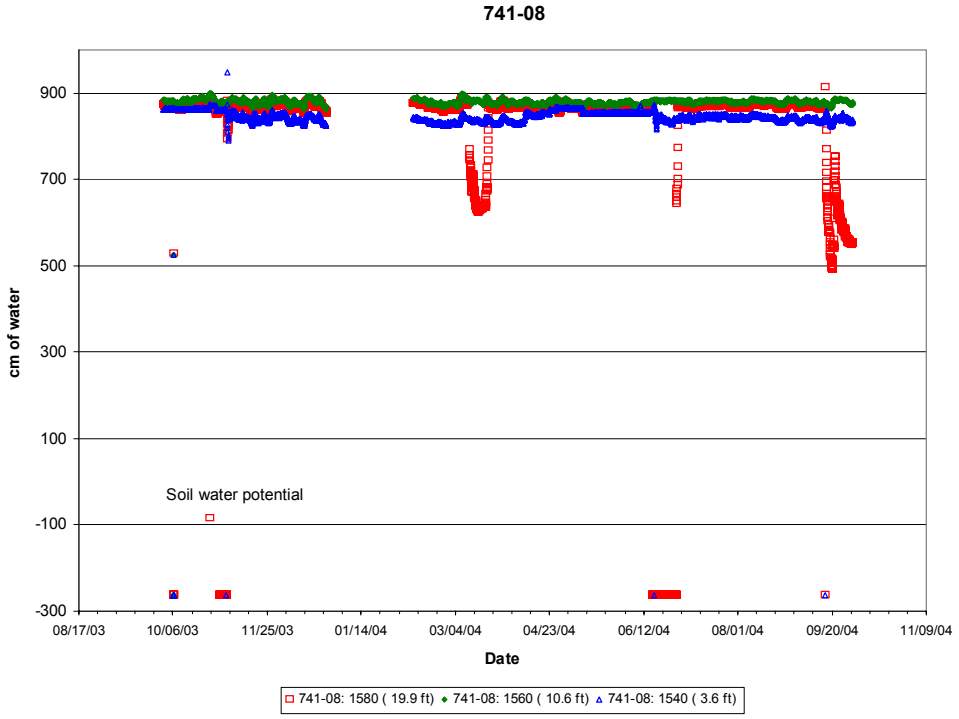


Figure B-1. Cluster 741-08.

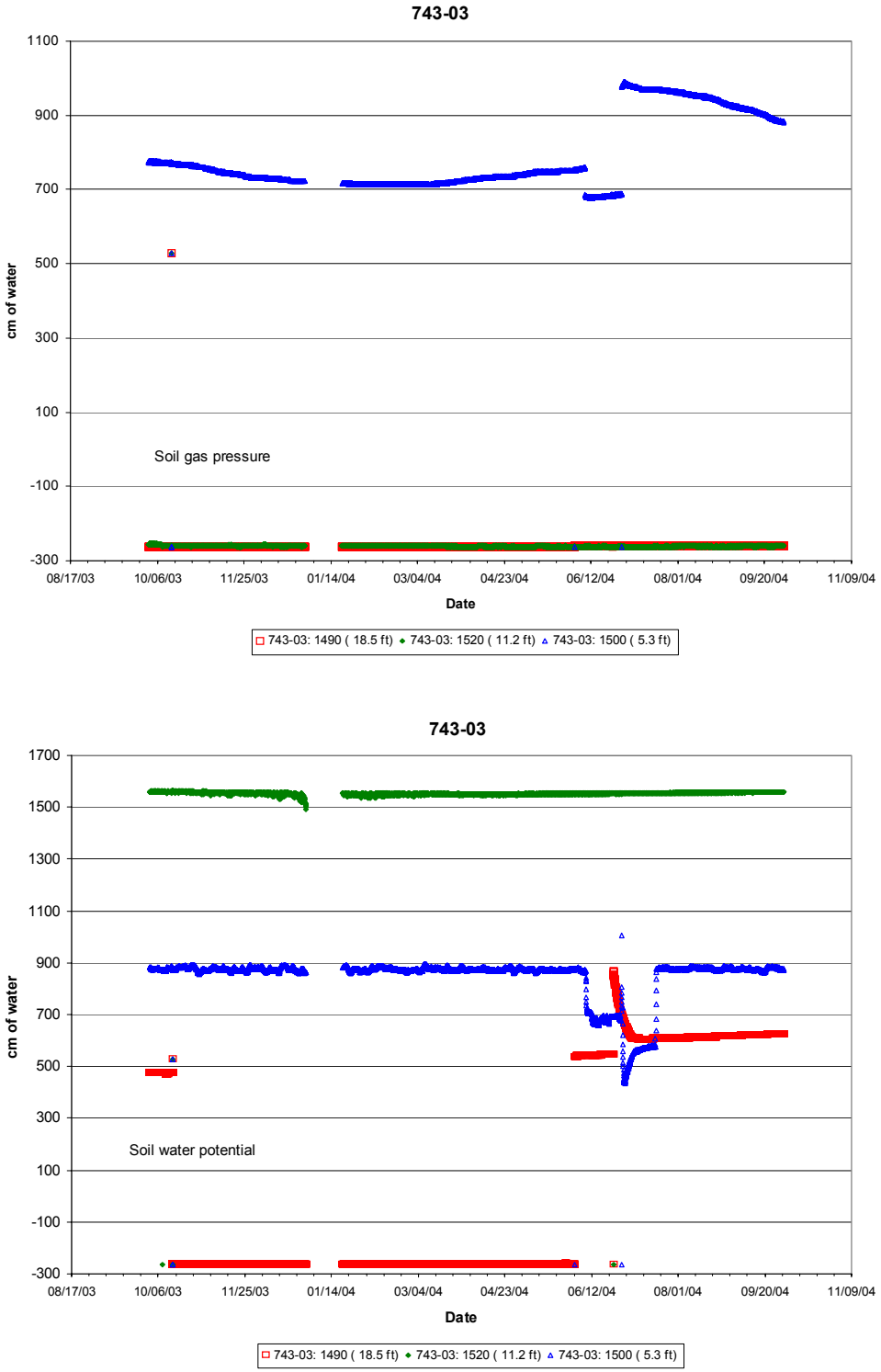
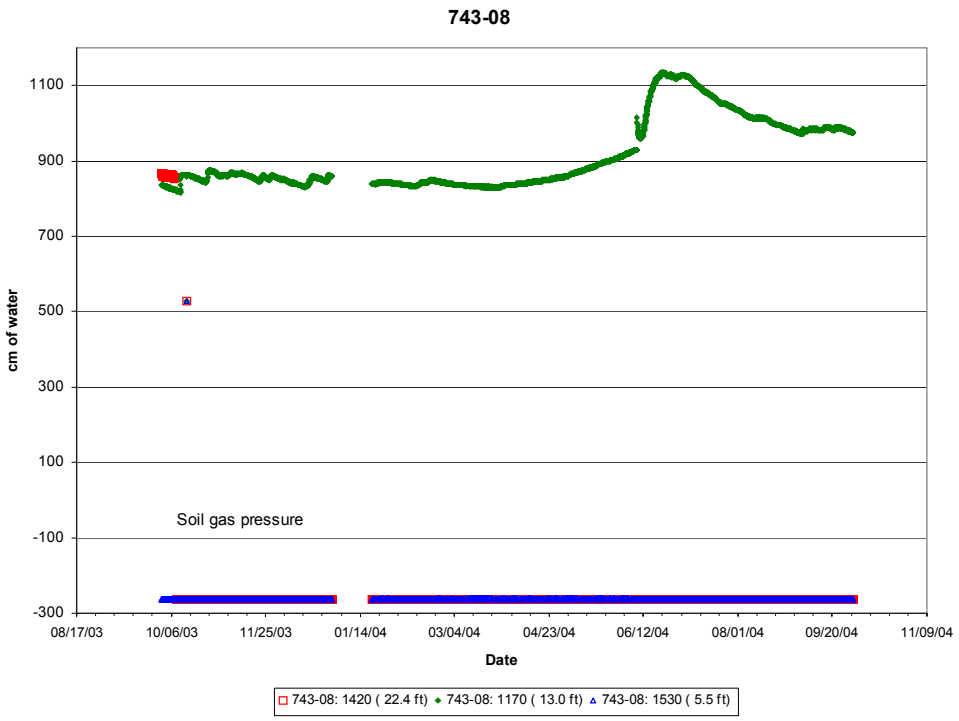


Figure B-2. Cluster 743-03.



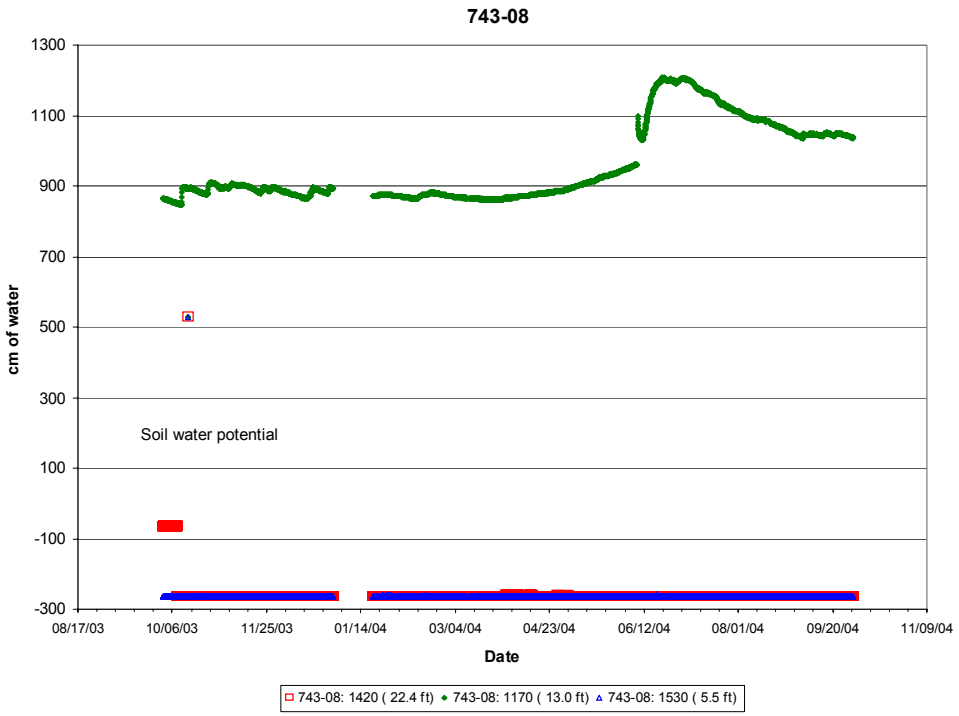


Figure B-3. Cluster 743-08.

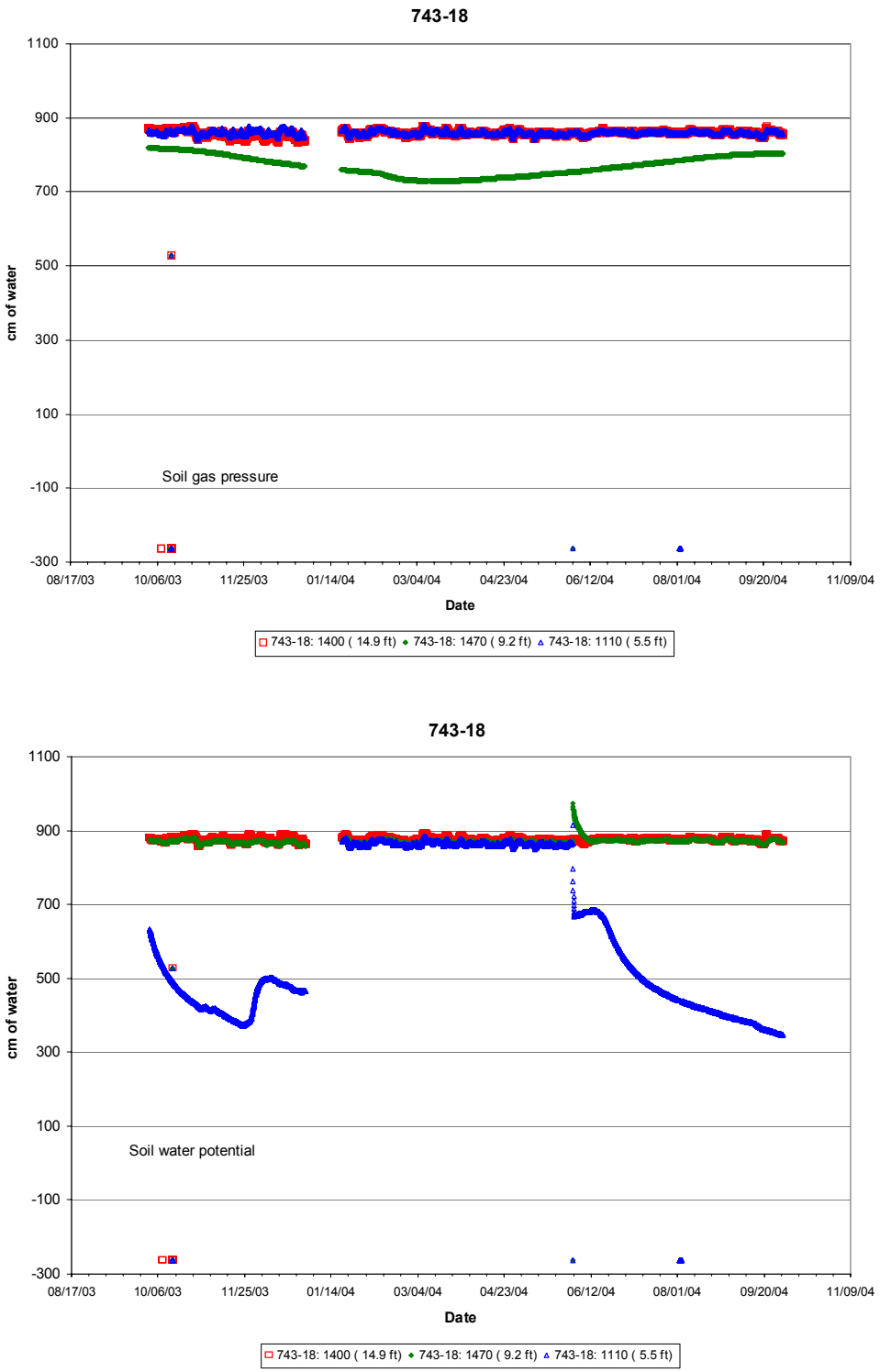


Figure B-4. Cluster 743-18.

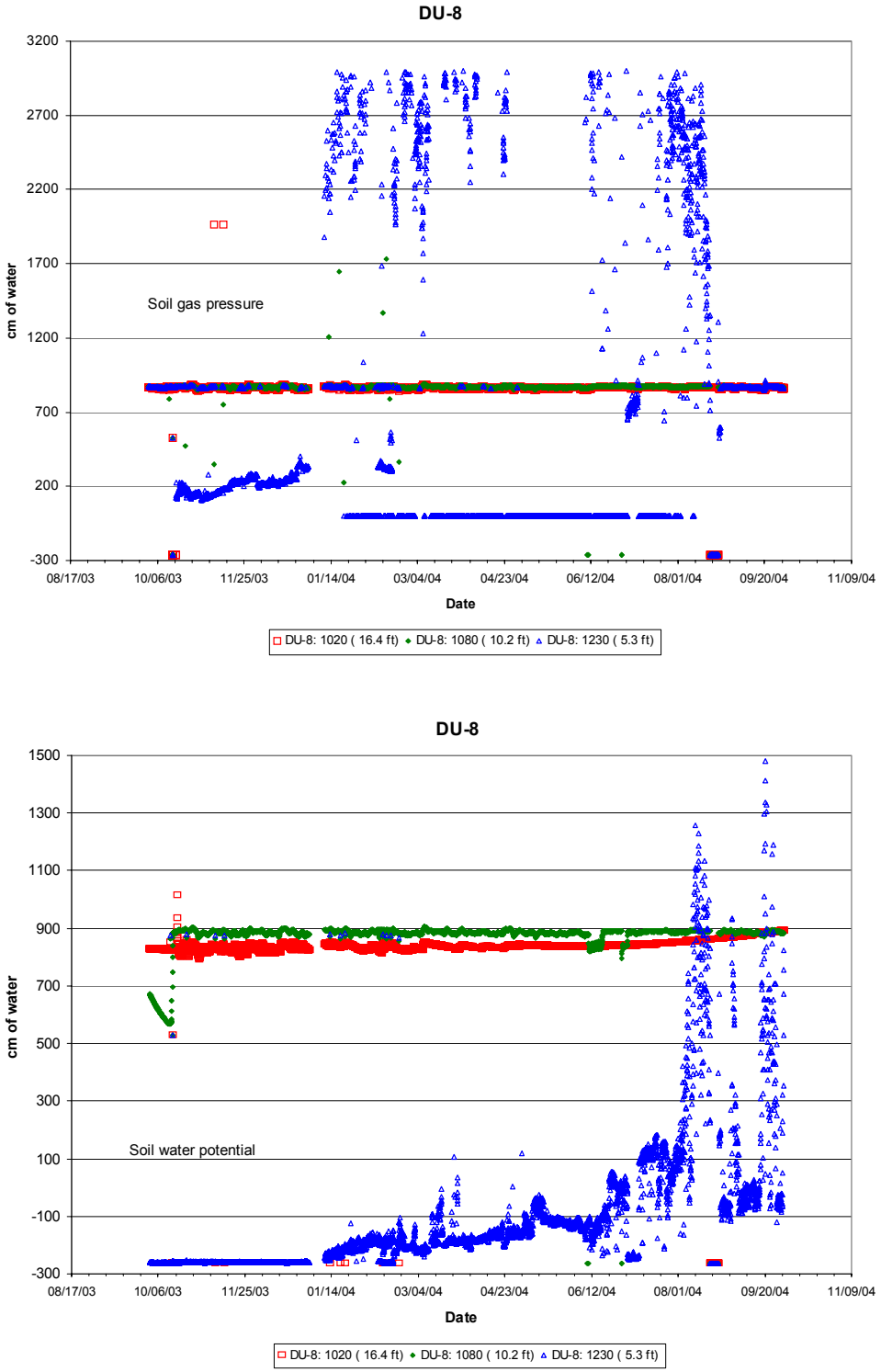


Figure B-5. Cluster DU-8.

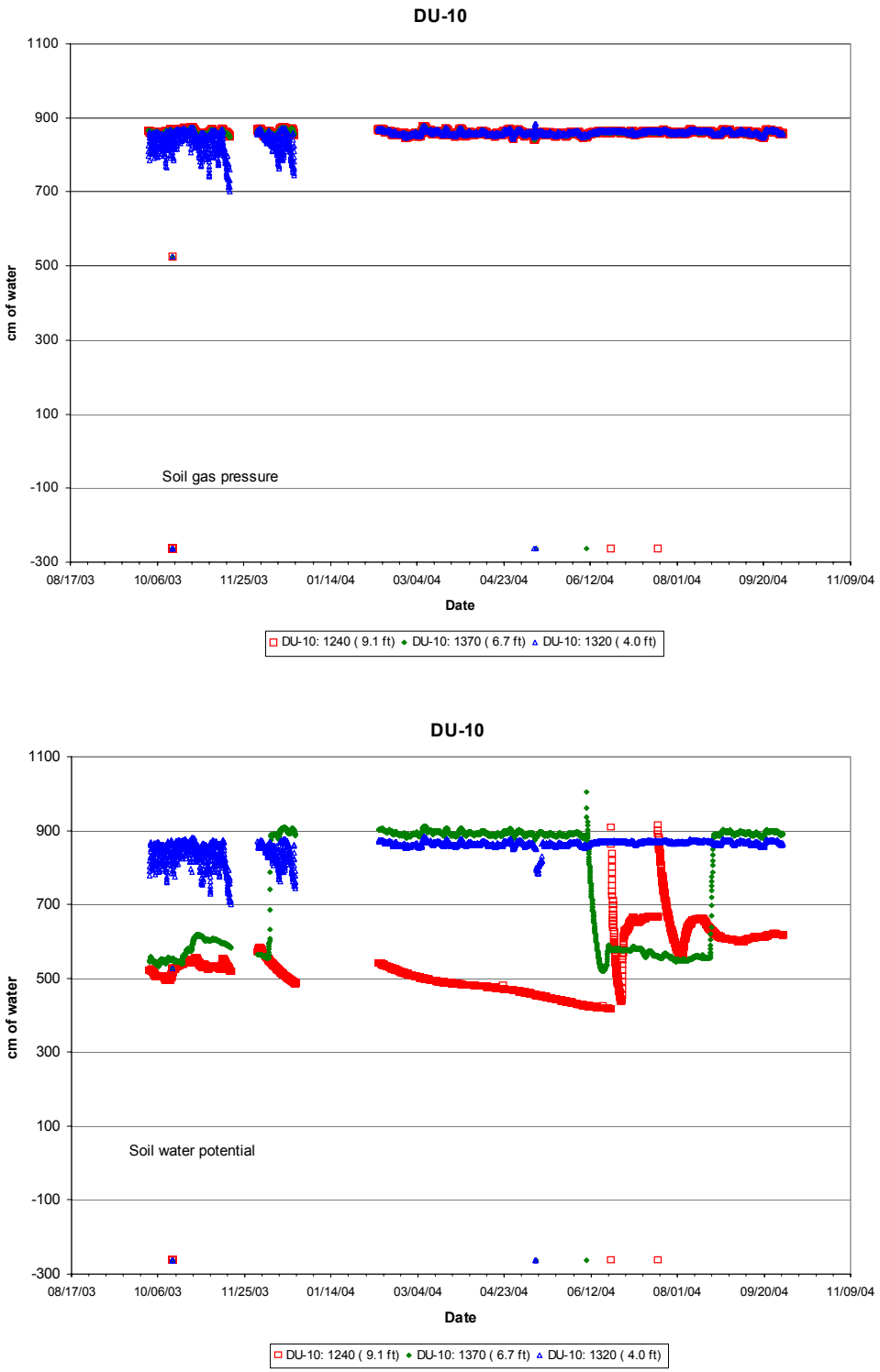


Figure B-6. Cluster DU-10.

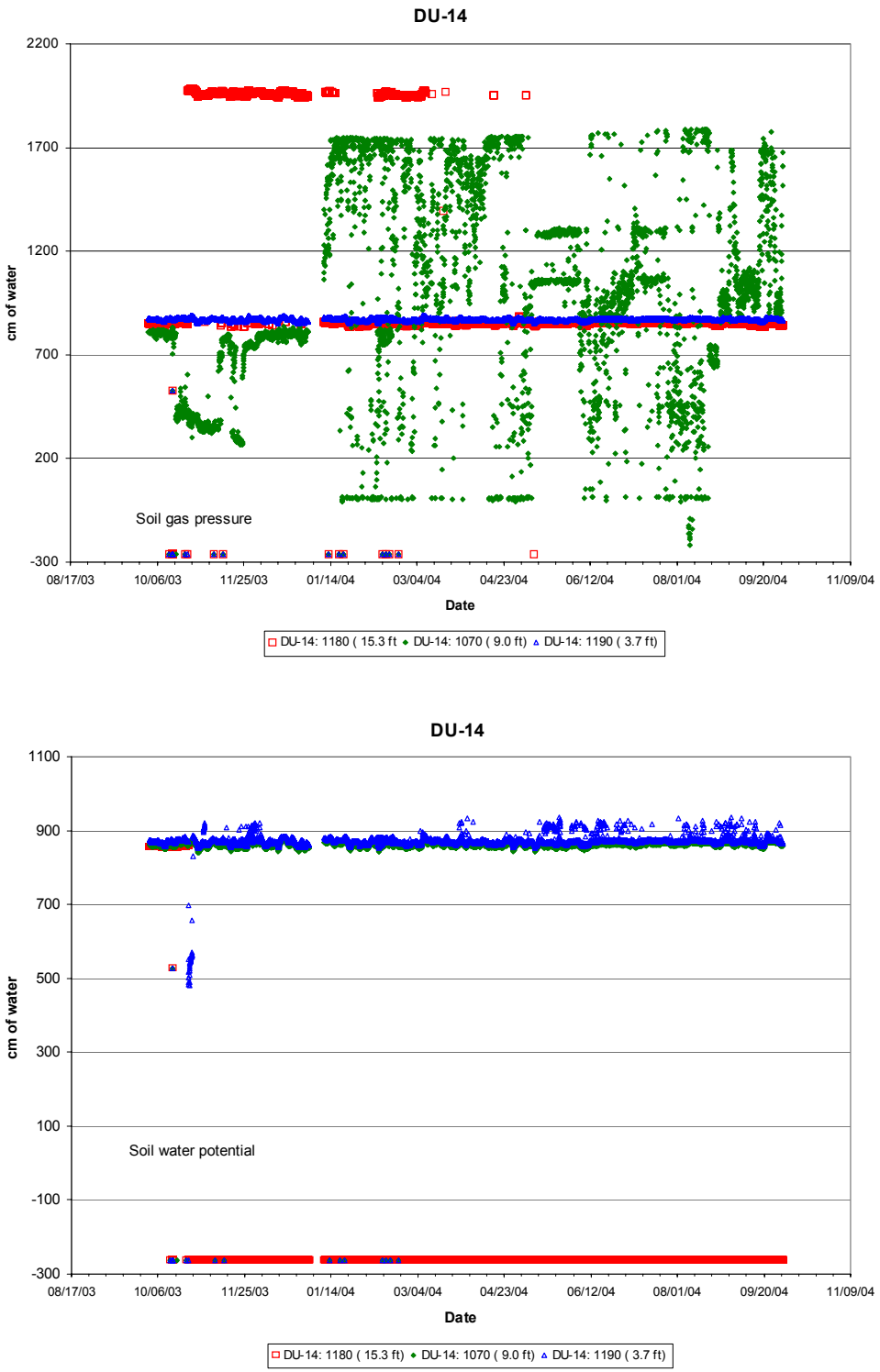


Figure B-7. Cluster DU-14.

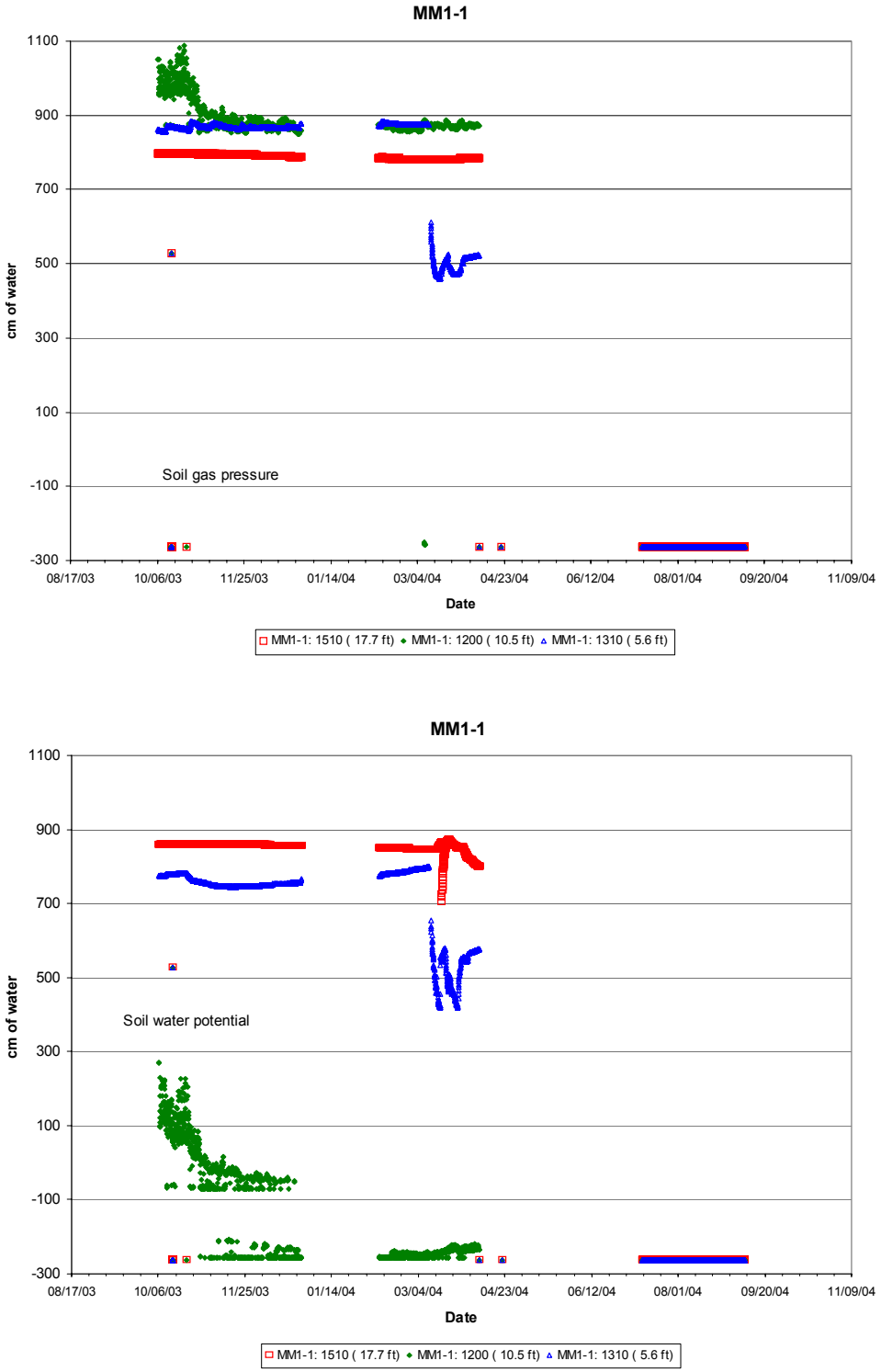


Figure B-8. Cluster MM1-1.

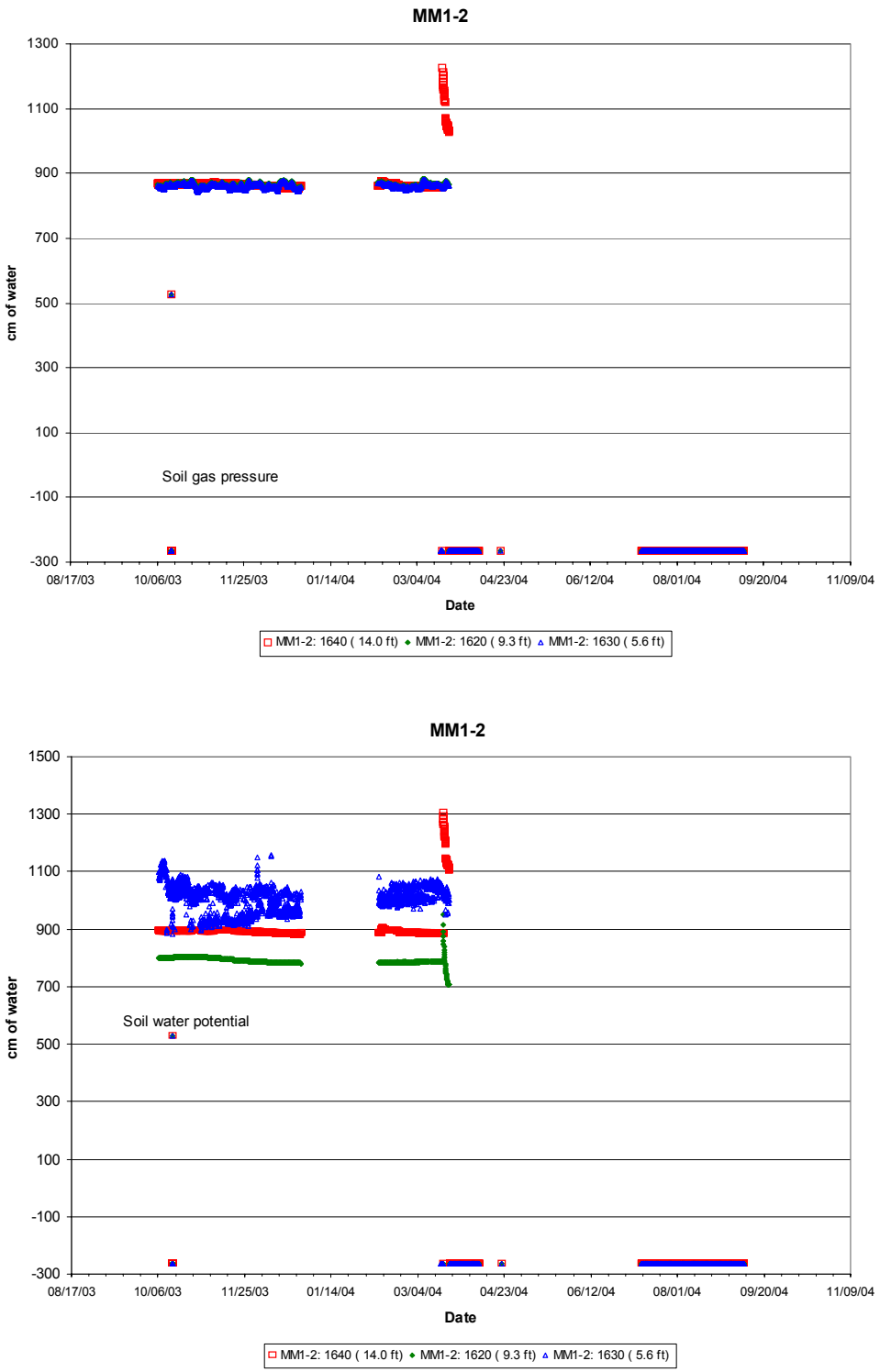


Figure B-9. Cluster MM1-2.

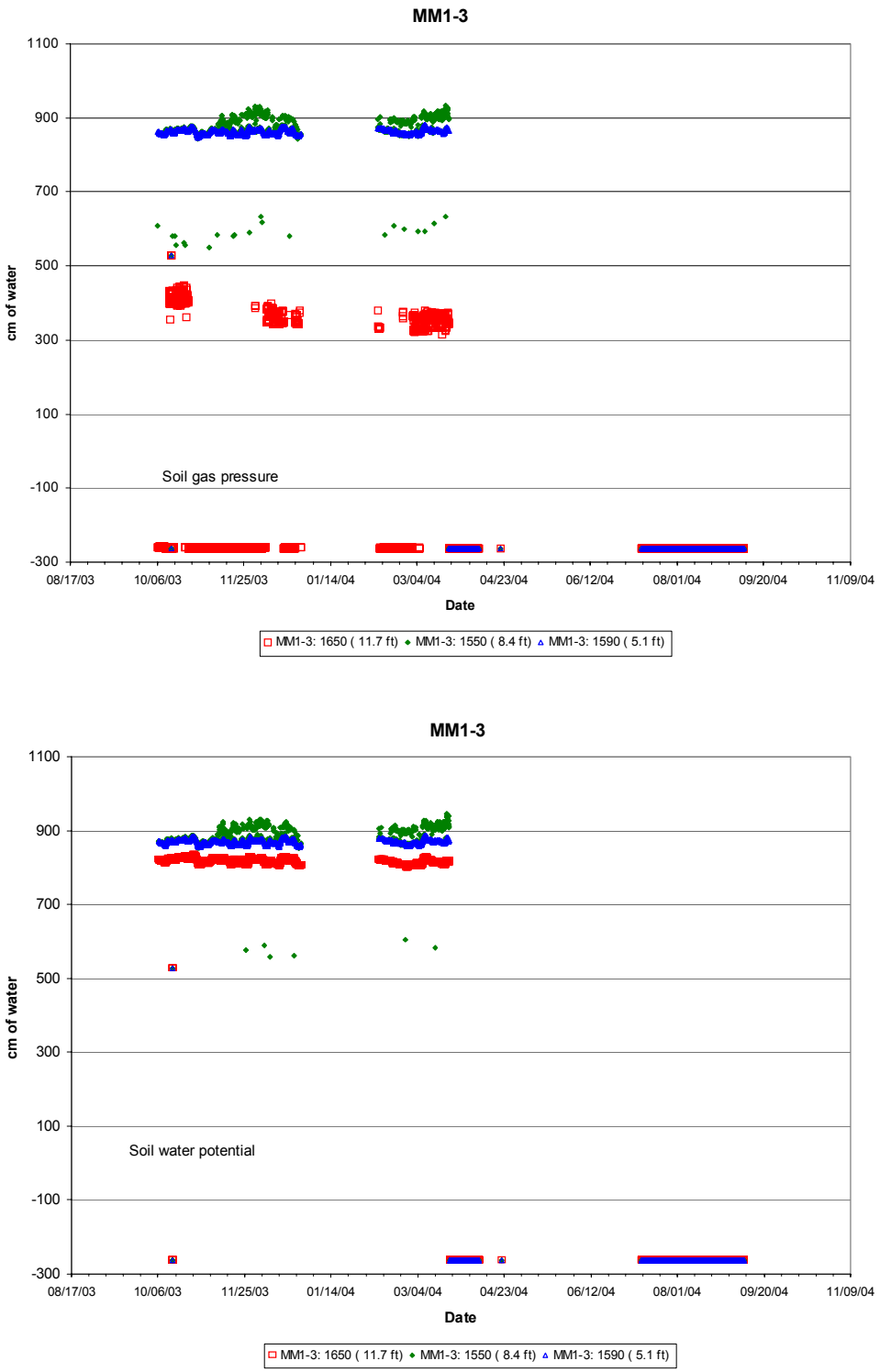


Figure B-10. Cluster MM1-3.

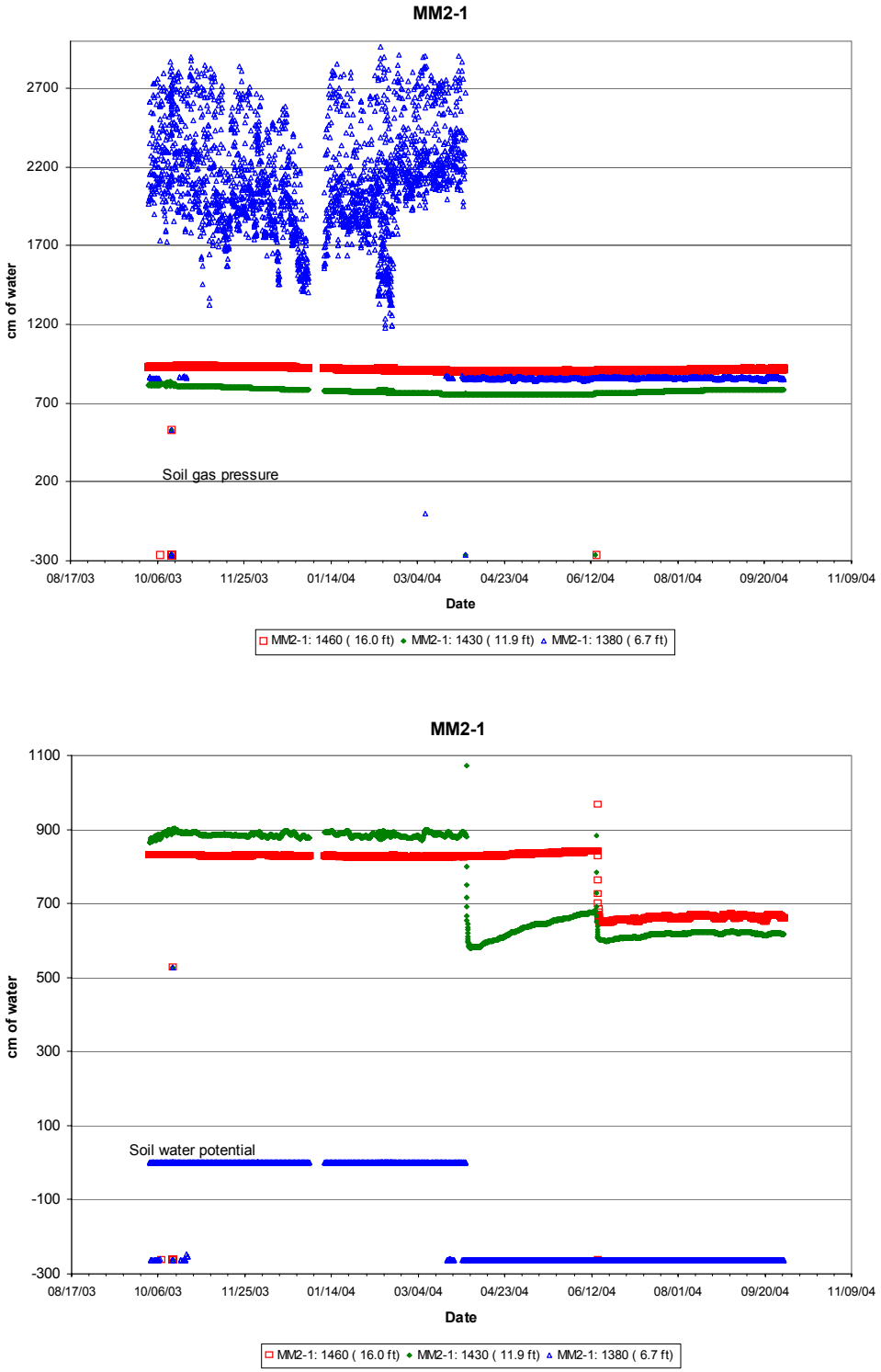


Figure B-11. Cluster MM2-1.

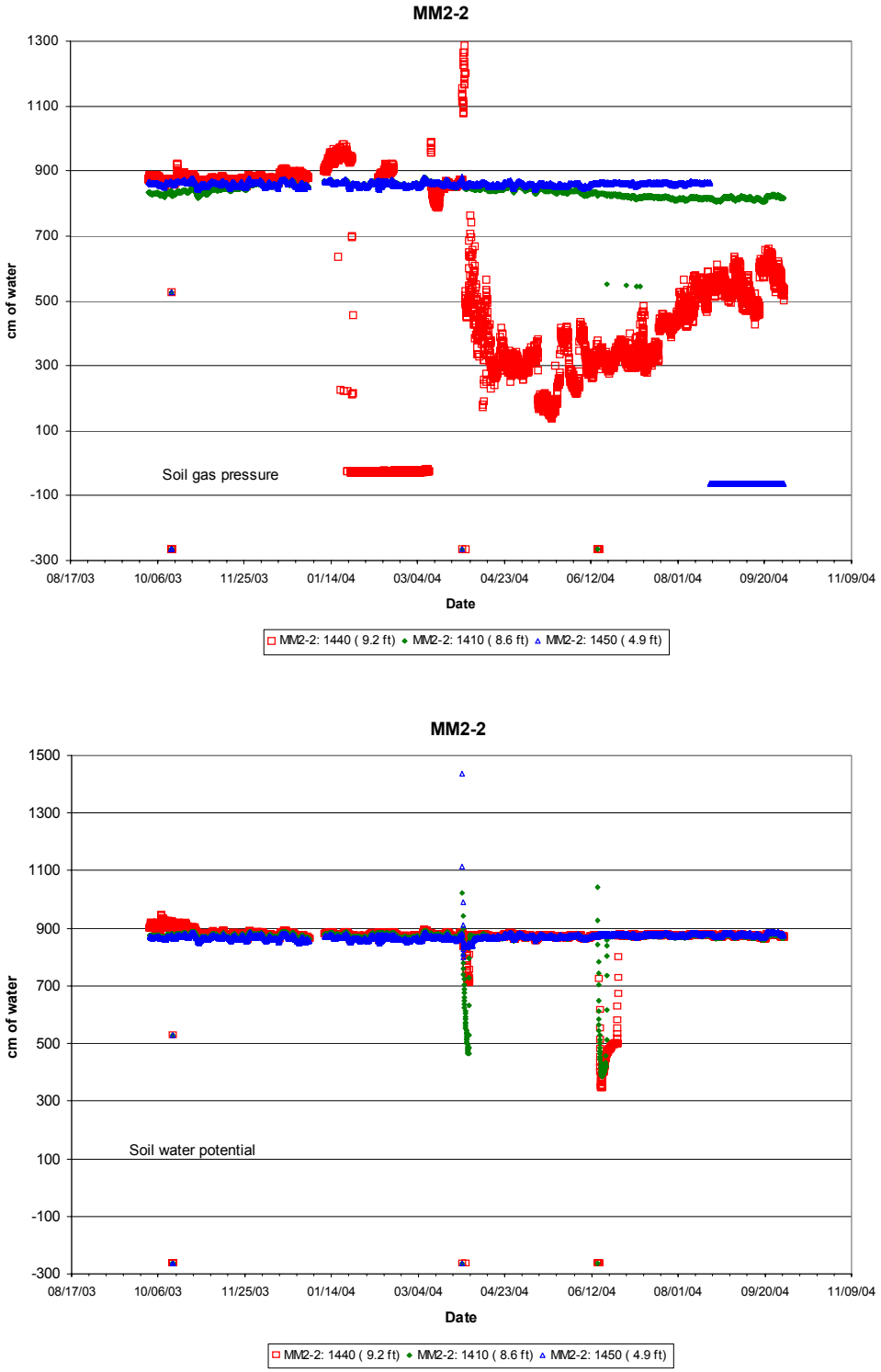


Figure B-12. Cluster MM2-2.

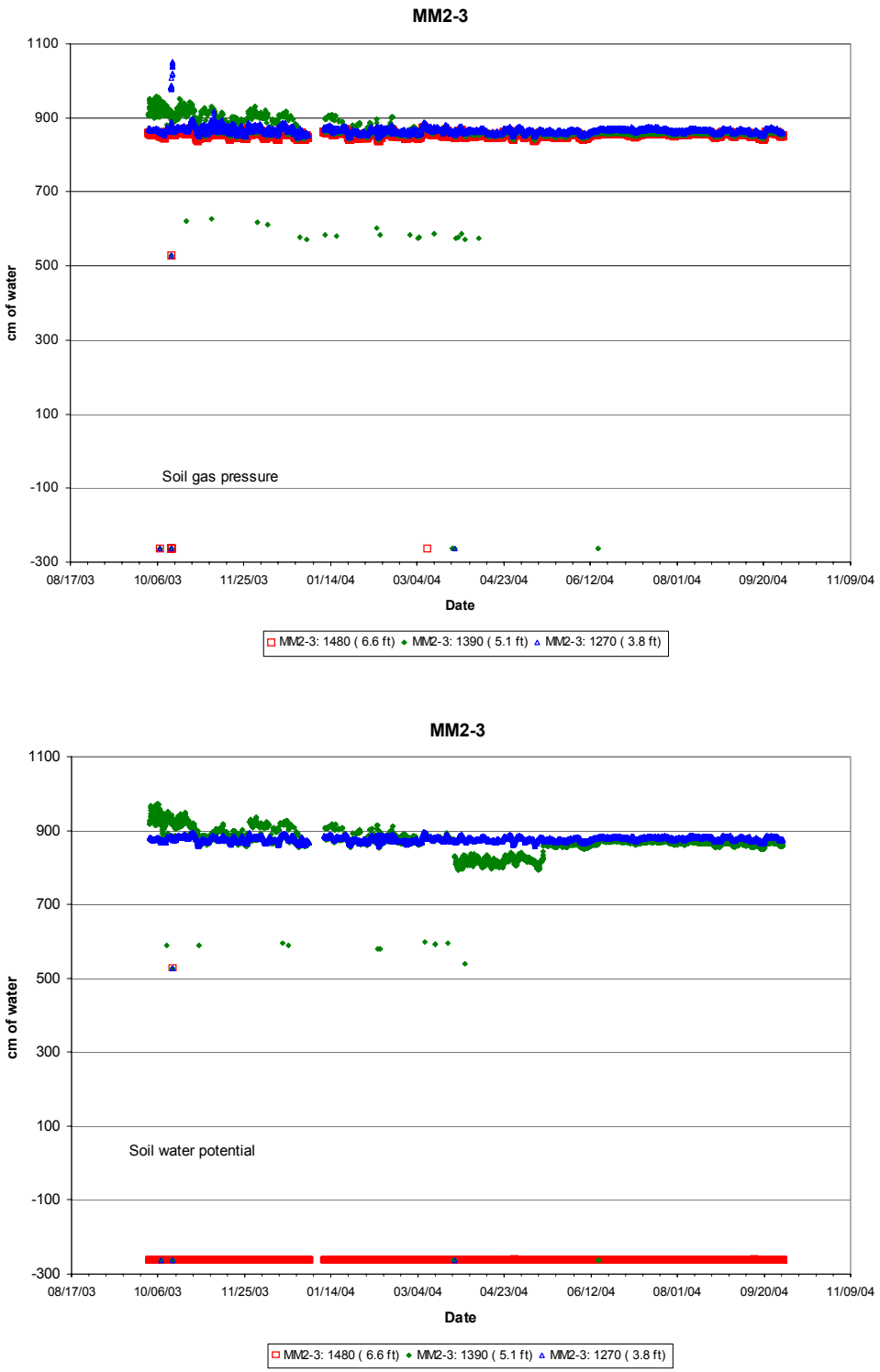


Figure B-13. Cluster MM2-3.

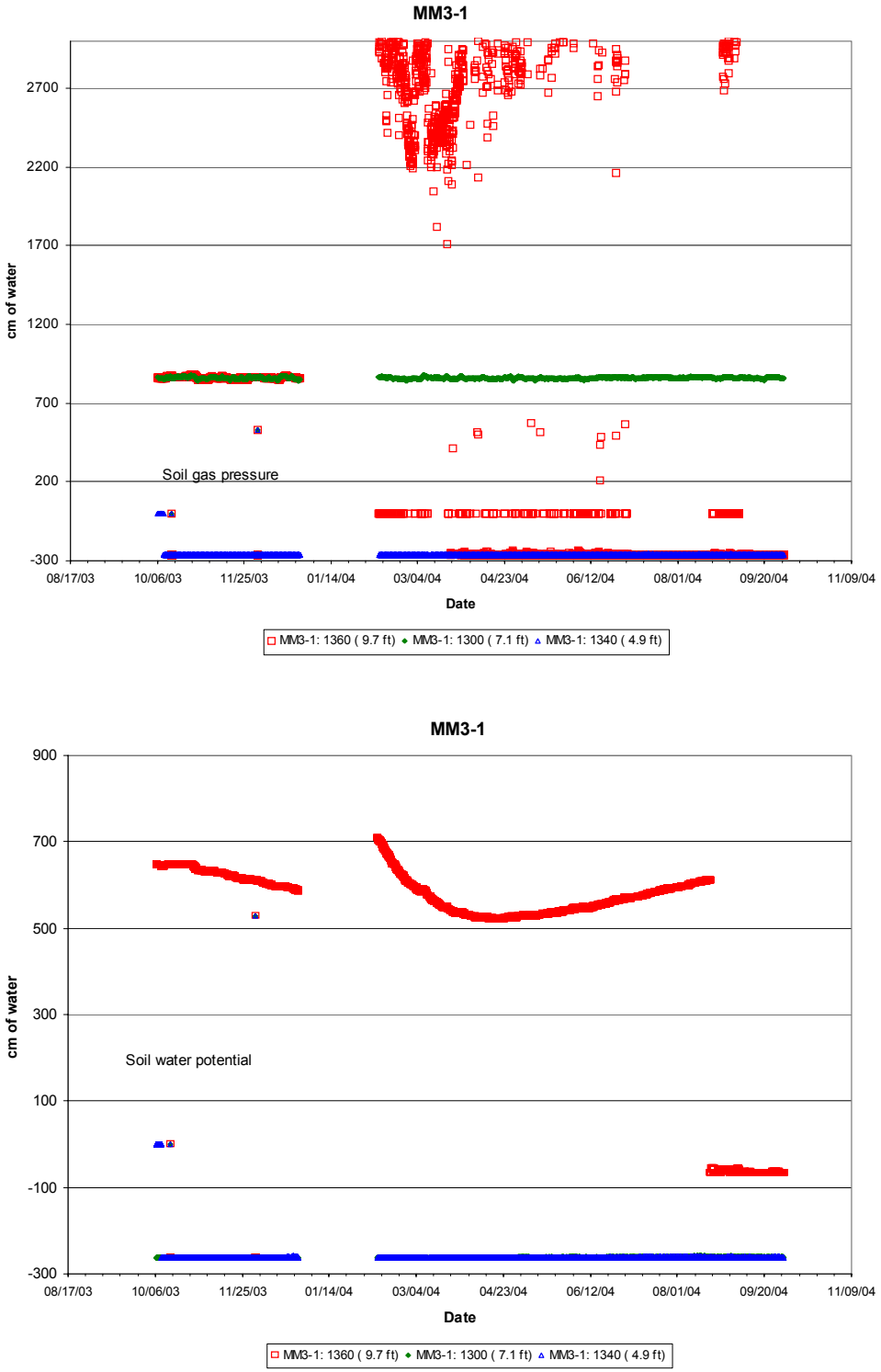


Figure B-14. Cluster MM3-1.

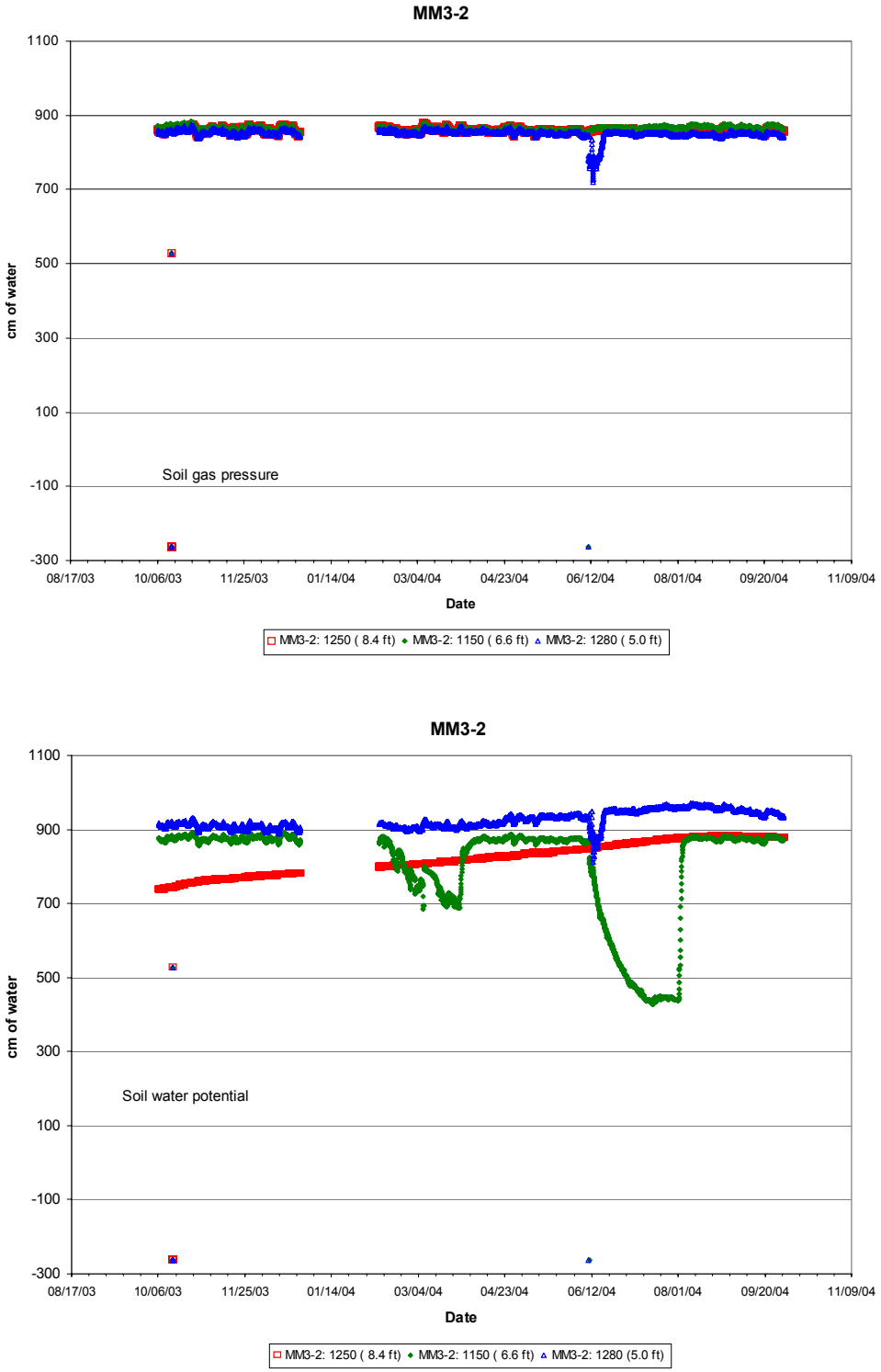


Figure B-15. Cluster MM3-2.

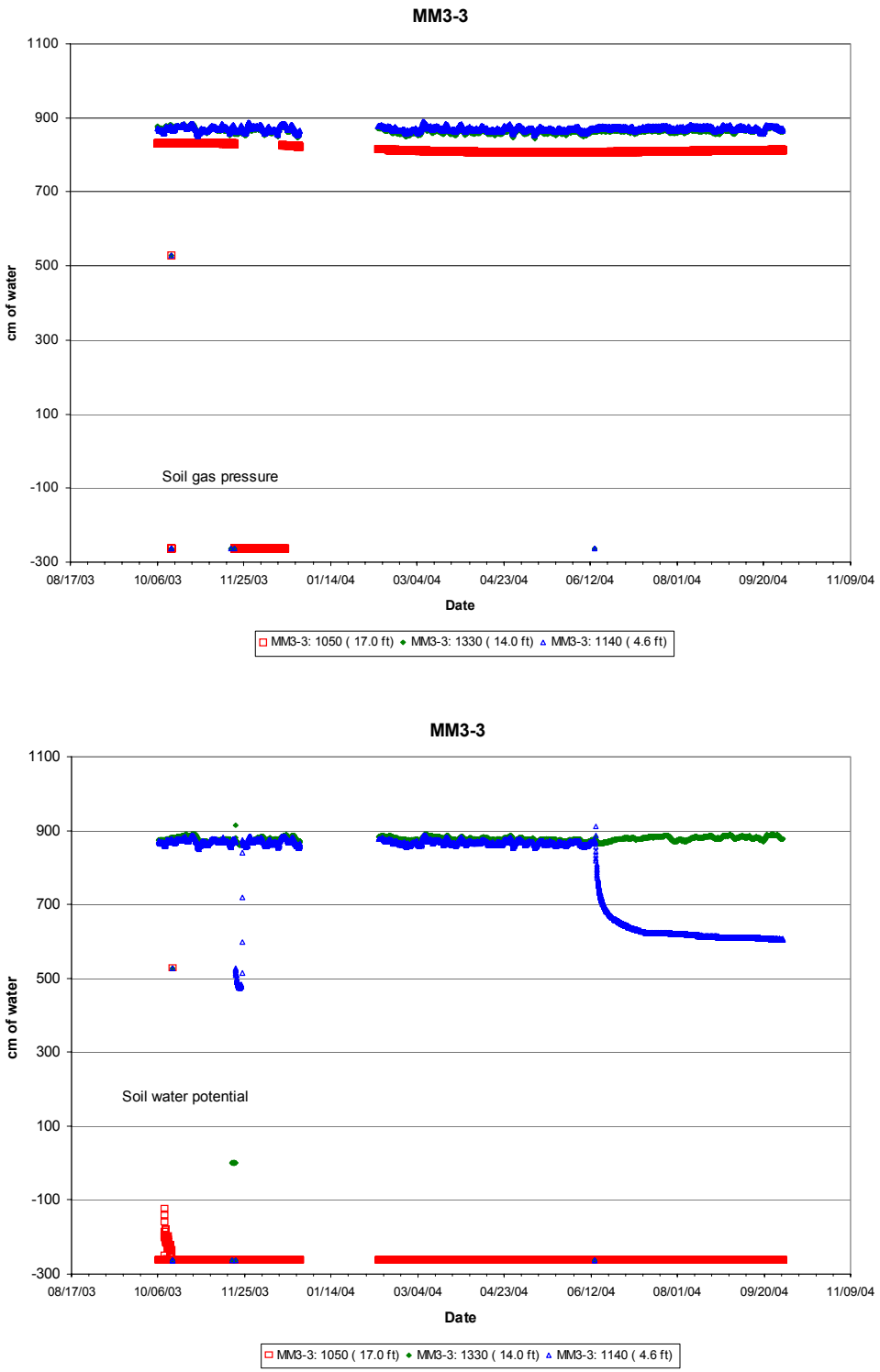


Figure B-16. Cluster MM3-3.

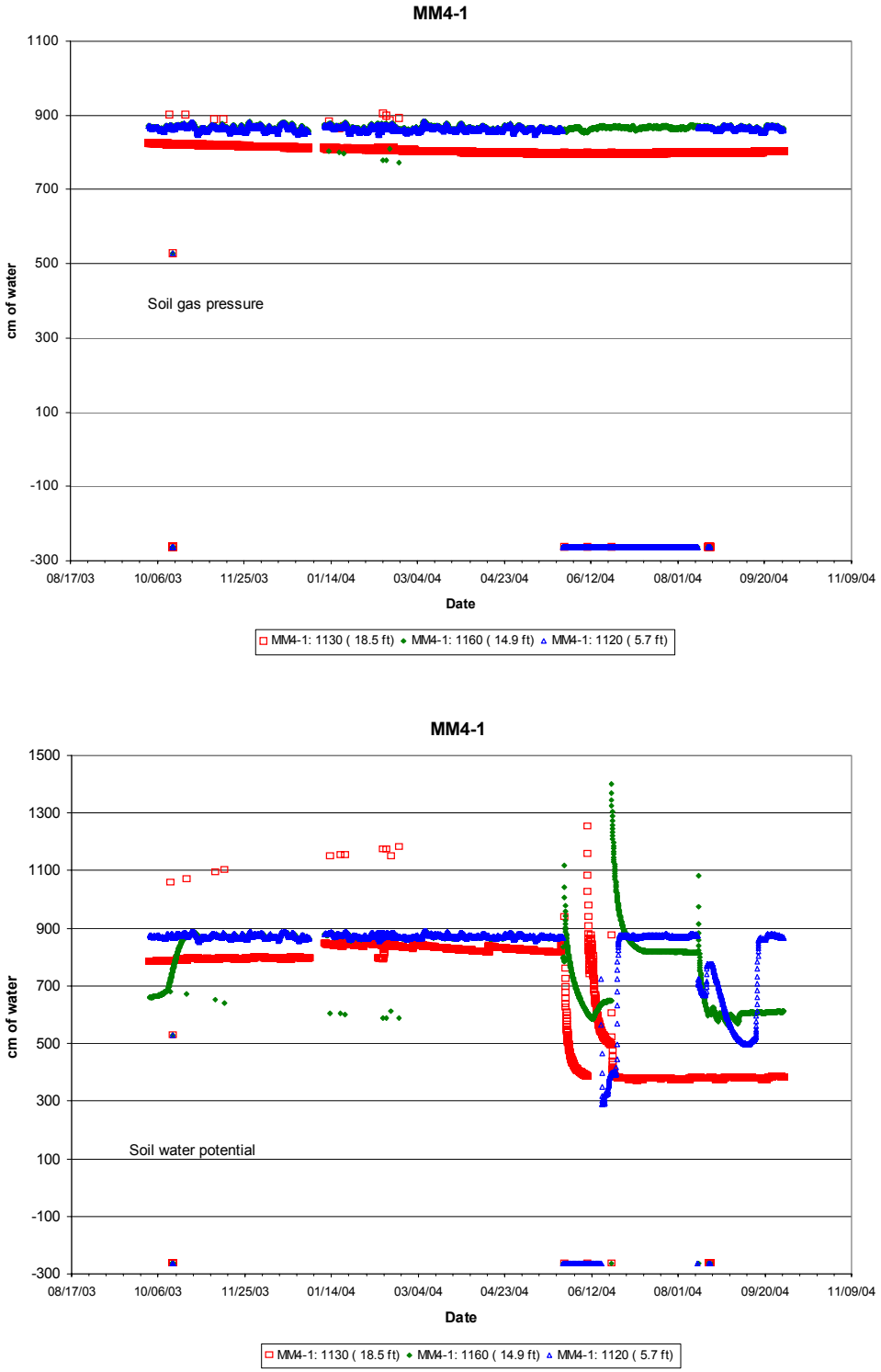


Figure B-17. Cluster MM4-1.

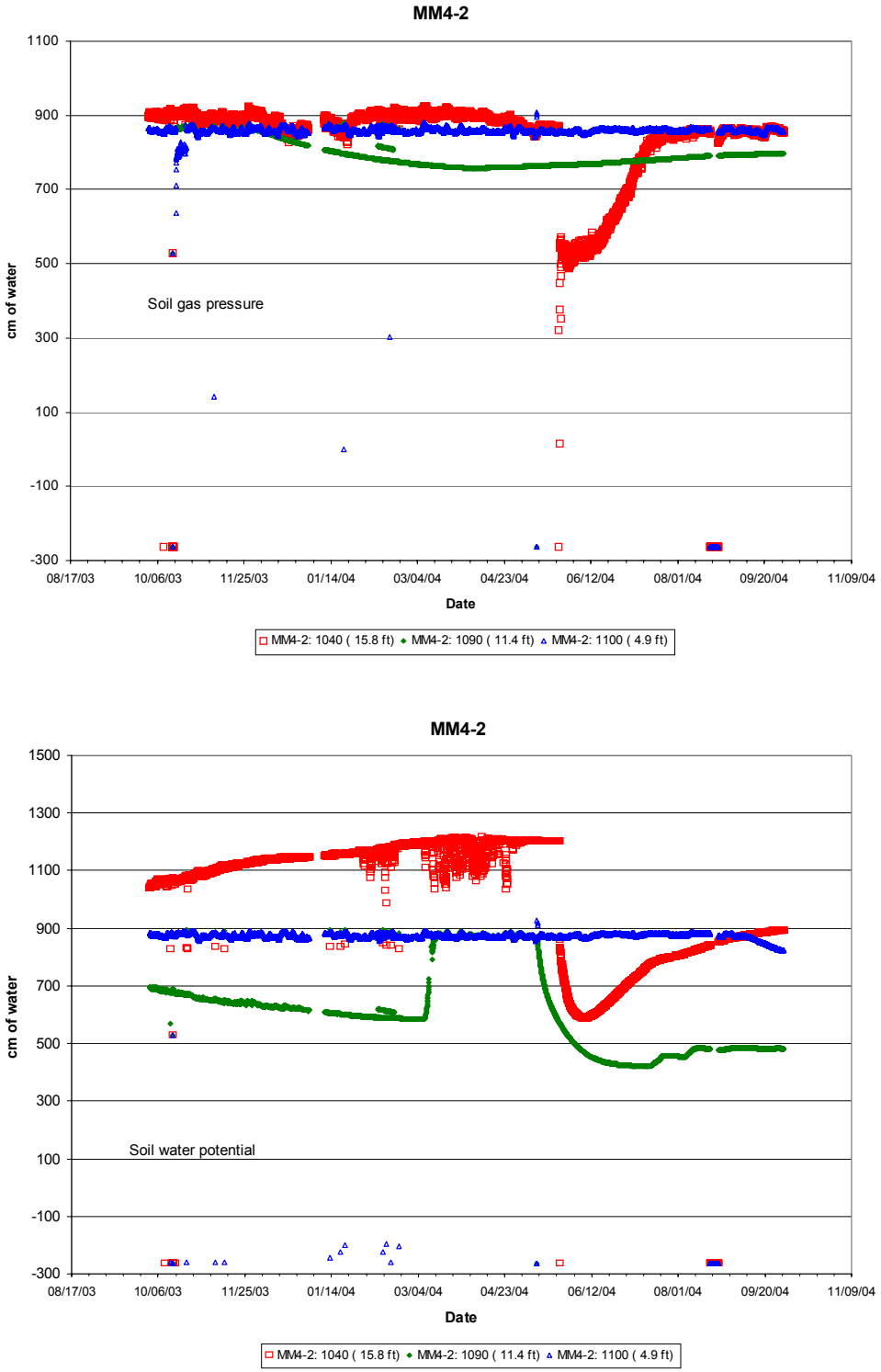


Figure B-18. Cluster MM4-2.

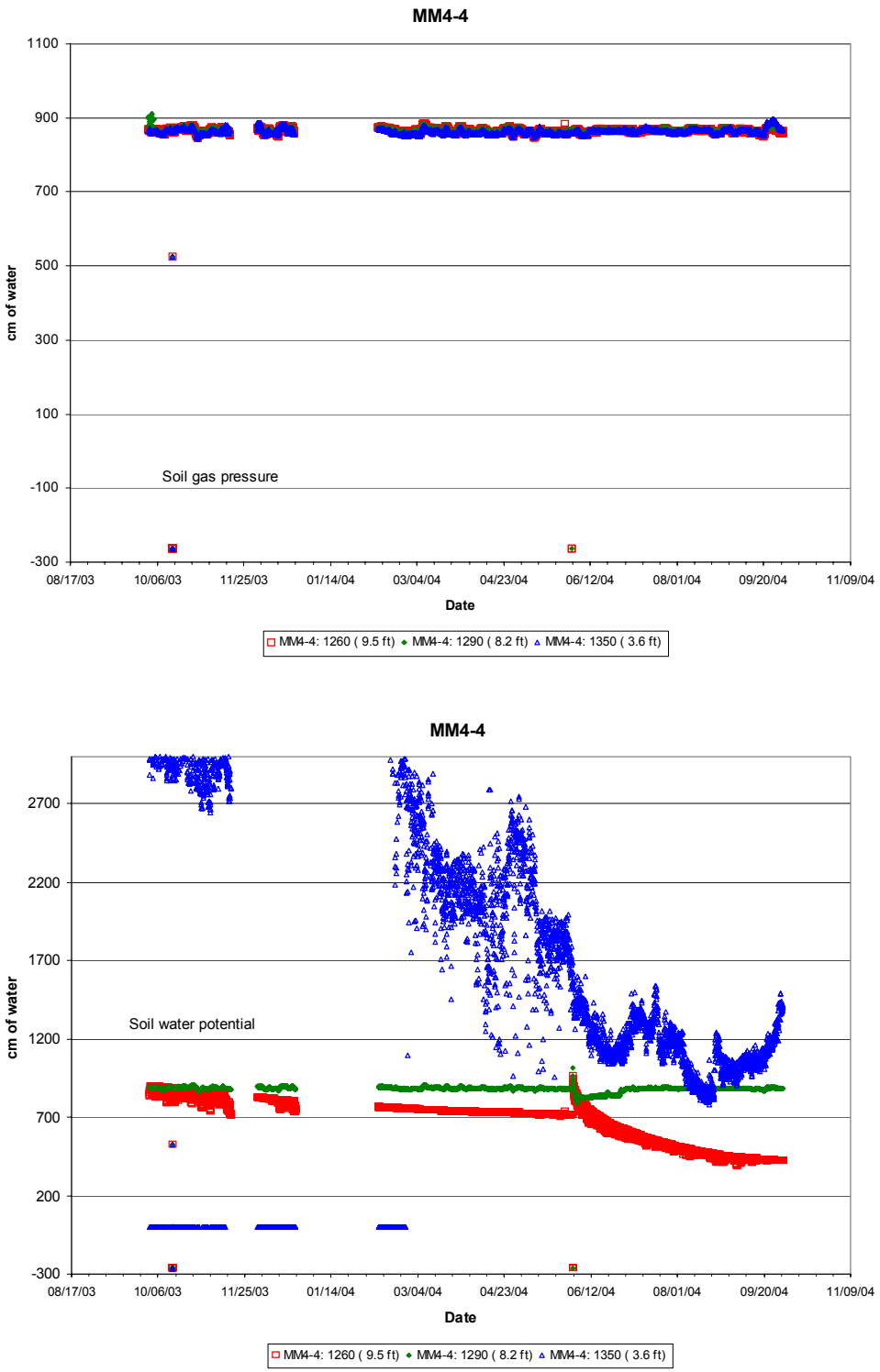


Figure B-19. Cluster MM4-4.

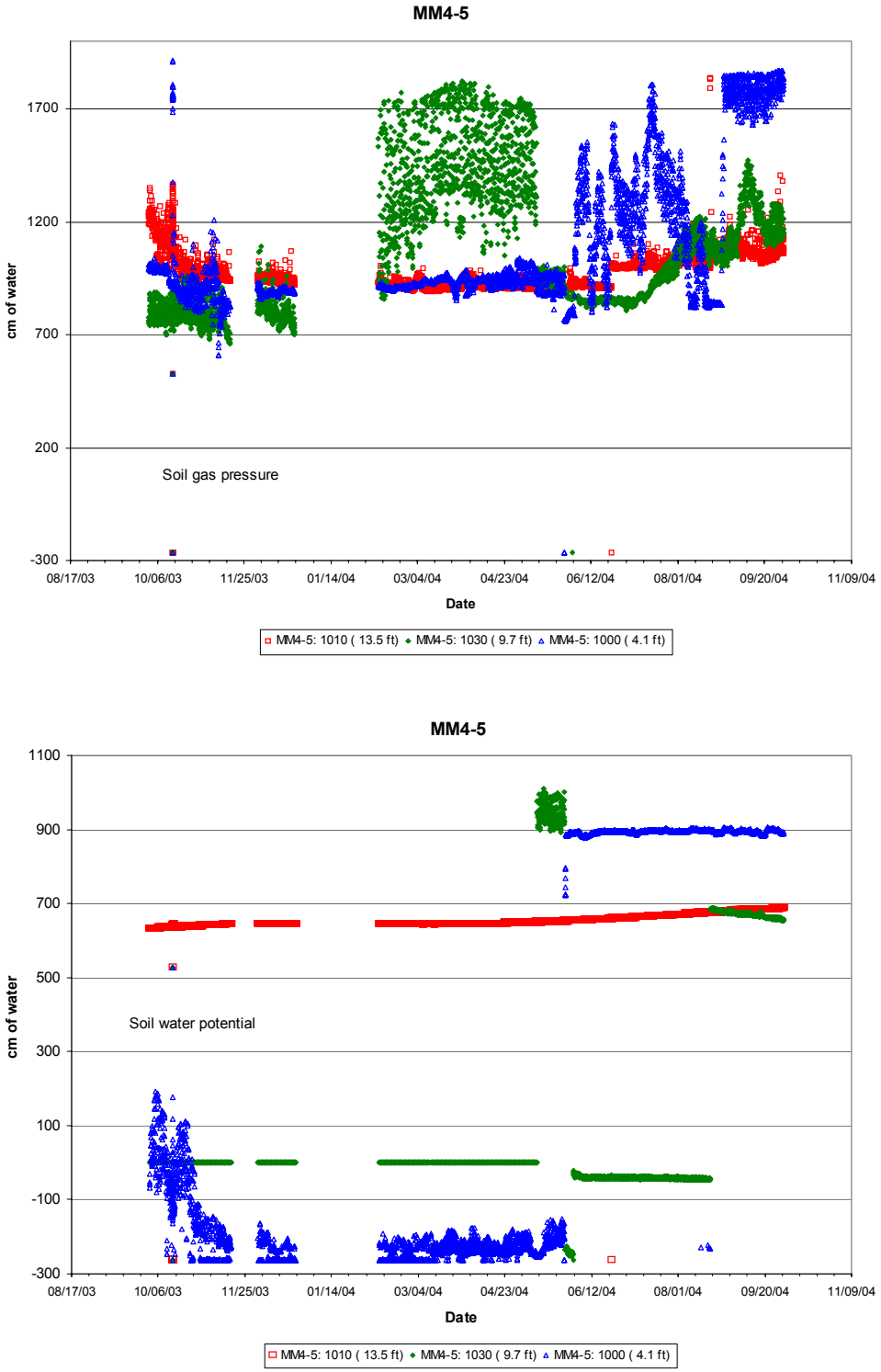


Figure B-20. Cluster MM4-5.

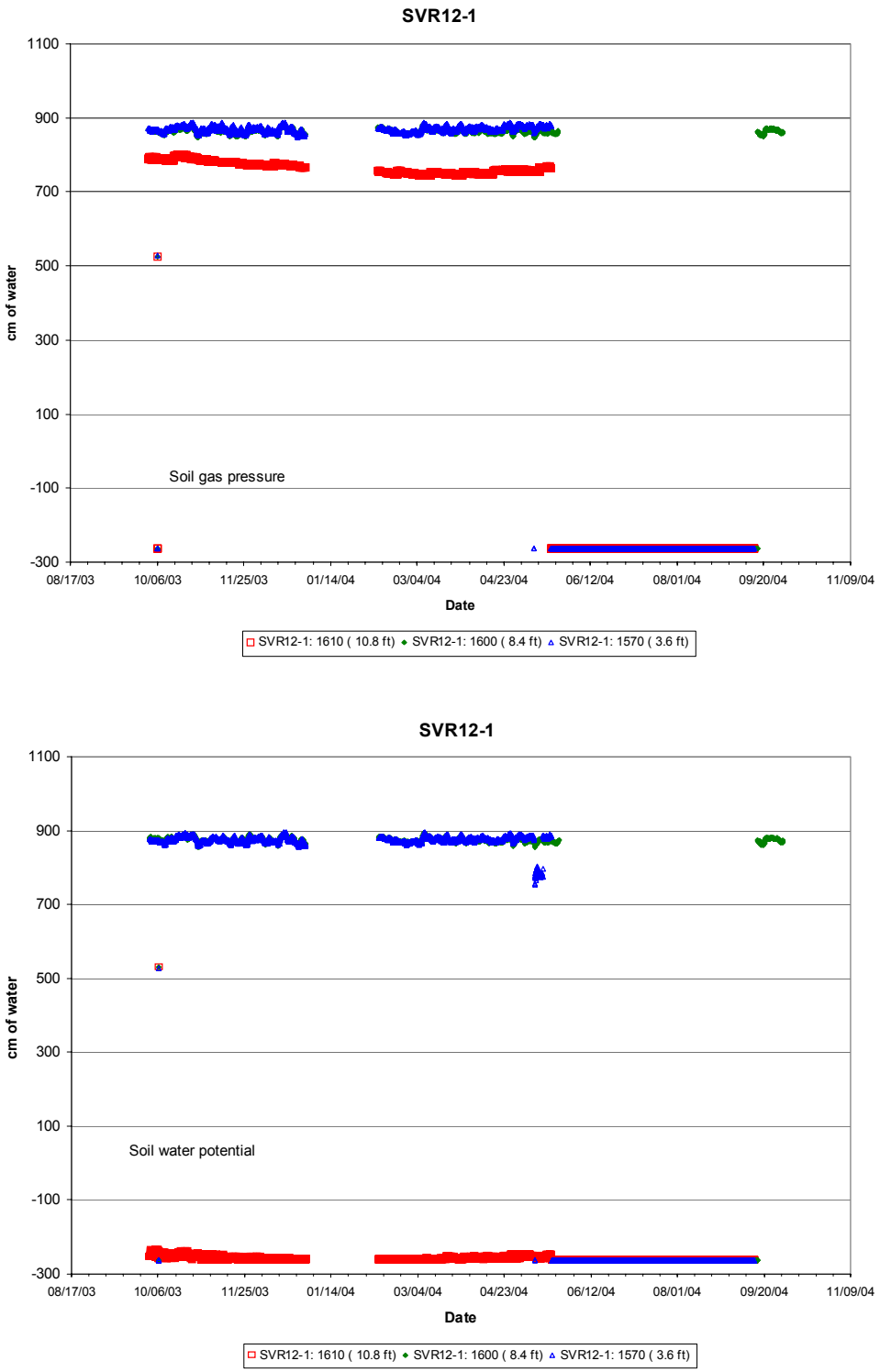


Figure B-21. Cluster SVR12-1.

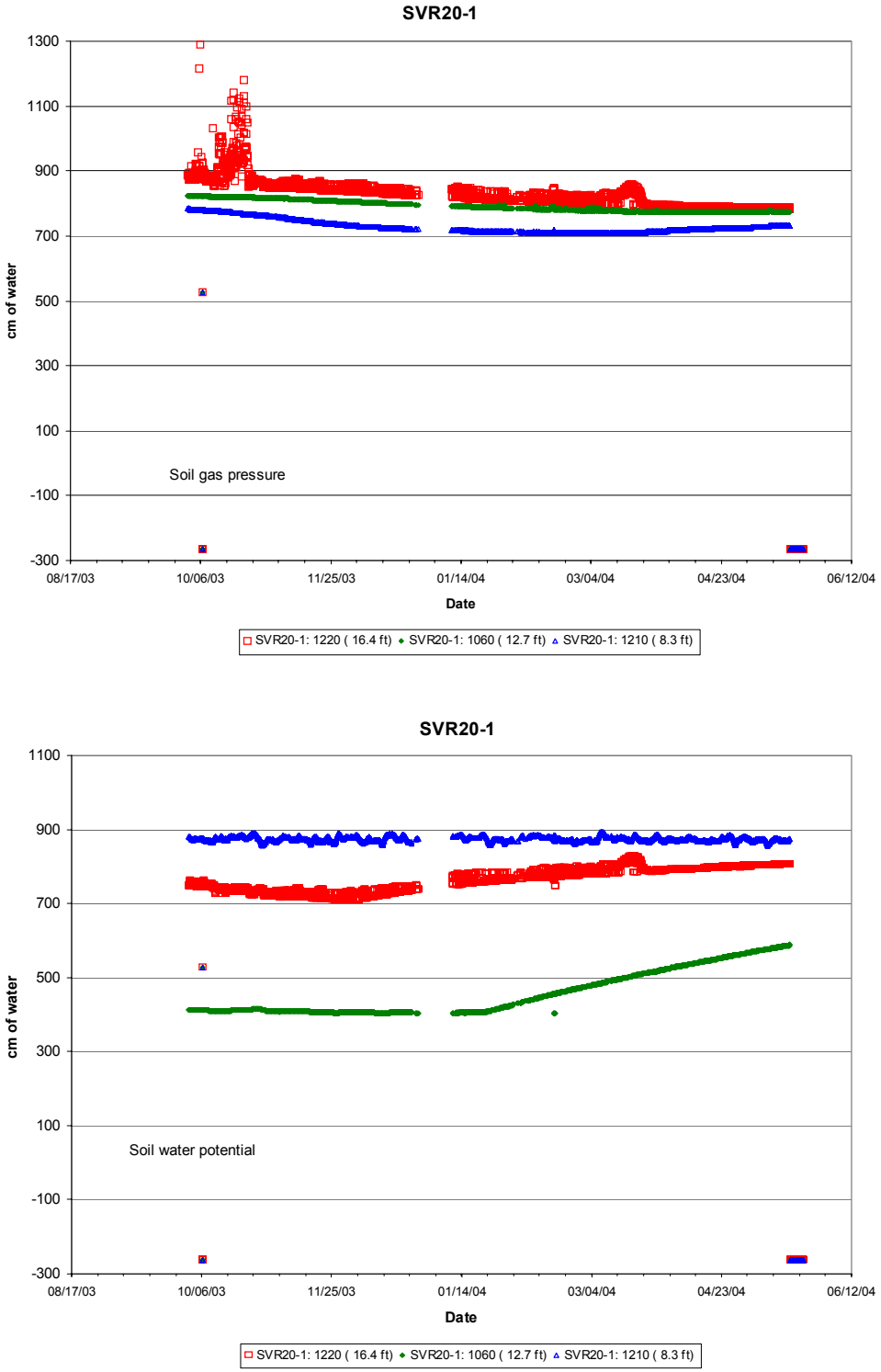


Figure B-22. Cluster SVR20-1.

Appendix C

Perched Water Plot from the Neutron Access Tubes for Fiscal Year 2004

Appendix C

Perched Water Plot from the Neutron Access Tubes for Fiscal Year 2004

The following are water level data from neutron access tubes located inside the SDA. The data show a change in water level readings in NAT-6, -11, -12, and -13 on June 19, 2004, in apparent response to a large precipitation event.

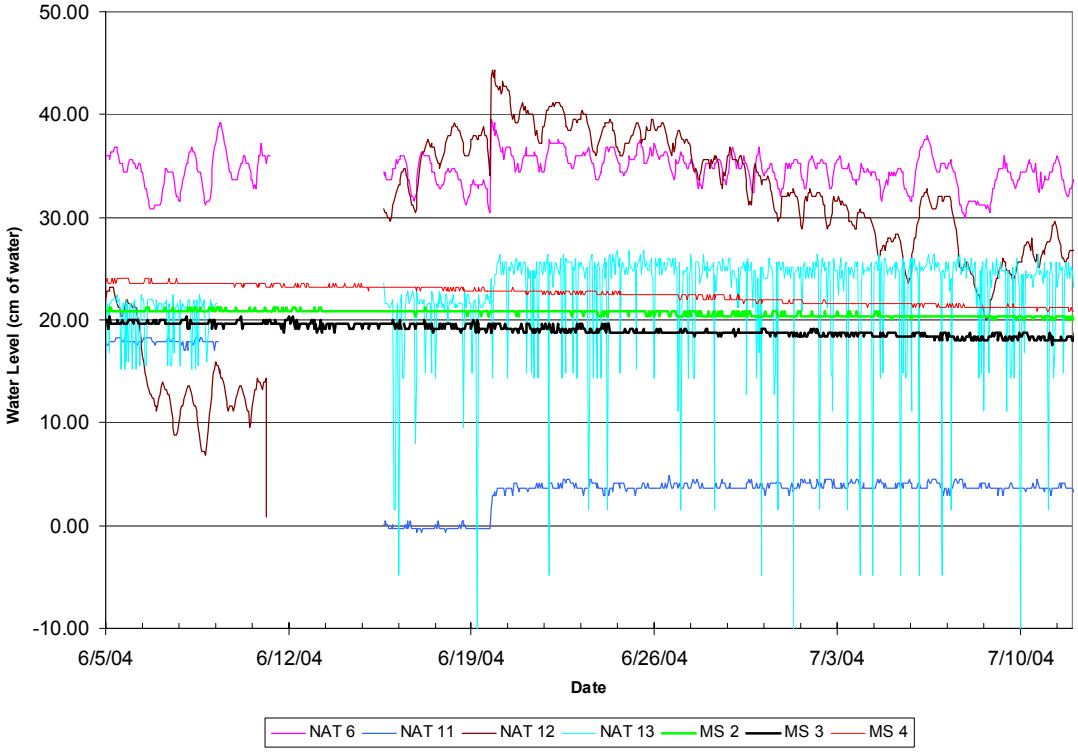


Figure C-1. Detail of water level data from the surficial sediments showing the formation of shallow perched water on June 19, 2003 in NAT-6, -11, -12, and -13.

Appendix D

Temperature Correction for the Soil-Moisture, Resistivity, and Temperature Sensors

Appendix D

Temperature Correction for the Soil-Moisture, Resistivity, and Temperature Sensors

Changes in temperature were found to impact some of the SMR sensors. Although there is uncertainty with the actual mechanism—whether surface temperature or soil temperature—some of the moisture trends follow the sinusoidal temperature trends (e.g., peak occurs July through August and bottom occurs January through February), as seen in Figure D-1.

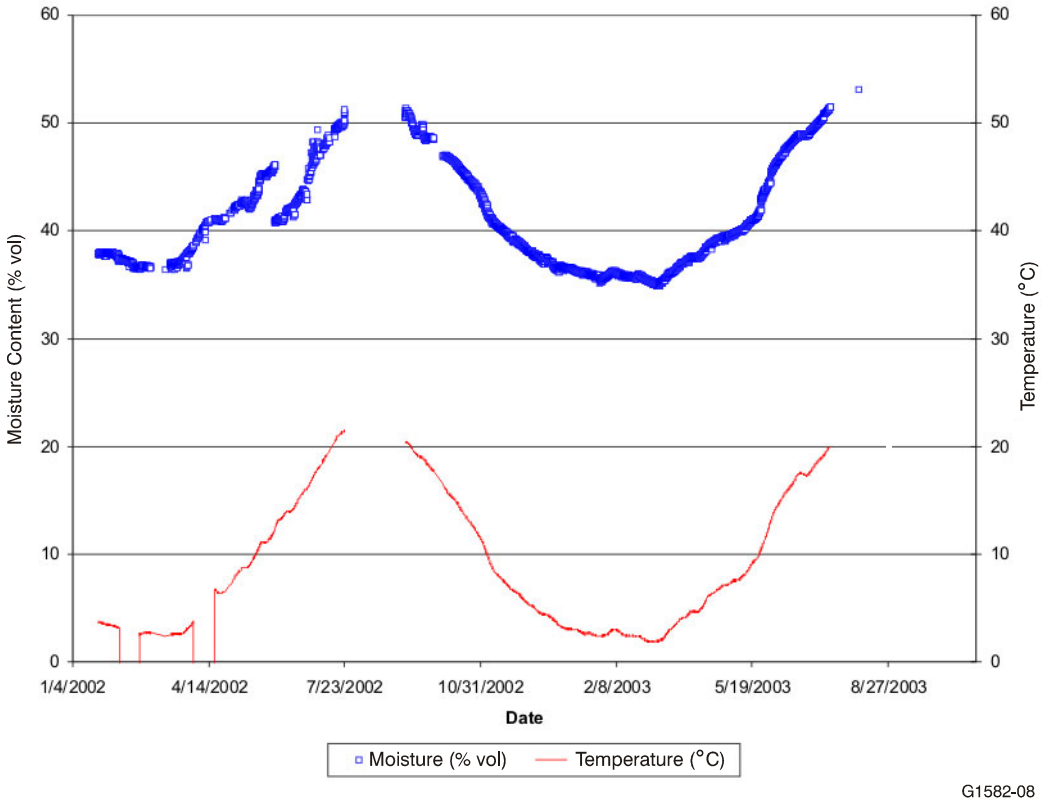


Figure D-1. Plot showing sinusoidal trend of moisture content data (Sensor 245) that mimics the temperature trend (from Myers et al. 2005).

When the temperature–moisture relationship was recognized, the SMR manufacturer (i.e., Applied Research Associates) was contacted to provide a temperature-correction equation that would remove the temperature impacts from the data. To verify that the temperature moisture dependence indeed existed, Applied Research Associates reviewed factory data recovered from temperature-sensor calibration tests that included moisture-channel readings in water at multiple temperatures. Applied Research Associates concluded that moisture reading variation-with-temperature was evident and quantifiable and fit a linear correction equation to the data. The linear correction equation adjusts the fraction of full scale reading from each sensor before applying the universal calibration equation. Applied Research Associates also determined that temperature dependence varies between sensors. Starting in May 2004, raw data, as well as processed data, was recorded to aid in the development of the equation.

The Applied Research Associates universal calibration equation is shown in Equation (D-1):

$$\theta = c_2 R^2 + c_1 R + c_0 \quad \text{(D-1)}$$

where:

c_0, c_1, c_2	=	calibration equation coefficients
R	=	$(N_{air} - N_i)/(N_{air} - N_{water})$
N	=	count proportional to oscillator frequency.

Equation (D-1) is currently applied to the processed data. Temperature correction is another calculation that is applied to R (i.e., the ratio). The R coefficient becomes Rcor (see Equation [D-2]) and consists of R and ΔR. The ΔR term consists of the slope and intercept coefficients and the temperature (see Equation [D-3]).

$$R_{cor} = R + \Delta R \quad . \quad \text{(D-2)}$$

$$\Delta R = aT + b \quad \text{(D-3)}$$

where:

T	=	temperature, C
a	=	slope
b	=	intercept.

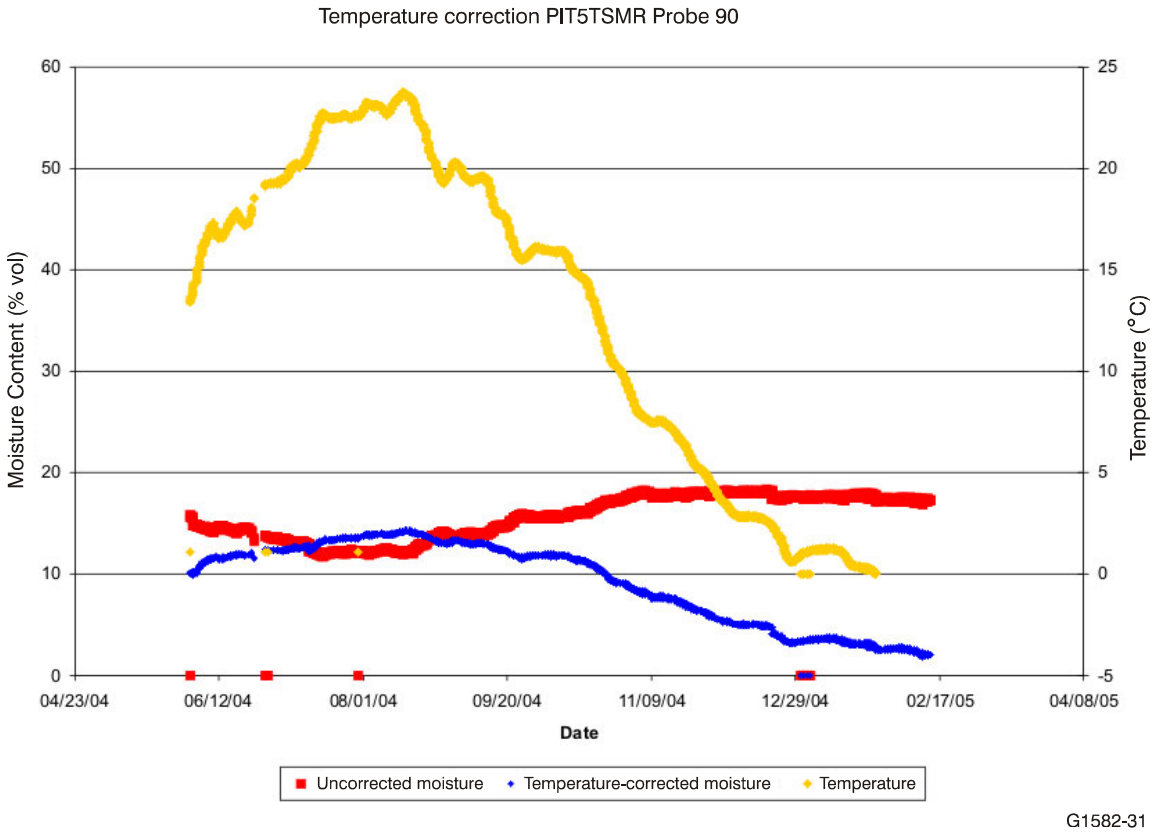
The coefficients a and b are sensor-specific and must be developed by testing each sensor, which is impossible because the sensors are deployed. Therefore, Applied Research Associates is working to recover calibration data developed for the sensors before shipment to the INL Site to determine the slope and intercept. Currently, Applied Research Associates have supplied the Idaho Cleanup Project with slopes and intercepts (or a and b) for 21 sensors. The slope and intercept data are listed in Table D-1. Corrections for the sensors listed in Table D-1 were applied to the FY 2004 data presented in this report.

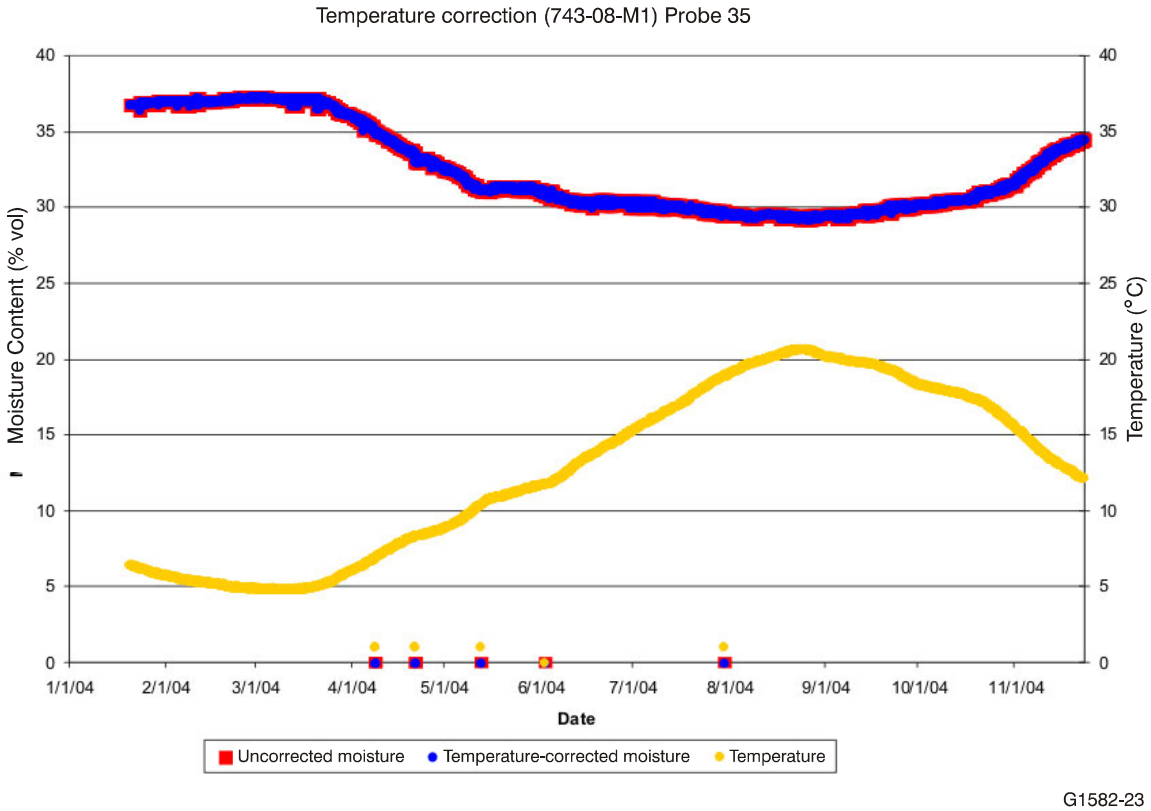
Unprocessed (i.e., raw—not temperature compensated) data were run through the equations and were compared with the processed data to evaluate the effectiveness of the temperature removal. The following plots show both corrected and uncorrected moisture content data sets along with the soil temperature. The blue line shows the uncorrected temperature. It is not clear that the temperature corrections have provided quantifiable data. Some moisture content sensors still follow the sinusoidal curves, which complicates interpretation of the data. The lack of confidence in the temperature corrections decreases the overall accuracy of the measurements. Only obvious moisture events or long-term (over several years) changes in yearly moisture cycles can be extracted from the data at this time.

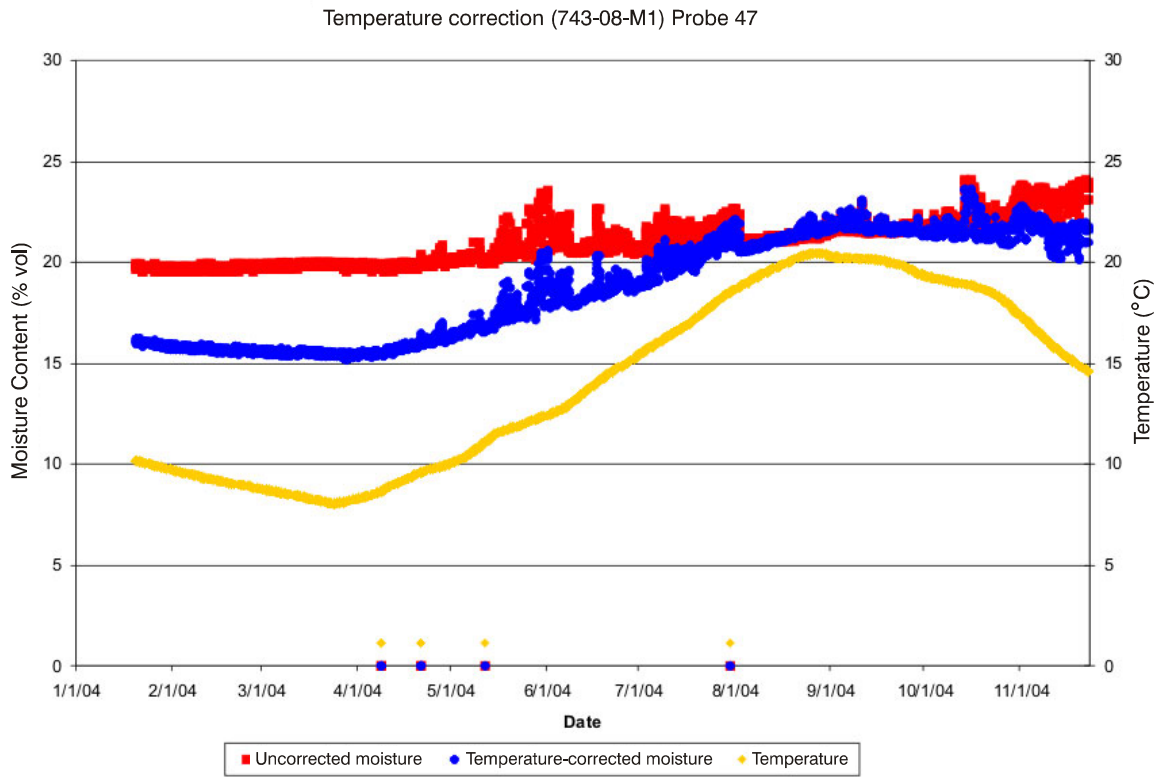
Applied Research Associates are checking to determine whether temperature is also influencing some of the resistivity measurements. It is expected that additional slope and intercepts will be provided for other sensors that are influenced by moisture.

Table D-1. Soil-moisture, resistivity, and temperature sensors with Applied Research Associates-supplied slopes and intercept coefficients.

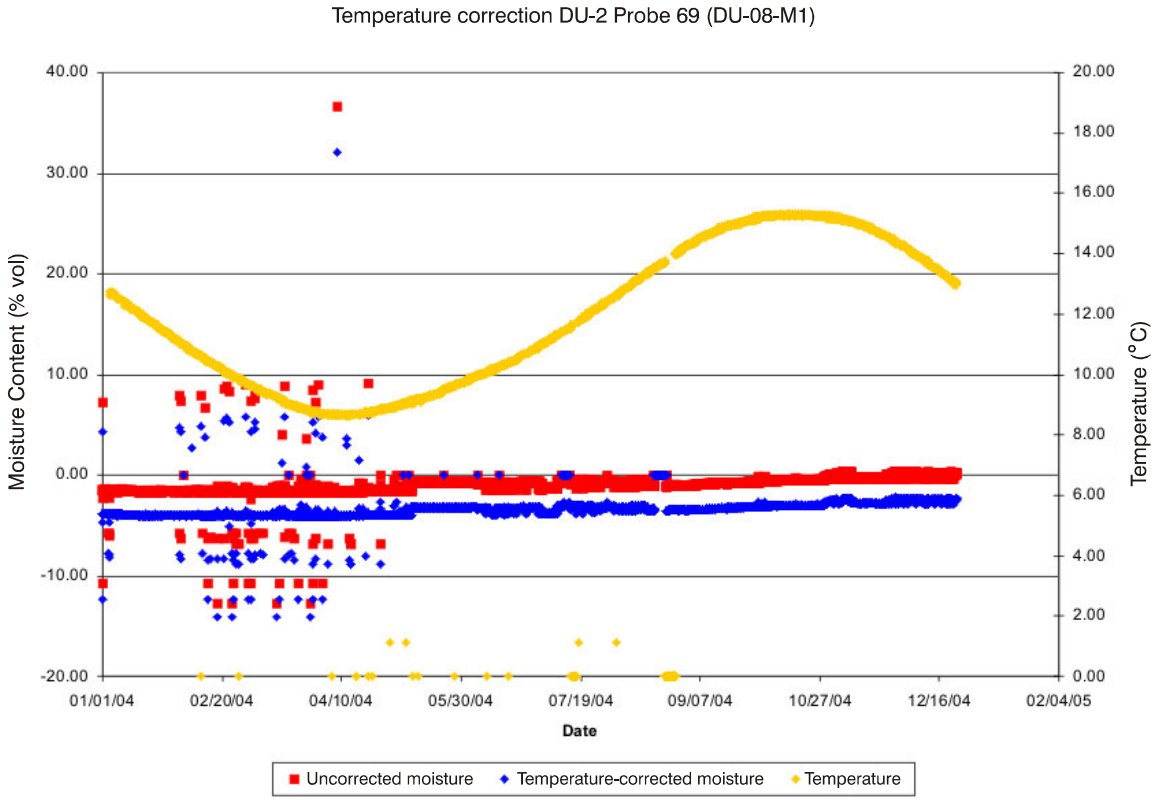
No.	Soil-Moisture, Resistivity, and Temperature Sensor Identification Number	Sensor Serial Number	Intercept	Slope
1	235	SMRT200035	-0.11814	0.006996
2	247	SMRT200047	-0.09264	0.004645
3	257	SMRT200057	-0.07065	0.003251
4	269	SMRT200069	-0.04744	6.61E-05
5	271	SMRT200071	-0.14003	0.005193
6	272	SMRT200072	0.063771	-0.002
7	274	SMRT200074	0.102927	-0.00531
8	275	SMRT200075	0.004711	-0.00144
9	277	SMRT200077	0.009285	-0.00011
10	278	SMRT200078	0.01525	-0.00468
11	279	SMRT200079	0.1262	-0.00664
12	280	SMRT200080	0.021538	-0.00138
13	290	SMRT200090	-0.20821	0.009966
14	297	SMRT200097	0.420939	-0.01625
15	298	SMRT200098	0.243597	-0.00886
16	299	SMRT200099	0.292374	-0.01184
17	2A0	SMRT2000A0	0.2864	-0.01159
18	2A2	SMRT2000A2	0.335818	-0.01238
19	2A3	SMRT2000A3	0.282692	-0.01107
20	2A4	SMRT2000A4	0.213538	-0.00747
21	2A5	SMRT2000A5	0.278269	-0.0101


Temperature correction PIT5TSMR Probe 90
Moisture Content (% vol)
Temperature (°C)
Date
04/23/04
06/12/04
08/01/04
09/20/04
11/09/04
12/29/04
02/17/05
04/08/05
Uncorrected moisture
Temperature-corrected moisture
Temperature
G1582-31

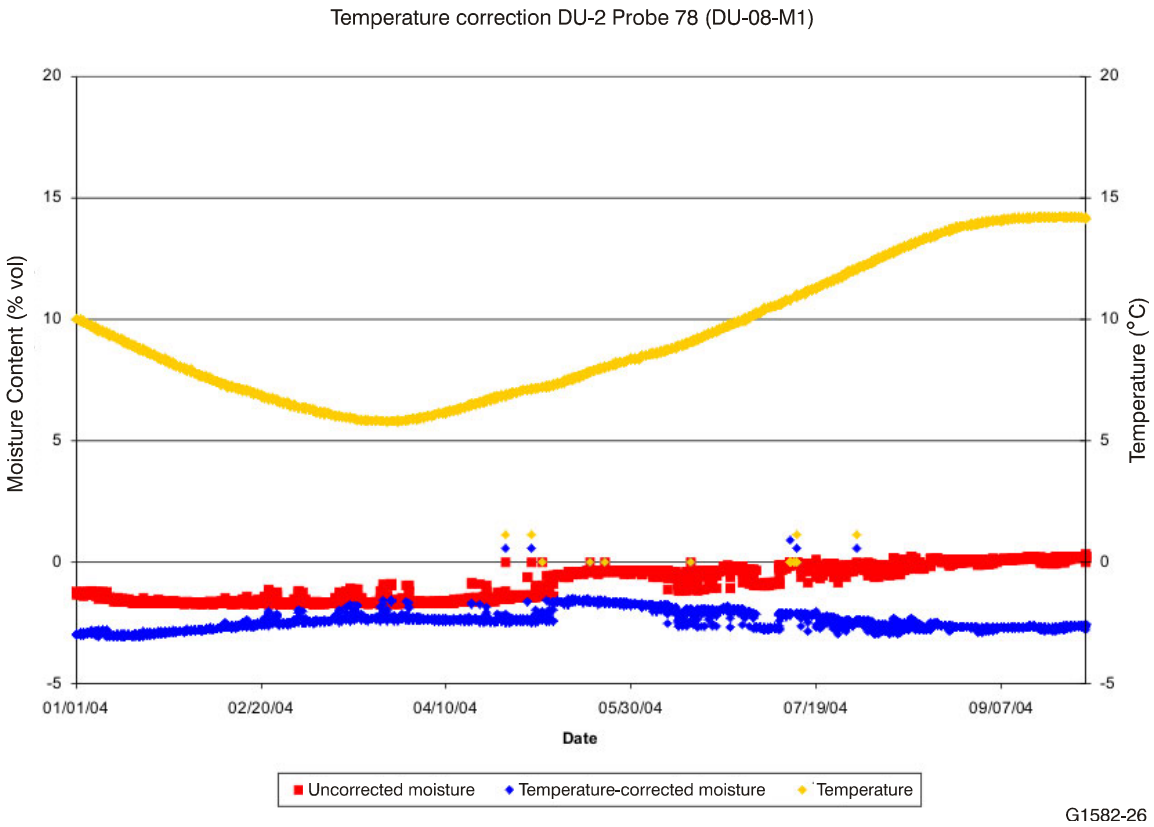

Temperature correction (743-08-M1) Probe 35
Moisture Content (% vol)
Temperature (°C)
Date
1/1/04
2/1/04
3/1/04
4/1/04
5/1/04
6/1/04
7/1/04
8/1/04
9/1/04
10/1/04
11/1/04
Uncorrected moisture
Temperature-corrected moisture
Temperature
G1582-23



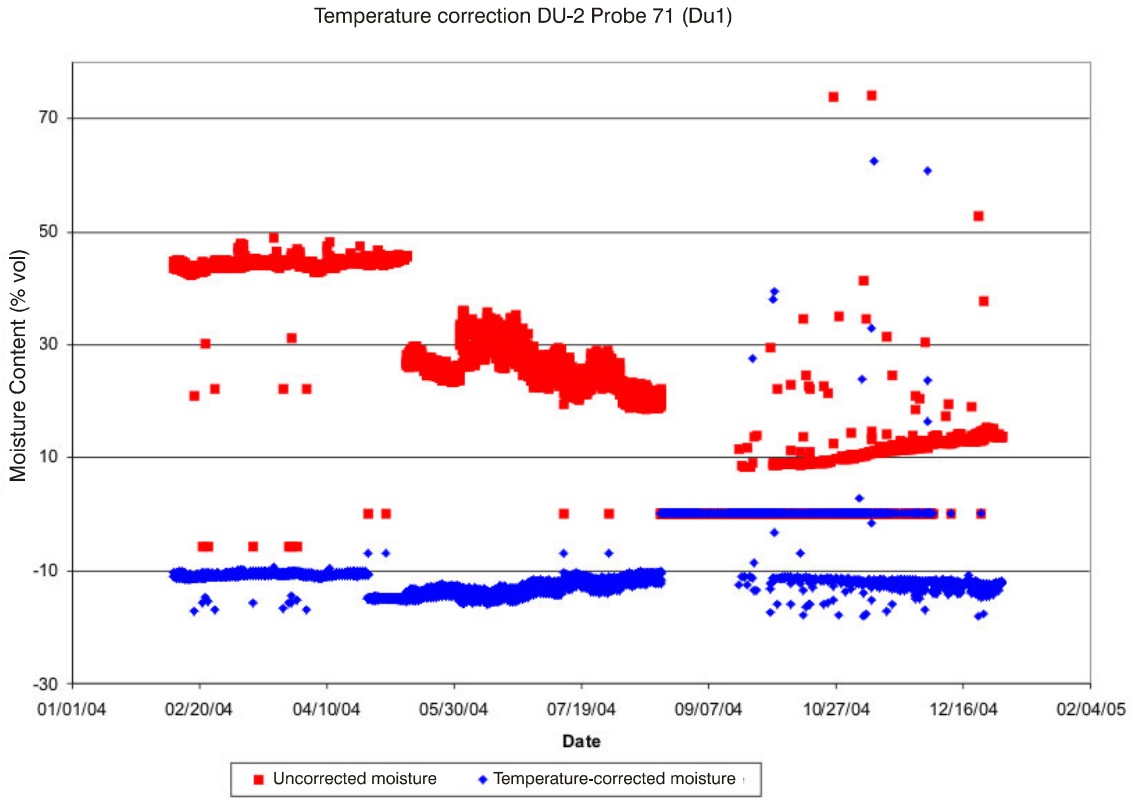
G1582-24



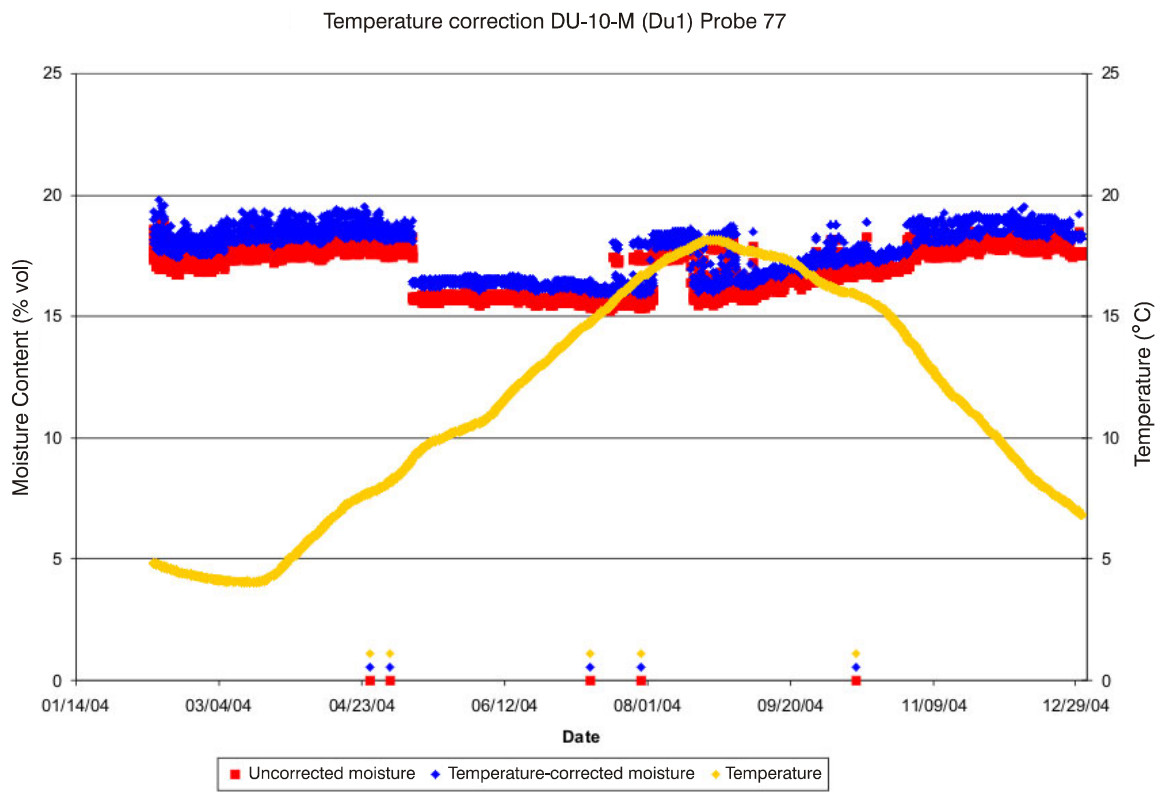
G1582-25



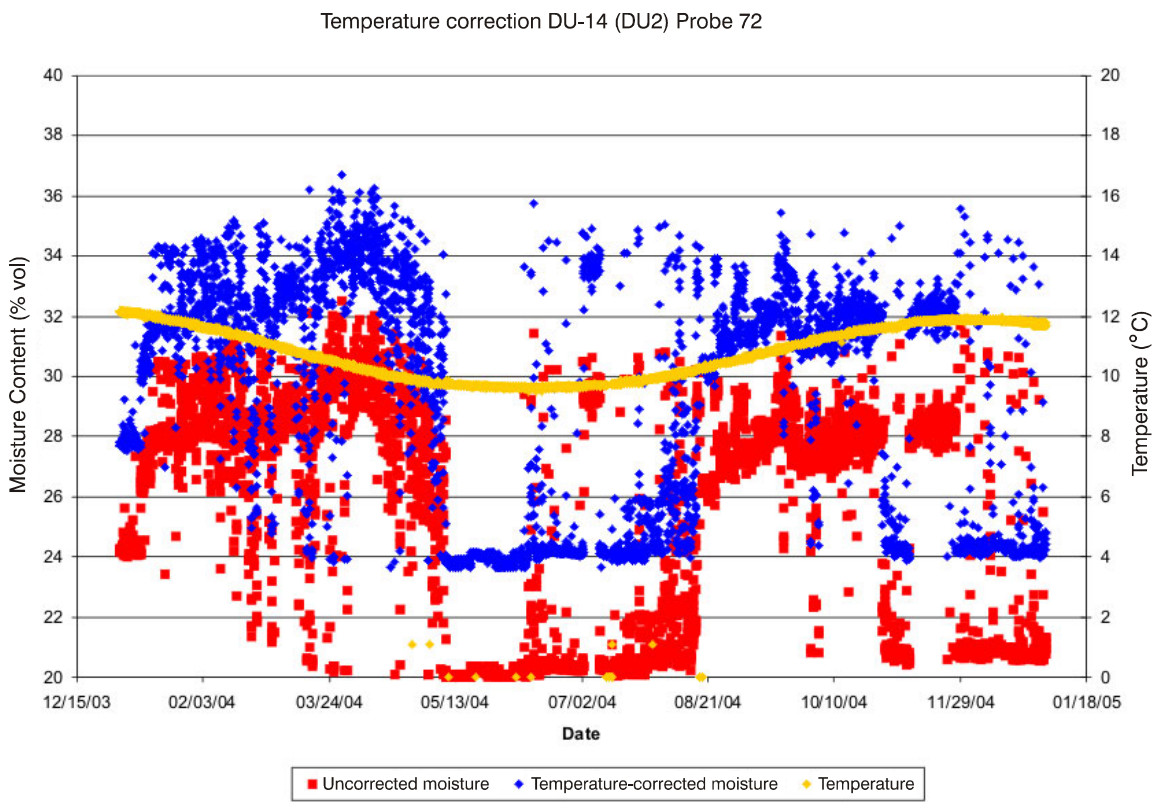
G1582-26



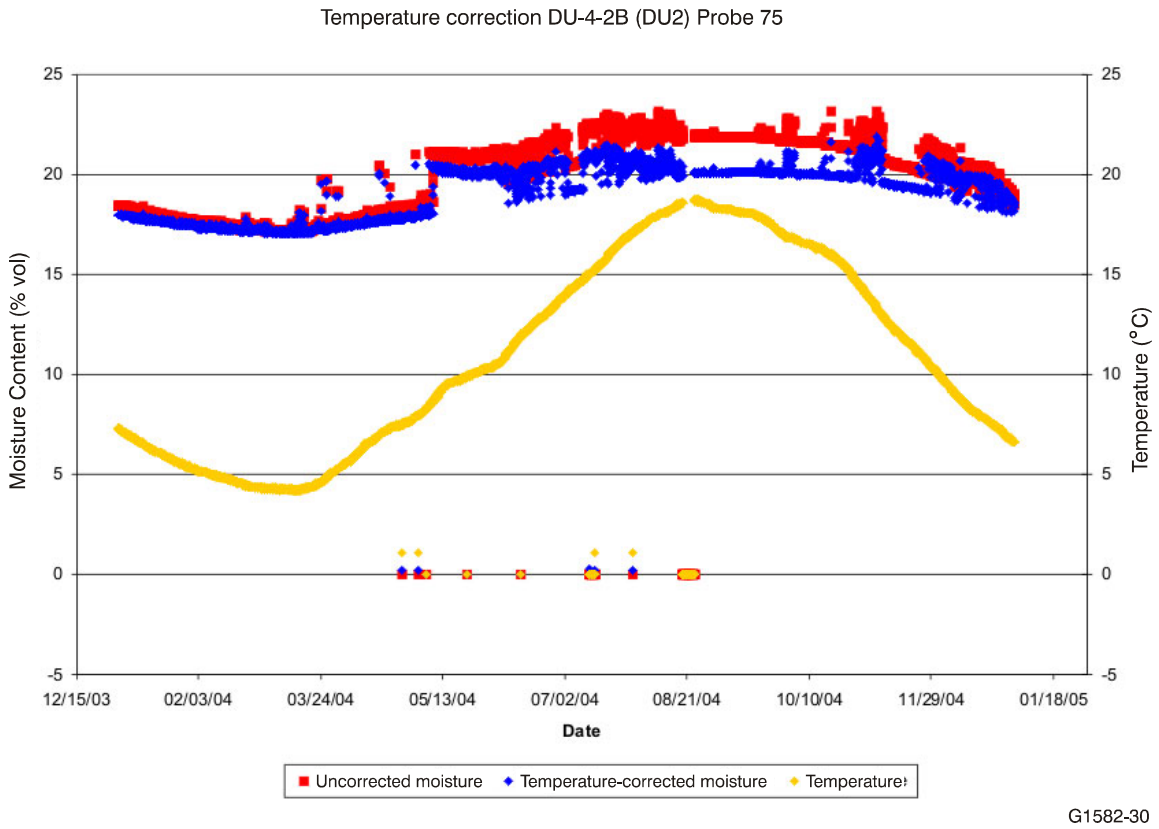
G1582-27



G1582-28



G1582-29


Temperature correction DU-4-2B (DU2) Probe 75
Moisture Content (% vol)
Temperature (°C)
25
20
15
10
5
0
-5
12/15/03
02/03/04
03/24/04
05/13/04
07/02/04
08/21/04
10/10/04
11/29/04
01/18/05
Date
Uncorrected moisture
Temperature-corrected moisture
Temperature
G1582-30