



Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex Monitor Mine Waste Rock Trial Covers: 2009 Data Summary

Prepared for:



Government of Yukon
Assessment and Abandoned Mines
Energy, Mines and Resources
Box 2703, Whitehorse, Yukon
Y1A 2C6

Prepared by:



Project Reference Number
SRK 1CY001.030



January 2010

Faro Mining Complex
Monitor Mine Waste Rock Trial Covers:
2009 Data Summary

Government of Yukon
Assessment and Abandoned Mines
Energy, Mines and Resources
Box 2703, Whitehorse, Yukon Y1A 2C6

SRK Consulting (Canada) Inc.
Suite 2200, 1066 West Hastings Street
Vancouver, B.C. V6E 3X2

Tel: 604.681.4196 Fax: 604.687.5532
E-mail: vancouver@srk.com Web site: www.srk.com

SRK Project Number 1CY001.030

January 2010

Executive Summary

Title: Faro Mining Complex, Monitor Mine Waste Rock Trial Covers: 2009 Data Summary

Consultant: SRK Consulting (Canada) Inc.

Status: Final

Date: January 2010

Size: 30 Pages of text (including cover, introductory and reference list); 68 Pages of Figures (including one flysheet), 6 Appendices containing 85 pages (including 10 flysheets).

Digital File: PDF format; 26 MB

Objectives and Primary Findings:

This report summarizes the data collected during the 2009 monitoring season (May to November) from the waste rock cover trials at the Faro Mining Complex. The intent of this report is to document the field results and provide feedback on the quality of the data collected. Where problems with the collected data have been identified, this report provides recommendations for remedying the problem as well as mitigation strategies to prevent similar problems from reoccurring. The scope of this report is simply to confirm that the data collected is following reasonable trends, and that the instrumentation and data acquisition systems are performing as expected.

Detailed information regarding operation, calibration, suitability, and accuracy of the monitoring instrumentation used to collect the data presented in this report is provided in the as-built report (SRK 2006a), and therefore it is not repeated here.

Future Work Recommendations

The report provides a series of recommendations to ensure the continued high quality data collection as well as improved database management during subsequent monitoring years. These range from datalogger maintenance and erosion repairs through migration of databases to a SQL Server.

Table of Contents

Executive Summaryi

1 Introduction and Scope of Report 1

1.1 General 1

1.2 Background of the Project..... 2

1.3 Scope of Work..... 2

1.4 Methods 3

1.5 Post Processing 4

1.6 Report Structure..... 4

2 Automated Instrumentation Data..... 5

2.1 Davis Instruments Vantage Pro (Weather Stations and Satellite Stations)..... 5

2.2 Campbell Scientific Data Loggers 6

2.2.1 General Setup 7

2.2.2 Battery Voltage..... 8

2.2.3 Soil Matric Suction..... 8

2.2.4 Soil Temperature..... 9

2.2.5 Soil Volumetric Moisture Content..... 9

2.2.6 Tipping Bucket Flow Gauges (Runoff and Interflow) 9

2.3 SeaMetrics DL75 Data Loggers (Surface Runoff and Interflow) 10

2.4 Lakewood Systems UL16 Data Logger (Soil Temperature)..... 10

3 Manually Collected Instrumentation Data..... 11

3.1 M-Squared Thermistor Cables (Soil Temperature) 11

3.2 Sentek Sensor Technologies Diviner 2000 (Soil Volumetric Moisture Content) 11

3.3 HOBO Water Level Loggers 11

4 In-Situ Geotechnical Testing..... 13

4.1 Saturated Hydraulic Conductivity 13

4.2 In-Situ Density Testing 14

5 Conclusion 16

5.1 Summary..... 16

5.2 Database Management..... 16

5.3 Erosion Damage Repairs 16

5.4 Action Items 17

6 References..... 19

List of Tables

Table 1: Summary of Primary Data Collected by Davis Instruments Vantage Pro Weather and Satellite Stations 6

Table 2: Summary of Performed In-situ Saturated Hydraulic Conductivity Tests 13

Table 3: Summary of In-Situ Density Tests..... 15

List of Figures

- Figure 1: Location plan for trial covers and thermistor strings
- Figure 2: Aerial view of trial cover layout
- Figure 3: Trial covers and lysimeter layout plan
- Figure 4: Schematic trial cover and lysimeter layout showing automated soil suction, moisture instrumentation, datalogger, as well as weather and satellite station locations
- Figure 5: Schematic trial cover and lysimeter layout showing diviner 2000 stations, surface runoff and interflow measurement locations
- Figure 6: Schematic instrument profiles for CT#1 and CT#4
- Figure 7: Schematic instrument profiles for CT#2A and CT#2B.
- Figure 8: Schematic instrument profiles for CT#3A and CT#3B.
- Figure 9: Schematic instrument profiles for L#1 and L#2.
- Figure 10: Location plan and schematic thermistor layout on Grum Overburden Dump
- Figure 11: Total hourly rainfall on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations
- Figure 12: Mean hourly air temperature on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations and Satellite Stations
- Figure 13: Mean hourly relative humidity on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations and Satellite Stations
- Figure 14: Mean hourly solar radiation on CT#1 & ct2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations
- Figure 15: Mean hourly barometric pressure on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations
- Figure 16: Mean hourly wind speed on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations
- Figure 17: Wind direction totals (measured hourly) on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations
- Figure 18: Mean hourly UV index on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations
- Figure 19: Mean hourly matric suction in CT#1 recorded by the Davis Instruments Vantage Pro Satellite Station
- Figure 20: Mean hourly soil temperature in CT#1 recorded by the Davis Instruments Vantage Pro Satellite Station
- Figure 21: Mean hourly matric suction in CT#2A recorded by the Davis Instruments Vantage Pro Satellite Station
- Figure 22: Mean hourly soil temperature in CT#2A recorded by the Davis Instruments Vantage Pro Satellite Station
- Figure 23: Daily battery voltage of the Campbell Scientific CR10X #1, CR10X#2, and CR1000 data loggers

- Figure 24: Soil matric suction measurements (taken every six hours) in CT#1 recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 25: Soil matric suction measurements (taken every six hours) in CT#2A recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 26: Soil matric suction measurements (taken daily) in CT#2B recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 27: Soil matric suction measurements (taken every six hours) in CT#3A recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 28: Soil matric suction measurements (taken every six hours) in CT#3B recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 29: Soil matric suction measurements (taken every six hours) in CT#4 recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 30: Soil matric suction measurements (taken every six hours) in L#1 recorded by cs229 sensors connected to Campbell Scientific data logger CR1000
- Figure 31: Soil matric suction measurements (taken every six hours) in L#2 recorded by cs229 sensors connected to Campbell Scientific data logger CR1000
- Figure 32: Soil temperature measurements (taken every six hours) in CT#1 recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 33: Soil temperature measurements (taken every six hours) in CT#2A recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #1 (array 168)
- Figure 34: Soil temperature measurements (taken every six hours) in CT#2B recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #1 (array 168)
- Figure 35: Soil temperature measurements (taken every six hours) in CT#3A recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 36: Soil temperature measurements (taken every six hours) in CT#3B recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 37: Soil temperature measurements (taken every six hours) in CT#4 recorded by cs229 sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 38: Soil temperature measurements (taken every six hours) in L#1 recorded by cs229 sensors connected to Campbell Scientific data logger CR1000
- Figure 39: Soil temperature measurements (taken every six hours) in L#2 recorded by cs229 sensors connected to Campbell Scientific data logger CR1000
- Figure 40: Volumetric moisture content measurements (taken every six hours) in CT#1 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 41: Volumetric moisture content measurements (taken every six hours) in CT#2A recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #1 (array 168)
- Figure 42: Volumetric moisture content measurements (taken every six hours) in CT#2B recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #1 (array 168)
- Figure 43: Volumetric moisture content measurements (taken every six hours) in CT#3A recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (array 168)

- Figure 44: Volumetric moisture content measurements (taken every six hours) in CT#3B recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 45: Volumetric moisture content measurements (taken every six hours) in CT#4 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (array 168)
- Figure 46: Volumetric moisture content measurements (taken every six hours) in L#1 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR1000
- Figure 47: Volumetric moisture content measurements (taken every six hours) in L#2 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR1000
- Figure 48: Interflow totals in CT#3A measured by a tipping bucket connected to Campbell Scientific data logger CR10X #1
- Figure 49: Interflow totals in CT#3B measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2
- Figure 50: Interflow totals in CT#4 measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2
- Figure 51: Surface flow totals in CT#1 measured by a tipping bucket connected to Campbell Scientific data logger CR10X#2
- Figure 52: Surface flow totals in CT#2A measured by a tipping bucket connected to Campbell Scientific data logger CR10X#2
- Figure 53: Surface flow totals in CT#2B measured by a tipping bucket connected to Campbell Scientific data logger CR10X#2
- Figure 54: Surface flow totals in CT#3A measured by a tipping bucket connected to Campbell Scientific data logger CR10X#2
- Figure 55: Surface flow totals in CT#3B measured by a tipping bucket connected to Campbell Scientific data logger CR10X#2
- Figure 56: Surface flow totals in CT#4 measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2
- Figure 57: Peripheral interflow totals in L#1 measured by a tipping bucket connected to Campbell Scientific data logger CR1000
- Figure 58: Central interflow totals in L#1 measured by a tipping bucket connected to Campbell Scientific data logger CR1000
- Figure 59: Surface flow totals in L#1 measured by a tipping bucket connected to Campbell Scientific data logger CR1000
- Figure 60: Peripheral interflow totals in L#2 measured by a tipping bucket connected to Campbell Scientific data logger CR1000
- Figure 61: Central interflow totals in L#2 measured by a tipping bucket connected to Campbell Scientific data logger CR1000
- Figure 62: Surface flow totals in L#2 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.
- Figure 63: Surface runoff (measured every minute) on CT#1 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 0506051)
- Figure 64: Surface runoff (measured every minute) on CT#2A by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 0506052)

- Figure 65: Surface runoff (measured every minute) on CT#3B by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 0506056)
- Figure 66: Surface runoff (measured every minute) on CT#4 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 0506058)
- Figure 67: Interflow (measured every minute) on CT#3A by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 02051709)
- Figure 68: Interflow (measured every minute) on CT#3B by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 02051710)
- Figure 69: Surface runoff (measured every minute) on CT#4 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 0506054)
- Figure 70: Surface runoff (measured every minute) on L#1 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 72649)
- Figure 71: Surface runoff (measured every minute) on L#2 by a Seametrics flowmeter connected to a Seametrics DL75 data logger (file 72651)
- Figure 72: Soil temperature (measured every twelve hours) in Grum overburden dump by an M-squared thermistor string connected to a Lakewood systems ul16 data logger (thermistor string a). Raw data displayed
- Figure 73: Soil temperature (measured every twelve hours) in Grum overburden dump by an M-squared thermistor string connected to a Lakewood systems ul16 data logger (thermistor string b). Raw data displayed
- Figure 74: Monthly soil temperature measurements in Grum overburden dump by an M-squared thermistor string measured manually (thermistor string 1). Raw data expressed as resistances
- Figure 75: Monthly soil temperature measurements in Grum overburden dump by an M-squared thermistor string measured manually (thermistor string 2). Raw data expressed as resistances
- Figure 76: Monthly soil temperature measurements in Grum overburden dump by an M-squared thermistor string measured manually (thermistor string 3). Raw data expressed as resistances
- Figure 77: Monthly soil temperature measurements in Grum overburden dump by an M-squared thermistor string measured manually (thermistor string 4). Raw data expressed as resistances
- Figure 78: Daily volumetric moisture content in CT#1 (station #1) measured manually by a Sentek Diviner 2000
- Figure 79: Daily volumetric moisture content in CT#1 (station #2) measured manually by a Sentek Diviner 2000
- Figure 80: Daily volumetric moisture content in CT#1 (station #3) measured manually by a Sentek Diviner 2000
- Figure 81: Daily volumetric moisture content in CT#1 (station #4) measured manually by a Sentek Diviner 2000
- Figure 82: Daily volumetric moisture content in CT#1 (station #5) measured manually by a Sentek Diviner 2000
- Figure 83: Daily volumetric moisture content in CT#1 (station #6) measured manually by a Sentek Diviner 2000

- Figure 84: Daily volumetric moisture content in CT#1 (station #7) measured manually by a Sentek Diviner 2000
- Figure 85: Daily volumetric moisture content in CT#1 (station #8) measured manually by a Sentek Diviner 2000
- Figure 86: Daily volumetric moisture content in CT#2A (station #9) measured manually by a Sentek Diviner 2000
- Figure 87: Daily volumetric moisture content in CT#2A (station #10) measured manually by a Sentek Diviner 2000
- Figure 88: Daily volumetric moisture content in CT#2A (station #11) measured manually by a Sentek Diviner 2000
- Figure 89: Daily volumetric moisture content in CT#2A (station #12) measured manually by a Sentek Diviner 2000
- Figure 90: Daily volumetric moisture content in CT#2A (station #13) measured manually by a Sentek Diviner 2000
- Figure 91: Daily volumetric moisture content in CT#2A (station #14) measured manually by a Sentek Diviner 2000
- Figure 92: Daily volumetric moisture content in CT#2B (station #15) measured manually by a Sentek Diviner 2000
- Figure 93: Daily volumetric moisture content in CT#2B (station #16) measured manually by a Sentek Diviner 2000
- Figure 94: Daily volumetric moisture content in CT#2B (station #17) measured manually by a Sentek Diviner 2000
- Figure 95: Daily volumetric moisture content in CT#2B (station #18) measured manually by a Sentek Diviner 2000
- Figure 96: Daily volumetric moisture content in CT#2B (station #19) measured manually by a Sentek Diviner 2000
- Figure 97: Daily volumetric moisture content in CT#2B (station #20) measured manually by a Sentek Diviner 2000
- Figure 98: Daily volumetric moisture content in CT#3A (station #21) measured manually by a Sentek Diviner 2000
- Figure 99: Daily volumetric moisture content in CT#3A (station #22) measured manually by a Sentek Diviner 2000
- Figure 100: Daily volumetric moisture content in CT#3A (station #23) measured manually by a Sentek Diviner 2000
- Figure 101: Daily volumetric moisture content in CT#3A (station #24) measured manually by a Sentek Diviner 2000
- Figure 102: Daily volumetric moisture content in CT#3A (station #25) measured manually by a Sentek Diviner 2000
- Figure 103: Daily volumetric moisture content in CT#3A (station #26) measured manually by a Sentek Diviner 2000
- Figure 104: Daily volumetric moisture content in CT#3B (station #27) measured manually by a Sentek Diviner 2000
- Figure 105: Daily volumetric moisture content in CT#3B (station #28) measured manually by a Sentek Diviner 2000

- Figure 106: Daily volumetric moisture content in CT#3B (station #29) measured manually by a Sentek Diviner 2000
- Figure 107: Daily volumetric moisture content in CT#3B (station #30) measured manually by a Sentek Diviner 2000
- Figure 108: Daily volumetric moisture content in CT#3B (station #31) measured manually by a Sentek Diviner 2000
- Figure 109: Daily volumetric moisture content in CT#3B (station #32) measured manually by a Sentek Diviner 2000
- Figure 110: Daily volumetric moisture content in CT#4 (station #33) measured manually by a Sentek Diviner 2000
- Figure 111: Daily volumetric moisture content in CT#4 (station #34) measured manually by a Sentek Diviner 2000
- Figure 112: Daily volumetric moisture content in CT#4 (station #35) measured manually by a Sentek Diviner 2000
- Figure 113: Daily volumetric moisture content in CT#4 (station #36) measured manually by a Sentek Diviner 2000
- Figure 114: Daily volumetric moisture content in CT#4 (station #37) measured manually by a Sentek Diviner 2000
- Figure 115: Daily volumetric moisture content in CT#4 (station #38) measured manually by a Sentek Diviner 2000
- Figure 116: Daily volumetric moisture content in CT#4 (station #39) measured manually by a Sentek Diviner 2000
- Figure 117: Daily volumetric moisture content in CT#4 (station #40) measured manually by a Sentek Diviner 2000
- Figure 118: Daily volumetric moisture content in L#1 (station #41) measured manually by a Sentek Diviner 2000
- Figure 119: Daily volumetric moisture content in L#1 (station #42) measured manually by a Sentek Diviner 2000
- Figure 120: Daily volumetric moisture content in L#1 (station #43) measured manually by a Sentek Diviner 2000
- Figure 121: Daily volumetric moisture content in L#1 (station #44) measured manually by a Sentek Diviner 2000
- Figure 122: Daily volumetric moisture content in L#1 (station #46) measured manually by a Sentek Diviner 2000
- Figure 123: Daily volumetric moisture content in L#1 (station #47) measured manually by a Sentek Diviner 2000
- Figure 124: Daily volumetric moisture content in L#1 (station #48) measured manually by a Sentek Diviner 2000
- Figure 125: Daily volumetric moisture content in L#1 (station #50) measured manually by a Sentek Diviner 2000
- Figure 126: Daily volumetric moisture content in L#2 (station #51) measured manually by a Sentek Diviner 2000
- Figure 127: Daily volumetric moisture content in L#2 (station #52) measured manually by a Sentek Diviner 2000

- Figure 128: Daily volumetric moisture content in L#2 (station #53) measured manually by a Sentek Diviner 2000
- Figure 129: Daily volumetric moisture content in L#2 (station #54) measured manually by a Sentek Diviner 2000
- Figure 130: Daily volumetric moisture content in L#2 (station #55) measured manually by a Sentek Diviner 2000
- Figure 131: Daily volumetric moisture content in L#2 (station #56) measured manually by a Sentek Diviner 2000
- Figure 132: Daily volumetric moisture content in L#2 (station #57) measured manually by a Sentek Diviner 2000
- Figure 133: Daily volumetric moisture content in L#2 (station #58) measured manually by a Sentek Diviner 2000
- Figure 134: Daily volumetric moisture content in L#2 (station #59) measured manually by a Sentek Diviner 2000
- Figure 135: Daily volumetric moisture content in L#2 (station #60) measured manually by a Sentek Diviner 2000
- Figure 136: Hydrostatic pressure measured using the HOBO water level logger installed on CT#2A. Only significant values are displayed
- Figure 137: Hydrostatic pressure measured using the HOBO water level logger installed on CT#2B. Only significant values are displayed
- Figure 138: Hydrostatic pressure measured using the HOBO water level logger installed on L#1. Only significant values are displayed
- Figure 139: Hydrostatic pressure measured using the HOBO water level logger installed on L#2. Only significant values are displayed

List of Appendices

- Appendix A: Technical Instructions for Data Processing and Visualisation in Microsoft Access – Technical Memorandum
- Appendix B: Additional Climatic Data Calculated and Stored by Davis Instruments Vantage Pro Data Logger
- Appendix C: Field Diagnostic Data Sheets
- Appendix D: Summary and Calculation Sheets of In-Situ Hydraulic Conductivity Testing Using the Guelph Permeameter and Single Ring Infiltrometer Methods
- Appendix D.1: Guelph Permeameter Data
- Appendix D.2: Tension Infiltrometer Data
- Appendix D.3: Ring Infiltrometer Data
- Appendix E: Field Records of In-Situ Density Measurements
- Appendix F: Summary of Erosion Damage Repairs – Technical Memorandum

1 Introduction and Scope of Report

1.1 General

In 1998, the mining activities undertaken by Anvil Range Mining Corporation (ARMC) ceased due to financial problems and Deloitte & Touche Inc. (D&T) was appointed Interim Receiver of the mine site. Included in the Interim Receiver's role were:

- management of the site's care and maintenance; and
- development of a site closure plan.

D&T was released of these obligations in April 2009. The Yukon Government (Energy, Mines and Resources Assessment and Abandoned Mines Branch) has assumed responsibility for the Faro Mine Complex, and in March 1, 2009, Denison Environmental Services (DES) was awarded a contract to provide care and maintenance services to Yukon Government at this site.

The Faro Mine Complex Closure and Remediation Project is subject to assessment under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA). Under YESAA, the project is required to submit a "Project Proposal".

Key elements of the Project Proposal include:

- Project purpose;
- Project description;
- Description of existing environmental and socio- economic conditions; and
- Identification of potential environmental and socio- economic effects and proposed mitigation measures.

The project also requires a variety of regulatory authorizations and land dispositions including a water licence for construction of diversions, construction/modification of impoundments, use of water, collection and treatment of contaminated water, and discharge of waste water.

SRK Consulting (Canada) Inc. (SRK) was retained by YG to assist in the development of the Project Description for the Faro Mine Complex Final Closure and Remediation Plan.

On December 4, 2009, SRK issued Draft 4 of the Project Description, which is one of many standalone supporting document being prepared for the Project Proposal. SRK is currently working towards preparation of the initial draft of the Project Proposal, which is due to be issued for internal review on February 19, 2009.

1.2 Background of the Project

The Faro Mining Complex (FMC) has about 185 million cubic meters of waste rock covering about 542 ha of surface area. Detailed geochemical characterization has confirmed that much of this waste rock is acid generating and contains leachable metals. As part of the approved Plan, one of the methods is physical covering of the waste rock piles.

The specific functions that a cover would have to perform have been defined as follows:

- prevent direct exposure and contact of humans and terrestrial wildlife with the waste rock;
- reduce infiltration through the waste rock to specified targets;
- provide a medium that would allow establishment of successional vegetation.

There appears to be consensus within the Work Group responsible for the description and evaluation of the cover methods that significant oxidation of the waste rock has already occurred. This fact effectively negates the benefits offered by oxygen exclusion, thus constructing covers to act as oxygen barriers would not result in significant changes in leachate chemistry.

One of the single most challenging aspects of cover design for the site entails designing an infiltration reducing cover that will continue to perform effectively in the very long term, using the locally available till and glacio-fluvial soils. It is standard practice to make use of numerical models to assess the potential performance ranges of different cover configurations. However, the only reliable method to evaluate the physical aspects that determine long-term cover performance is to monitor site specific trial covers.

Subsequently, six trial covers (CT#1, CT#2A, CT#2B, CT#3A, CT#3B and CT#4) were constructed on the Vangorda waste rock pile in September 2004, as illustrated in Figures 1, 2 and 3. These trial covers have been designed to test a range of different physical performance criteria for the available materials, specifically focused towards evaluating performance as “infiltration reducing” covers. Detailed water balance instrumentation was installed in the trial covers in June 2005 (see Figures 4 through 8).

In 2007, following the recommendation of the Independent Peer Review Panel a set of two large lysimeters (25 meters by 25 meters) were constructed on the plateau of the Vangorda waste rock dump. As shown in Figure 3, the lysimeters were built immediately west of the existing cover trial plots, adjacent to CT#2A. The lysimeters were instrumented in June 2008, using the same suite of instrumentation installed for the existing cover trials (Figure 9). Details about the location and type of instrumentation can be found in the lysimeters as-built report (SRK 2008b).

1.3 Scope of Work

This report summarizes the data collected from the trial covers during the 2009 monitoring season (October 2008 to November 2009). The intent of this report is to document the basic field results

and provide feedback on the quality of data collected. Where data collection problems are identified, this report provides recommendations to remedy the problems as well as propose mitigation measures that can be implemented to prevent similar problems from occurring in the future. This report does not contain a technical analysis of the data. A preliminary performance review was completed (SRK 2008c), based on three years of data.

Instrumentation was re-commissioned by SRK in May 2009. FMC personnel retrieved data from all automated data loggers every two weeks until September 28, 2009. Manual thermistor and soil moisture content (Diviner) data respectively were collected starting May 21 through August 28. The last download for the season was performed by Tayfun Gurdal of SRK at the time of decommissioning of the instrumentation, on November 7, 2008.

Detailed information regarding the monitoring instrumentation used to collect the data presented in this report, pertaining to their operation, calibration, suitability and accuracy, is provided in the respective as-built reports (SRK 2006a, SRK 2008b), and is therefore not repeated here.

1.4 Methods

Six trial covers (Figures 2 and 3) were constructed in September 2004, in accordance with SRK design requirements. Construction was carried out by a local contractor, Tim Moon Construction, supported by FMC staff and equipment. Construction supervision was carried out by two SRK engineers, Maritz Rykaart, P.Eng. and Peter Mikes, E.I.T. The instrumentation was installed and commissioned in June 2005 by Maritz Rykaart, with complete construction and instrumentation details provided in an as-built report (SRK 2006a). Two lysimeters were built in August 2007 by the same local contractor, Tim Moon Construction, with support from FMC staff. Supervision of the construction phase was provided by SRK engineer Jozsef Miskolczi, EIT. Instrumentation was installed and commissioned in June 2008 by Jozsef Miskolczi. Detailed construction and instrumentation notes can be found in the as-built report (SRK 2008b).

DES site staff was trained by SRK to carry out the field monitoring for the 2009 monitoring season (May to September). In addition, a SRK summer student was also trained in data download procedures, in case DES could not provide field staff. The presence of the summer student on site was in the end not necessary, as DES could provide the required staff (Jesse Luchinski and Kevin Ramsay).

A written monitoring protocol was provided to DES. Data was downloaded directly from the different data loggers onto a laptop computer. In addition, a series of readings were collected manually and converted into electronic format. All field data collected by DES was sent to SRK via e-mail.

SRK used proprietary software linked to each of the data loggers to open and view the data to ensure that the loggers were operating satisfactorily. All data was collated into a series of databases at the end of the season. These databases convert raw field data into its final usable format by applying material specific calibration information and some format manipulation. As a final step, all data is

linked to a master database to simplify the visualization process. The figures illustrating the field data presented in this report (Figures 11 through 139) were created using this master database. Figures 11 through 139 do not show all the data collected to date. These figures only present the data collected during the 2009 monitoring season. As a result, some figures presenting data as a graph will have lines extending from the end of the 2008 data set to the start of the 2009 data set. The range of the x-axis has been set to obscure this artefact but it can still be observed on the left hand side of the graph. Complete details of how data is prepared for input into the database are included in Appendix A.

In addition to the data presented in this report, weather data is collected from two on-site Weather Stations, and annual snow surveys are conducted by staff from the Yukon Territorial Government (Janowicz *et al.* 2005, 2006, 2007, and 2008). This data is not presented here, but will be used to compare the validity of the trial cover data when detailed data analysis is carried out following future years of monitoring.

1.5 Post Processing

In an effort to simplify the post-processing protocol, following challenges identified during the 2008 monitoring season it was decided to make use of the Visual Basic and SQL programming capabilities of Microsoft Access. The 2008 and subsequent data was compiled using this new protocol. Older data (2007 and earlier) was also processed and stored in the database format to allow easy integration of all data at a later time. The new post-processing protocol does not change the data download protocols from the field instruments.

1.6 Report Structure

Section 2 contains information associated with the series of automated data loggers which collect field monitoring data for the trial covers. The remainder of the instrumentation data is collected manually, the details of which are presented in Section 3. The in-situ material characterization program carried out in 2009 is summarised in Section 4, while the final section of the report provides a summary of the action items arising from this data summary report.

2 Automated Instrumentation Data

2.1 Davis Instruments Vantage Pro (Weather Stations and Satellite Stations)

Complete climatic data is collected at the Vangorda Waste Rock Pile trial cover location using two Davis Instruments Vantage Pro Weather stations. The first station is located on the sloped CT#1 trial cover and the second on the dividing berm between horizontal trial covers CT#2A and CT#2B. Figure 2 schematically illustrates these locations. Additional climatic data (air temperature and relative humidity), as well as shallow soil moisture and temperature data, are collected via two satellite Davis Instruments stations located approximately 25 m from these two primary Weather Stations, as illustrated in Figure 4. Figures 6 and 7 illustrate the locations of the soil moisture and temperature sensors installed as part of the Satellite Stations.

At each setup, data from the weather station and the satellite station is collected by a Vantage Pro data logger housed in the weather-proof enclosure situated beneath the weather station. The data loggers collect and store primary climatic data, as listed in Table 1. This data is measured directly from the suite of climatic sensors. This data is also presented as time-series graphs in Figures 11 through 22, and spans from May 20 through November 7, 2009.

In addition to the sensor data listed in Table 1, the data logger uses this primary data to calculate a series of secondary climatic information. Since this report focuses on the integrity of the primary collected data, this reduced data was not reported. SRK did, however, review all this data to confirm that the data logger was operating satisfactorily, and that the data collected made sense. This data has also been imported into the central database for future use. Appendix B provides a brief summary of this data.

Maintenance or recalibration was not carried out on the weather or Satellite Stations in 2009. The rechargeable batteries installed in 2008 were replaced at the beginning of the 2009 season. As a precautionary measure, a spare set of batteries were provided on site, but did not have to be used.

As shown in Figure 21, data from Soil Moisture sensor reported from the Satellite Station (Soil_Moisture_02) on CT2A2B was erratic resulting in a horizontal line on the graph. On closer examination of the raw data followed by consultation with the manufacturer, it was concluded that the sensor is most likely defective. Furthermore, it became evident that there are communication issues between the wireless satellite station and the console, resulting in intermittent loss of data. This malfunction also affected the data received from the soil moisture sensor (Soil_Temp_02). Although some data was lost (about 3-4 data points every day) the graph presented in Figures 21 and 22 were processed to hide this and only show the valid data collected.

It was recommended by the manufacturer that both satellite stations be sent to their shop for repairs, as well as replacement of the moisture content and soil temperature sensors. To ensure that repairs

to the satellite station transmitters are performed in a timely manner, as to not delay the recommissioning of the weather stations, SRK recommends appropriate actions be taken in February 2010.

The horizontal lines at maximum suction (200 kPa) recorded from both weather stations starting mid-October are due to the freeze-up of the sensors, which are not suitable to operate in sub-zero temperatures.

Table 1: Summary of Primary Data Collected by Davis Instruments Vantage Pro Weather and Satellite Stations

Parameter	Location	Sample Frequency	Units	Figure	Comment
Rainfall	Both Weather Stations	Every 50-60 sec; output as hourly total	mm	Figure 11	Hourly total; Rain rate (mm/hr) is also recorded (not presented)
Ambient Outside Air Temperature	Both weather and Satellite Stations	Every 10-12 sec; output as mean hourly	°C	Figure 12	Max/Min hourly also recorded at Weather Stations (not presented)
Relative Humidity	Both weather and Satellite Stations	Every 50-60 sec; output as mean hourly	%	Figure 13	Range of 0% to 100%
Solar Radiation	Both Weather Stations	Every 50-60 sec; output as mean hourly	W/m ²	Figure 14	"Hi solar radiation", i.e. peak hourly solar radiation also recorded (not presented)
Barometric Pressure	Both Weather Stations	Every 50-60 sec; output as mean hourly	kPa	Figure 15	
Wind Speed	Both Weather Stations	Every 2.5-3 sec; output as mean hourly	km/hr	Figure 16	Max/Min hourly also recorded at Weather Stations (not presented)
Wind Direction	Both Weather Stations	Every 2.5-3 sec; output as mean hourly	N/E/S/W	Figure 17	Max hourly also recorded at Weather Stations (not presented)
Ultraviolet (UV) Index	Both Weather Stations	Every 50-60 sec; output as mean hourly	Scale 1 – 16	Figure 18	"Hi UV Index", i.e. maximum hourly UV Index also recorded (not presented)
Soil Moisture ¹	Both Satellite Stations	Every 50-60 sec; output as mean hourly	kPa	Figure 19 (CT#1); Figure 21 (CT#2A)	Measured at two depths
Soil Temperature	Both Satellite Stations	Every 50-60 sec; output as mean hourly	°C	Figure 20 (CT#1); Figure 22 (CT#2A)	Measured at two depths

1. Soil moisture is measured in units of centibar (Cb) according to the supplier, which is not a true unit of soil moisture. The true parameter measured by this instrument is soil matric suction.

2.2 Campbell Scientific Data Loggers

Installing the lysimeter instrumentation resulted in the addition of a Campbell Scientific CR1000 data logger to the existing two CR10X dataloggers. The CR1000 performs the same functions as the CR10X, and is basically the next generation of the same family of data loggers. Although the output files have different structure, the full integration of the data from all data loggers was made possible by adjusting the post-processing protocols.

2.2.1 General Setup

Two Campbell Scientific CR10X and one CR1000 data loggers collect soil matric suction and temperature data from Campbell Scientific CS229 thermal conductivity sensors, as well as soil volumetric moisture content from Sentek Sensor Technologies EnviroScan sensors. Flow volumes from the tipping bucket flow gauges are also monitored by these data loggers. In addition, the data loggers monitor and record the minimum battery voltage each day, for diagnostic purposes. The CR10X are located adjacent to each other in the lower monitoring hut at the base of CT#3B while the CR1000 is located in the upper monitoring hut between CT#4 and CT#3A, as illustrated in Figures 4 and 5.

The first data logger (CR10X #1) collects volumetric moisture content data from CT#2A and 2B, as well as the entire suite of flow data from 9 tipping buckets. The second data logger (CR10X #2) records the soil temperature and suction from CT#1, CT#2A, CT#2B, CT#3A, CT#3B, and CT#4, as well as moisture content data from CT#1, CT#3A, CT#3B, and CT#4. In addition, the CR1000 is collecting soil temperature, suction, moisture content and flow data from Lysimeters L#1 and L#2. Details of the instrument locations are presented in Figures 4 through 9.

Data collected by the CR10X data loggers is stored in a series of “arrays” (i.e. a summary table of data). The soil matric suction, temperature and volumetric moisture content are recorded every six hours (midnight, 6AM, noon, and 6PM). The interflow is continuously monitored by both CR1000 and CR10X#2 and cumulative flow is output every 30 minutes. Daily summary of the battery voltage is also recorded for diagnostic purposes.

The Campbell Scientific data loggers are not decommissioned during winter months and as a consequence data is continuously collected, as opposed to the Weather Stations that are decommissioned during winter. Because moisture content and suction cannot be measured in frozen soils, only soil temperature data presented in this report spans from the end of the 2008 monitoring season in October to November 2009. The rest of the parameters are presented over the regular monitoring season, from May to November.

The CR10X dataloggers were installed in 2005, totalling to date over 30,000 hours of operation. As per the manufacturer’s recommendation, the dataloggers should be serviced and recalibrated to ensure accuracy and continued good operation.

During the routine quality checks of the field data it was observed that erroneous soil moisture content data was collected by CR10X#1 datalogger, starting on August 18. The sensors monitored by this datalogger are located on CT#2A and CT#2B. A first attempt to fix the issue, on September 14 was unsuccessful, and a site visit by Iozsef Miskolczi was required to further investigate and fix the malfunction. Troubleshooting revealed that the malfunction was caused by a defective data transfer cable. The defective cable was replaced with an armoured surface cable. Data collection was restored on September 27. The monitoring of the tipping bucket flow gauges (monitored by the

same CR10X#1 datalogger) was uninterrupted during the period of malfunction except for the short periods when the datalogger was shut down for troubleshooting.

During the 2008 monitoring season it was noted that some of the sensors (L#2 sensor 6, CT#4 sensor 12, CT#3A sensor 1) installed on the EnviroScan probes were reporting erroneous values. These sensors were replaced in August with new ones.

2.2.2 Battery Voltage

The Campbell Scientific data loggers and instruments connected to them are powered by 12V batteries (one per data logger). These batteries are continuously recharged using solar energy (one solar panel per battery). The data logger has an internal protection circuit that will shut the logger down if the battery voltage drops below 8V, or exceeds 15V. For this reason, the data loggers have been programmed to record the battery voltage as part of the daily summary array. Figure 23 presents the graph of daily minimum battery voltages measured for each of the Campbell Scientific data loggers.

At time of recommissioning of the instrumentation in the spring of 2009 evidence of high water levels inside the upper monitoring hut was noted (housing the lysimeter instrumentation), most likely originating from snowmelt. It appeared the battery was completely submerged at some point, but the voltage recovered in the spring and no lasting damage was observed. The datalogger and the flow meters installed on the walls of the hut are above the high water mark.

As shown in Figure 23, the battery voltage of the CR1000 datalogger was lower than optimum in several occasions during the first half of the 2009 monitoring season. Following up on this issue, a second solar panel was installed in August 2009. As can be observed in Figure 23, the battery voltage of the CR1000 datalogger was maintained at optimum levels after the installation of the solar panel.

The written monitoring protocol required a physical diagnostic check on the batteries and solar panels installed in the lower monitoring hut (housing the CR10X dataloggers and the connected instrumentation) every time that the data is downloaded, which confirmed that both systems were functioning properly. Observation sheets are included as Appendix C.

2.2.3 Soil Matric Suction

Soil matric suction is measured in each trial cover using a series of Campbell Scientific CS229 thermal conductivity sensors. There are three to six sensors in each trial cover and four sensors in each lysimeter, as illustrated in Figures 6 to 9. Soil matric suction is recorded as a voltage differential by the data logger. This voltage differential, through the application of material specific calibration curves, is converted to matric suction, expressed in kPa. This is done by SRK during the conversion of the data from its raw format. Figures 24 through 31 illustrate the converted soil matric suction values recorded during the 2009 season. Due to the fact that suction measured in some of the

covers were very high, the graphs presenting these suction values are shown on a log scale (Figures 26, 30, and 31).

The straight lines on Figures 30 and 31, presenting the suction measured on L#1 and L#2 respectively are the result of the fact that measured values fell outside the calibrated range of the individual sensors. The sharp transition of the suction curve from the jagged nature in the first half of the year to the relatively smooth nature in the second half is the artefact of the log scale used to present the data.

2.2.4 Soil Temperature

The soil temperature is measured using the same CS229 thermal conductivity sensors. This is possible because the first step in recording the soil matric suction entails taking an in-situ soil temperature reading. Just as with the matric suction data, the raw data is recorded as a voltage and, through application of the material specific calibration curves in the post-processing phase, the soil temperature profiles illustrated in Figures 32 to 39 are produced. As shown in Figure 33, some erroneous values were collected from one sensor on CT#2A. As the sensor resumed operation spontaneously, no investigation was made to determine the cause of the error.

2.2.5 Soil Volumetric Moisture Content

A profile of soil volumetric moisture content is measured in each trial cover using EnviroScan probes manufactured by Sentek Sensor Technologies. Each profile contains between seven and thirteen individual beads, as illustrated in Figures 6 to 9. The data recorded by the sensors is relative volumetric moisture content, expressed as a fraction, using a standard calibration curve. During the post-processing, these values are corrected to actual volumetric moisture contents by applying material specific calibration curves. This data is presented in Figures 40 through 47. The data recorded from CT#2B (Figure 42) and CT#3B (Figure 44) is shown as a reduced sample in the sense that full 2009 data set from only a few sensors is presented, as the complete files are too large. Nevertheless, the entire dataset was checked and no anomalies were found.

The straight lines shown in Figures 41 and 42 are the result of missing data, as described in Section 2.2.1.

2.2.6 Tipping Bucket Flow Gauges (Runoff and Interflow)

The flow (interflow as well as surface flow) data is collected using two methods: tipping bucket flow gauges and SeaMetrics turbine flow gauges. The tipping buckets located in the lower monitoring hut are continuously monitored by CR10X #1 through two SDM-SW8A pulse counter devices connected in series; cumulated totals of tips are recorded every 30 minutes. The tipping bucket flow gauges installed at the lysimeters are monitoring the surface flow and two interflow values on each lysimeter through the CR1000 data logger, with 30 minute totals being recorded. The interflow of the lysimeters was separated in order to quantify the purely vertical infiltration from the infiltration affected by the cover-liner boundary.

A series of new Tipping Bucket flow gauges were installed in the Upper monitoring hut, on August 19, 2009. The new instruments have a much wider range (up to 20 Litres per minute), replacing the smaller rain gauges originally installed. This change was necessary to allow for an overlap between the capacity of the tipping buckets and the flow meters, thus improving accuracy of the flow monitoring system.

The recorded interflow data for CT#3A/B and CT#4 is presented in Figures 48 to 50, while surface runoff data for all cover trials is presented in Figures 51 through 56. Flow data from the Lysimeters is presented in Figures 57 to 62.

2.3 SeaMetrics DL75 Data Loggers (Surface Runoff and Interflow)

Surface runoff is measured from each trial cover using individual SeaMetrics flowmeters, each connected to an individual SeaMetrics DL75 data logger. Interflow from CT#3A, CT#3B and CT#4 is also measured with a similar setup (in addition to tipping buckets, as discussed in Section 2.2.6). Each of these nine flowmeters is located in the lower monitoring hut, with the flow directed to them through a series of buried drainage pipes, as illustrated in Figure 5. In addition, a similar setup was installed for the lysimeters, with the SeaMetrics data loggers installed on drainage pipes inside the upper monitoring hut.

Acting on the observations made in the previous season regarding the sediments affecting the performance of the flow meters in the upper monitoring hut, a series of sediment traps were installed in August, one on each water transport pipe.

The data loggers record an instantaneous flow rate every 60 seconds. This data is used to calculate an incremental flow volume. In addition, each data logger calculates a total volume and flow rate over a user specified timeframe. During the post-processing of the data, the null values (no flow recorded) are removed from the database to save space, thus the graphs in this report show only the non-null values in chronological sequence. This data is presented in Figures 63 through 71.

All flowmeters were performing as expected. Maintenance of the flow meters was performed at the beginning of the 2009 monitoring season.

2.4 Lakewood Systems UL16 Data Logger (Soil Temperature)

Two thermistor strings, each with eight M-Squared thermistor beads, have been installed in the Grum Overburden Dump, as illustrated in Figure 10. These two thermistor strings (String A and String B) are monitored by a Lakewood UL16 data logger which records a relative voltage every twelve hours. These raw voltage profiles are presented in Figures 72 and 73, and confirm that the strings are in general performing as expected.

As it can be seen in Figures 72 and 73, data was not collected between April 4, 2009 and May 22, 2009. The malfunction was caused by loss of power due to the fact that the battery reached the end of its service life. Data collection was resumed once the battery was replaced.

3 Manually Collected Instrumentation Data

3.1 M-Squared Thermistor Cables (Soil Temperature)

Four thermistor strings each with eight thermistor beads have been installed adjacent to the two strings connected to the Lakewood Systems data logger, in the Grum Overburden Dump. Their installation details are presented in Figure 10. These four thermistor strings are manually read at regular intervals by the site staff and the raw data is reported as resistances. These resistance values are converted to soil temperatures during the post-processing phase. The measured soil temperature profiles for the 2007 season from these four strings are shown in Figures 74 through 77. All thermistor strings performed as expected. Measurements were taken on 7 occasions, between June 4th and August 28th.

3.2 Sentek Sensor Technologies Diviner 2000 (Soil Volumetric Moisture Content)

Each trial cover has six to eight vertical PVC access tubes, as illustrated in Figure 5, while the lysimeters have ten access tubes each. A Sentek Sensor Technologies Diviner 2000 probe is inserted manually into each of these tubes to record an instantaneous value of the soil volumetric moisture content profile at 10 cm intervals. Data was collected throughout the 2009 monitoring season from each of the 60 access tubes between May 21st and August 12th for a total of 26 events. Data was recorded using a portable data logger, and the results are expressed in terms of relative volumetric moisture content. During the post-processing stage, material specific calibration curves are applied. Figures 78 through 135 present the final volumetric moisture content profiles for each access tube. Data collected from these tubes confirm that the instrument performed as expected.

Data from profiles #45 and #49 is missing due to the fact that the access tubes contained water, and no valid measurements could be taken. The tubes should be bailed out and dried before at time the instrumentation is recommissioned for the 2010 monitoring season.

3.3 HOBO Water Level Loggers

In an effort to mitigate the difficulty of measuring flow in the beginning and end of each season due to frozen drainage pipes, a series of culverts were installed on CT#2A, CT#2B, and both lysimeters. The culverts consist of a wooden channel placed in a gap in the containment berm. Each culvert was instrumented with a HOBO water level logger that monitors and samples the pressure every 60 seconds. Changes in recorded pressure will be an indication of water level fluctuations, i.e. flow through the culvert. Due to low sensitivity of the level logger (± 3 mm), the instruments are not suitable to quantify the volume of flow, but rather to confirm the number and duration of flow events. Because of the closed pressure cell of the HOBO instrument, the recorded data has to be reduced by subtracting the atmospheric pressure recorded by the Weather Stations on site. Due to limited available memory of the HOBO device, the download protocol provided to the site personnel required download every 14 days. Data presented in Figures 136 to 139 represents the uncorrected,

absolute pressure values collected by the HOBO loggers. Although data is collected every minute, the data presented in this report was reduced to represent only one value for each hour of operation, as the complete files are too large to be presented in an Access graph.

The level logger installed in L#1 was observed to be defective and was removed for servicing on June 18.

4 In-Situ Geotechnical Testing

The 2009 in-situ geotechnical investigations were performed between August 10 and August 19. The investigations included saturated hydraulic conductivity measurements, performed using the single ring infiltrometer and the Guelph permeameter methods, as well as in-situ density measurements using a nuclear density gauge owned and operated by EBA Engineering Consultants Ltd.

4.1 Saturated Hydraulic Conductivity

In-situ saturated hydraulic conductivity was tested on the trial covers between August 8 and August 13. Constant head testing was performed using two separate Guelph Permeameter kits for the different methods: the standard “in-hole” method and the Tension Infiltrometer method. Falling head testing was performed using the single ring infiltrometer method. Table 2 summarizes the testing carried out on each test cover.

Table 2: Summary of Performed In-situ Saturated Hydraulic Conductivity Tests

Testing Method	Test Location	Hydraulic Conductivity (cm/s)	Comments
Guelph Permeameter	L#1_1	8.09E-04	
Guelph Permeameter	L#1_2	8.57E-05	
Guelph Permeameter	L#2_1	9.06E-05	
Guelph w/ tension infiltrometer	L#2_2	N/A	Inconclusive
Guelph w/ tension infiltrometer	CT#1_1	3.47E-04	
Guelph w/ tension infiltrometer	CT#1_2	-3.50E-06	
Guelph Permeameter	CT#2A_1	-2.98E-04	
Guelph Permeameter	CT#2A_2	1.10E-04	
Guelph Permeameter	CT#2B_1	-3.38E-06	
Guelph w/ tension infiltrometer	CT#3A_1	6.59E-05	
Guelph w/ tension infiltrometer	CT#3A_2	8.83E-04	
Guelph w/ tension infiltrometer	CT#3A_3	1.11E-04	
Guelph w/ tension infiltrometer	CT#3B_1	8.30E-04	
Guelph w/ tension infiltrometer	CT#3B_2	1.07E-03	
Guelph w/ tension infiltrometer	CT#3B_3	4.39E-04	
Guelph Permeameter	CT#4_1	1.43E-04	
Ring Infiltrometer	CT#1_1	7.77E-06	
Ring Infiltrometer	CT#1_2	5.49E-05	
Ring Infiltrometer	CT#1_3	5.84E-05	
Ring Infiltrometer	CT#3A_9	7.17E-04	
Ring Infiltrometer	CT#3A_10	5.12E-04	
Ring Infiltrometer	CT#3A_11	1.38E-03	
Ring Infiltrometer	CT#3B_6	6.15E-04	
Ring Infiltrometer	CT#3B_7	2.41E-03	
Ring Infiltrometer	CT#3B_8	9.50E-04	
Ring Infiltrometer	CT#4	N/A	Inconclusive
Ring Infiltrometer	L#2	N/A	Inconclusive

* Random locations were selected on each cell.

The tension infiltrometer method uses a porous disc to act as interface with the test surface. Constant head is maintained over the disc using a Mariotte bubbler. The water reservoir of the Guelph permeameter is used as source for replacing the water lost during the test due to suction. The tension infiltrometer method allows measurement of saturated hydraulic conductivity without the need to auger a hole into the till. The surface upon which the tension infiltrometer base is placed must be as smooth and horizontal as practicable, to ensure a good hydraulic contact between the tension infiltrometer and the soil surface. To ensure good hydraulic contact, fine grained uniform sand is used as filler.

In cases where the surface of the covers is horizontal (CT#2A, CT#2B, L#2), the tests were performed directly on the surface. For the sloped covers (CT#1, CT#3A, CT#3B, and CT#4) an excavation was made to create a levelled base upon which to perform the infiltration test.

The ring infiltrometer tests were performed using 30 cm sections cut from a section of steel pipe (13 mm wall thickness), with an internal diameter of 59 cm. The rings were pushed into ground to a depth of approximately 7.5 cm using the bucket of the excavator, and then a sealing ring of bentonite paste was placed on the outside base of the ring. In the case of the sloped trial covers, a horizontal pad was prepared by hand, and the rings installed as previously described. The measurements were performed as falling head tests, meaning that the rings were filled with water and then left to drain, the draining rate being recorded. To avoid the accumulation of precipitation as well as excessive evaporation, the rings were covered with plywood lids.

The testing program concentrated on testing the covers on CT#1, CT#3A and CT#3B. Nevertheless constant head testing was performed on all 8 covers, for a total number of 16 tests performed. Only 11 ring infiltrometer tests were performed, due to the fact that the excavator broke down and it was only repaired the day previous to leaving site. The targeted covers were same as in the case of the constant head testing, with no tests performed on CT#2A, CT#2B, and L#1. Although one test was performed on both CT#4 and L#2, the tests were inconclusive due to insufficient time for the test to come to equilibrium.

Complete individual field data calculation sheets can be found in Appendix D.

4.2 In-Situ Density Testing

In-situ density testing was carried out on August 19, using a nuclear density probe owned and operated by EBA Engineering Consultants Ltd. of Whitehorse, YT. The in-situ density was measured on every cover, as well as on both lysimeters. Table 3 summarizes the test results, while field data sheets are attached in Appendix E.

It should be noted that the reference dry density of 2,130 Kg/m³ used to calculate the percentage of Standard Proctor compaction reflects the maximum density achievable in laboratory conditions of the glacial till used for the covers, thus it is not representative of the glacio-fluvial material used for the covers on CT#3A and CT#3B. The values of percentage Standard Proctor Compaction could

therefore be misleading in the case of the uncompacted glacio-fluvial material and have been excluded from the results summarised in Table 3.

Table 3: Summary of In-Situ Density Tests

Trial Cover	Material Tested	Number of Tests	Average Moisture Content (%)	Average Dry Density (kg/m³)	Average Standard Proctor Compaction (%)
CT#1	Till	18	9.5	2,055	96.5
CT#2A	Till	18	8.3	2,153	101.1
CT#2B	Till	18	8.2	2,115	99.3
CT#3A	Glacio-Fluvial	18	4.5	2,069	N/A
CT#3B	Glacio-Fluvial	18	4.3	2,037	N/A
CT#4	Till	18	8.9	2,112	99.1
L#1	Loose Till	21	7.2	1,750	82.2
L#2	Compacted Till	21	7.1	2,166	101.7

The in-situ density data will be used for relative comparison changes in the soil profile over time, and the absolute values recorded are of less importance.

5 Conclusion

5.1 Summary

This report documents the 2009 season of data collected for the trial covers constructed on the Vangorda waste rock pile. The trial covers were constructed in September 2004 with the instrumentation installed in June 2005. Two lysimeters were added in August 2007 and the instrumentation installed in June 2008. For the 2009 season, instrumentation was commissioned on May 20th and shut down on November 11th. Data collection and instrumentation performance was good, and partial loss of data experienced for some of the instruments will not significantly affect the overall quality of information.

5.2 Database Management

2009 was the 5th year of continuous monitoring of the instrumented cover trials. The total sum of data collected to date is in excess of 4.5 million data points, which exceeds the file size limit of Microsoft Access. About 1.2 million data points will be added to this dataset every year, as monitoring continues.

Up to the end of 2008, post-processing of the data was performed using dedicated code written in Fortran, and only calibrated and corrected data was transferred to the Access database. In an effort to simplify database maintenance and post-processing, the post-processing protocols were re-written in SQL and Visual Basic codes in 2009. This eliminates the need for external code and ensures that all data management occurs within the actual database. This process however significantly increased the amount of data that has to be stored in the database. As a result, the database in its current format as an Access database is no longer usable.

To resolve the data management issue, SRK will store the dataset on a SQL Server. This action does not change the post-processing protocols, and Microsoft Access will remain the user interface. The advantage of this option is that eliminates the file size limitation of Microsoft Access, allowing for improved database management.

5.3 Erosion Damage Repairs

At the time of instrument recommissioning in May 2009, it was noted that the upper monitoring hut was flooded by snowmelt water, while the containment berms for CT#4, CT#3A and CT#1 were badly damaged by surface erosion. The ensuing site investigation found that inadequate grading of a drainage ditch prevented the water from flowing away, resulting in overflow of the ditch. During July extensive erosion damage repair works were performed under the supervision of SRK engineer Michelle Murphy. Besides the immediate repair works performed, a series of preventative measures were implemented to ensure similar events will not occur in the future. Details of the repairs are presented in the Technical Memorandum attached as Appendix F.

To ensure adequate performance of the cover trials in the future, SRK recommends that any damage to the containment berms caused by erosion over the winter be repaired as early in the spring of 2010 as possible, and repeated each spring, as required.

5.4 Action Items

The monitoring of the instrumentation should continue for at least 3 more years, and the following is a list of recommendations that should be implemented to ensure that future monitoring is successful:

- The Campbell Scientific CR10X dataloggers should be sent to manufacturer for general maintenance and recalibration prior to recommissioning for the 2010 season. SRK recommends action be taken in February 2010.
- The wireless transmitters of the Davis Vantage Pro satellite stations should be uninstalled and sent to the manufacturer for repairs. SRK recommends action be taken in February 2010.
- The moisture content and temperature sensors connected to the Davis Vantage Pro weather stations should be replaced at time of instrumentation recommissioning.
- All instrumentation should be re-commissioned in May 2010.
- The HOBO level logger of L#1 was repaired and should be re-installed at time of instrumentation recommissioning.
- Site staff should be retrained on the download protocols.
- The desiccant packs in the weatherproof enclosure of each data logger must be replaced every two weeks. The removed desiccant packs can be dried out in the laboratory oven as per the manufacturer's instructions.
- Sand traps installed in the upper monitoring hut should be inspected and cleaned of any sediment at the beginning of the monitoring season, and on a monthly basis thereafter throughout the monitoring season.
- General maintenance of all tipping bucket flow gauges in both the lower and upper monitoring huts should be performed at time of recommissioning.
- Level of all tipping buckets should be checked at the beginning of the monitoring season, and monthly thereafter throughout the season. Horizontal position should be restored, as required.
- Positive drainage around each Diviner and EnviroScan tube should be created by mounding some soil around the pipes, to minimise the preferential drainage paths along the pipes.
- All Diviner and EnviroScan access tubes should be checked for condensed water, and where necessary water should be bailed out and the tube dried prior to commencing the 2010 monitoring season.
- Desiccant packs should be placed in each EnviroScan tube to eliminate condensation.
- Throughout the 2010 monitoring season daily data should be collected using the Diviner 2000 instrument, weather permitting.

- Another round of in-situ density and hydraulic conductivity testing should be carried out on the trial covers in July/August 2010. Density testing using the sand cone replacement method should be carried out on all test covers in parallel to the nuclear density testing, to allow for direct comparison between the two methods.

This report, “**Faro Mine Complex, Monitor Mine Waste Rock Trial Covers: 2009 Data Summary**”, has been prepared by SRK Consulting (Canada) Inc.

Prepared by:

ORIGINAL SIGNED
AND STAMPED

Jozsef Miskolczi, E.I.T.
Consultant

Reviewed by:

ORIGINAL SIGNED
AND STAMPED

Maritz Rykaart, PhD., P.Eng.
Principal

6 References

Janowicz, J.R., Hedstrom, N.R., Granger, R.J. (2005). Investigation of Anvil Range Mining Corporation (Faro) Waste Dump Water Balances – 2003/04 Water Year – Preliminary Water Balance. Report prepared for SRK Consulting Inc. on behalf of Deloitte & Touche Inc., March.

Janowicz, J.R., Hedstrom, N.R., Granger, R.J. (2006). Investigation of Anvil Range Mining Corporation (Faro) Waste Dump Water Balance – Final Water Balance – Draft. Report prepared for SRK Consulting Inc. on behalf of Deloitte & Touche Inc., May.

Janowicz, J.R., Hedstrom, N.R., Granger, R.J. (2007). Investigation of Anvil Range Mining Corporation (Faro) Waste Dump Water Balance – Vangorda Trial Covers Water balance. Report prepared for SRK Consulting Inc. on behalf of Deloitte & Touche Inc., December.

Janowicz, J.R., Hedstrom, N.R., Granger, R.J. (2008). Investigation of Anvil Range Mining Corporation (Faro) Waste Dump Water Balance – Vangorda Trial Covers Water balance. Report prepared for SRK Consulting Inc. on behalf of Deloitte & Touche Inc., September.

SRK Consulting (Canada) Inc. (2006a). Anvil Range Mining Complex Mine Waste Rock Trial Covers As-Built Report, Faro, Yukon, Canada. Consultants report submitted to Deloitte & Touche Inc. on behalf of the Faro Mine Closure Planning Office, Project No. 1CD003.051, April.

SRK Consulting (Canada) Inc. (2006b). Anvil Range Mining Complex Monitor Mine Waste Rock Trial Covers: 2005 Data Summary, 2005/2006 Task 20a, Faro, Yukon, Canada. Consultants report submitted to Deloitte & Touche Inc. on behalf of the Faro Mine Closure Planning Office, Project No. 1CD003.051, April.

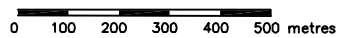
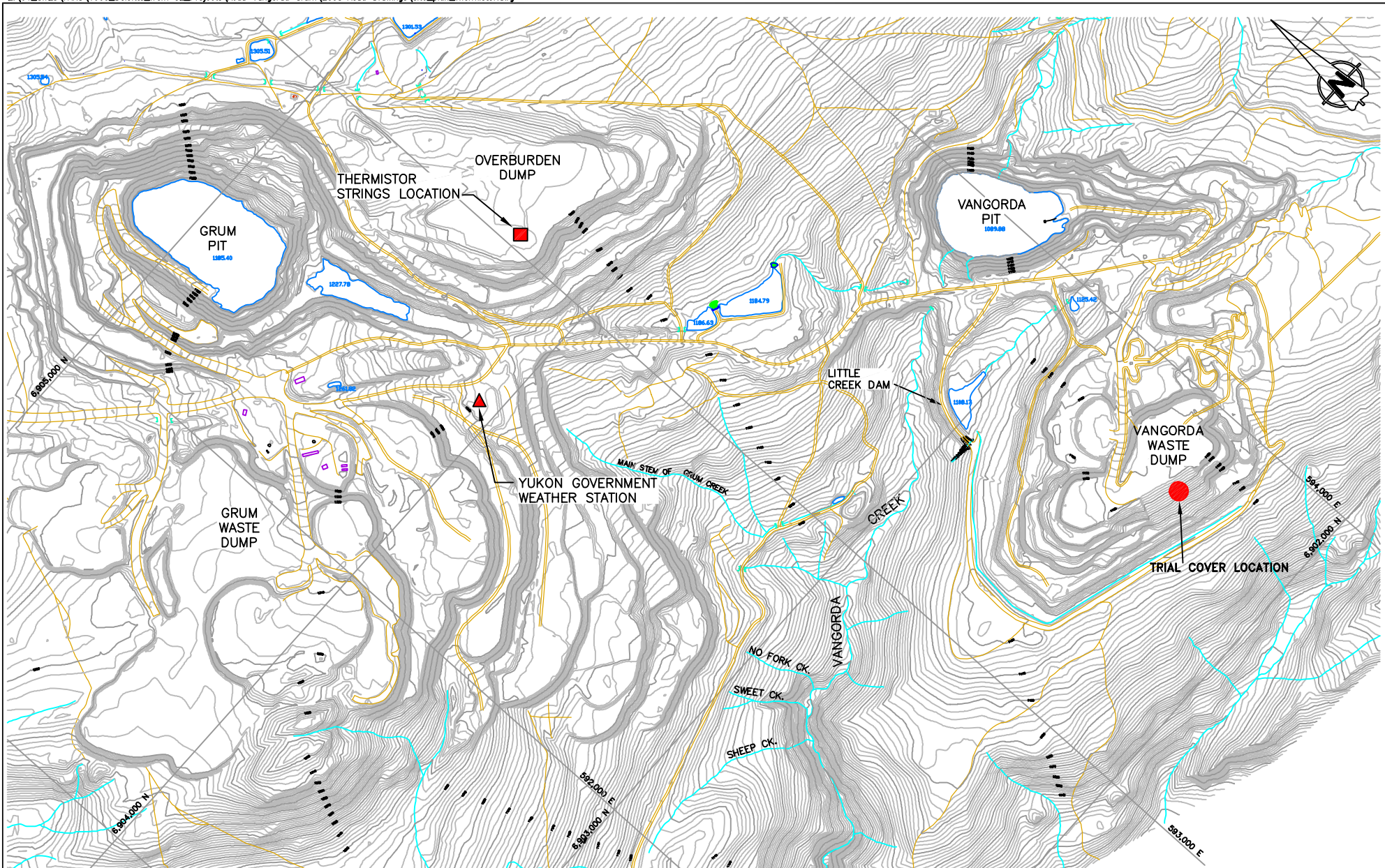
SRK Consulting (Canada) Inc. (2007). Anvil Range Mining Complex Monitor Mine Waste Rock Trial Covers: 2006 Data Summary, 2006/2007 – task 17a, Faro, Yukon, Canada. Consultants report submitted to Deloitte & Touche Inc. on behalf of the Faro Mine Closure Planning Office, Project No. 1CD003.086, July.

SRK Consulting (Canada) Inc. (2008a). Anvil Range Mining Complex Monitor Mine Waste Rock Trial Covers: 2007 Data Summary, 2007/08 – task 18a, Faro, Yukon, Canada. Consultants report submitted to Deloitte & Touche Inc. on behalf of the Faro Mine Closure Planning Office, Project No. 1CD003.093, July.

SRK Consulting (Canada) Inc. (2008b). Faro Mine Complex Vangorda Lysimeter As-built Report, 2007/08 – task 30, Faro, Yukon, Canada. Consultants report submitted to Deloitte & Touche Inc. on behalf of the Faro Mine Closure Planning Office, Project No. 1CD003.095, November 2008.

SRK Consulting (Canada) Inc. (2008c). Faro Mine Complex Waste Rock Cover Trials Preliminary Performance Report. Consultants report submitted to Yukon Government on behalf of the Faro Mine Closure Planning Office, Project No. 1CY001.020, November.

Figures



Monitor Mine Area Waste Rock Trial Covers
2009 Data Summary

Location Plan for Trial Covers
and Thermistor Strings

SRK JOB NO.: 1CY001.030.600

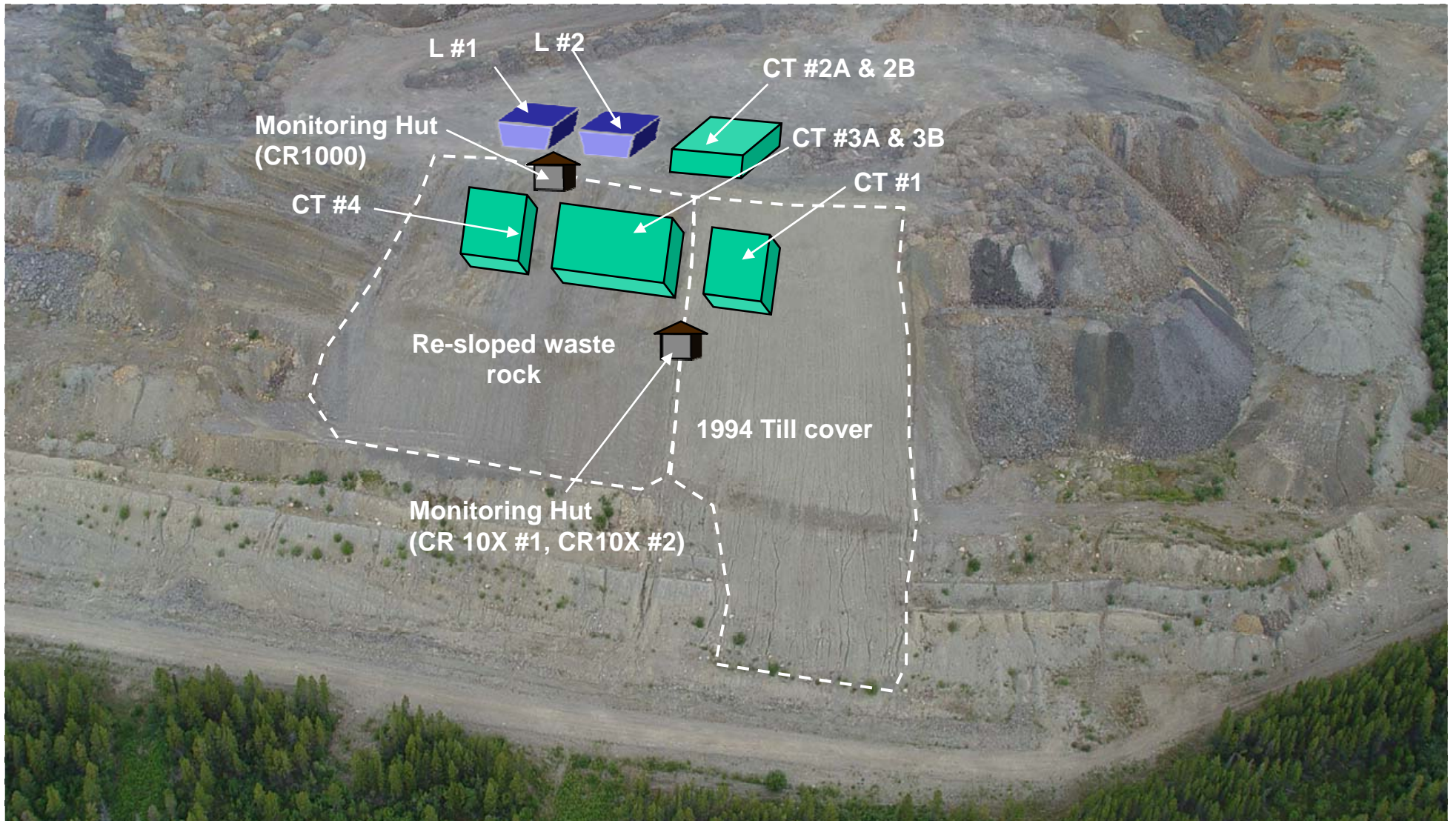
FILE NAME: site_plan_Thermistor.dwg

Faro Mining Complex

DATE: Jan.2010

APPROVED: JM

FIGURE: 1



Monitor Mine Area Waste Rock Trial Covers
2009 Data Summary

Aerial View of Trial Cover Layout

Job No: 1CY001.030.600

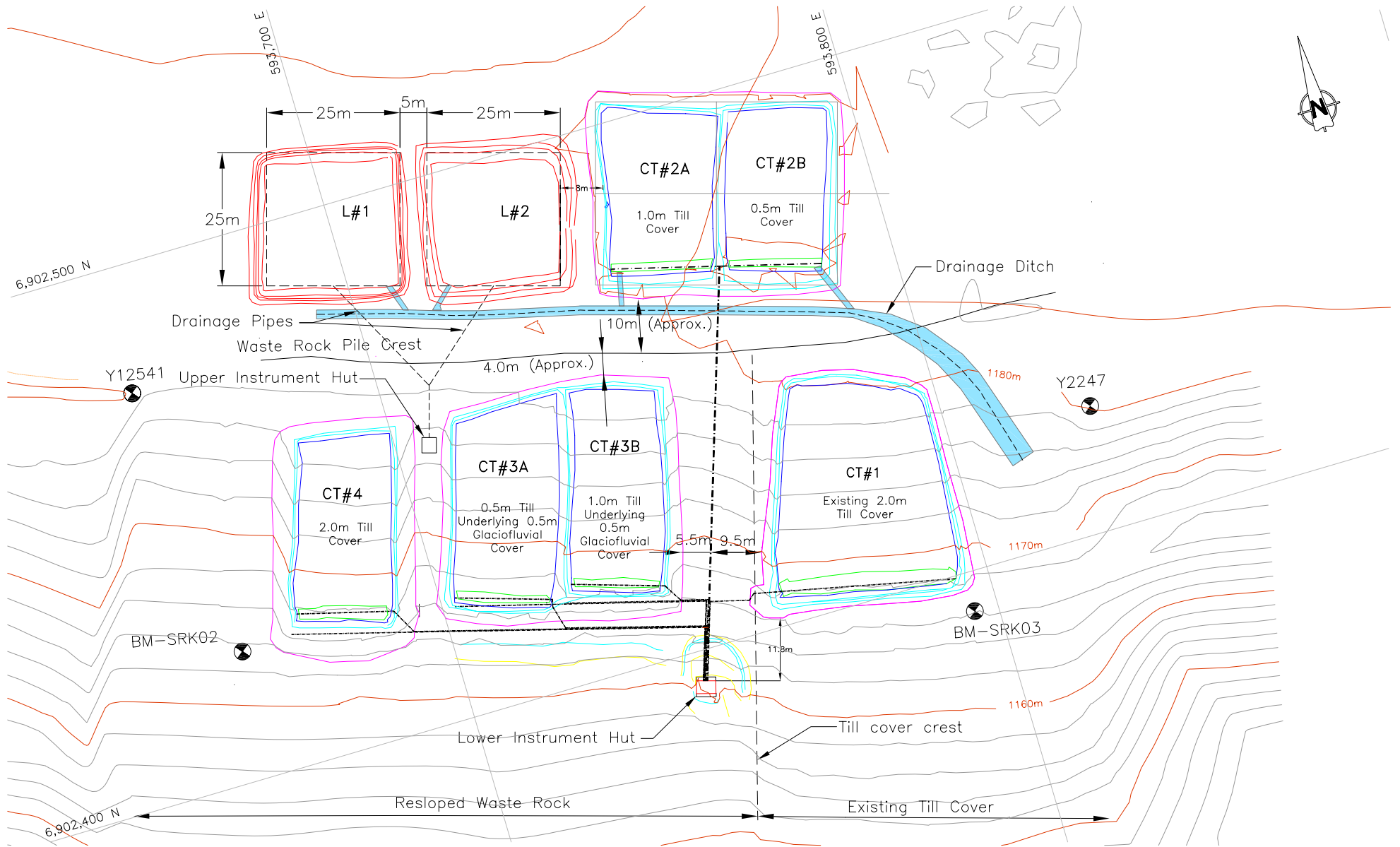
Filename: Fig2_4-9_Trial covers_20100113.ppt

Faro Mine Complex

Date:
Jan. 2010

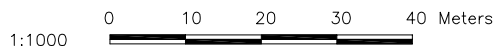
Approved:
JM

Figure: **2**



LEGEND

Benchmark



1:1000



SRK JOB NO.: 1CY001.030
FILE NAME: Test Covers Asbuilt with Ditch.dwg



Faro Mining Complex

Monitor Mine Area Waste Rock Trial Covers
2009 Data Summary

**Trial Covers and
Lysimeter Layout Plan**

DATE: Jan. 2010	APPROVED: JM	FIGURE: 3
--------------------	-----------------	--------------

Legend:



Multiplexer



Campbell Scientific Datalogger



Satellite Station



Weather Station



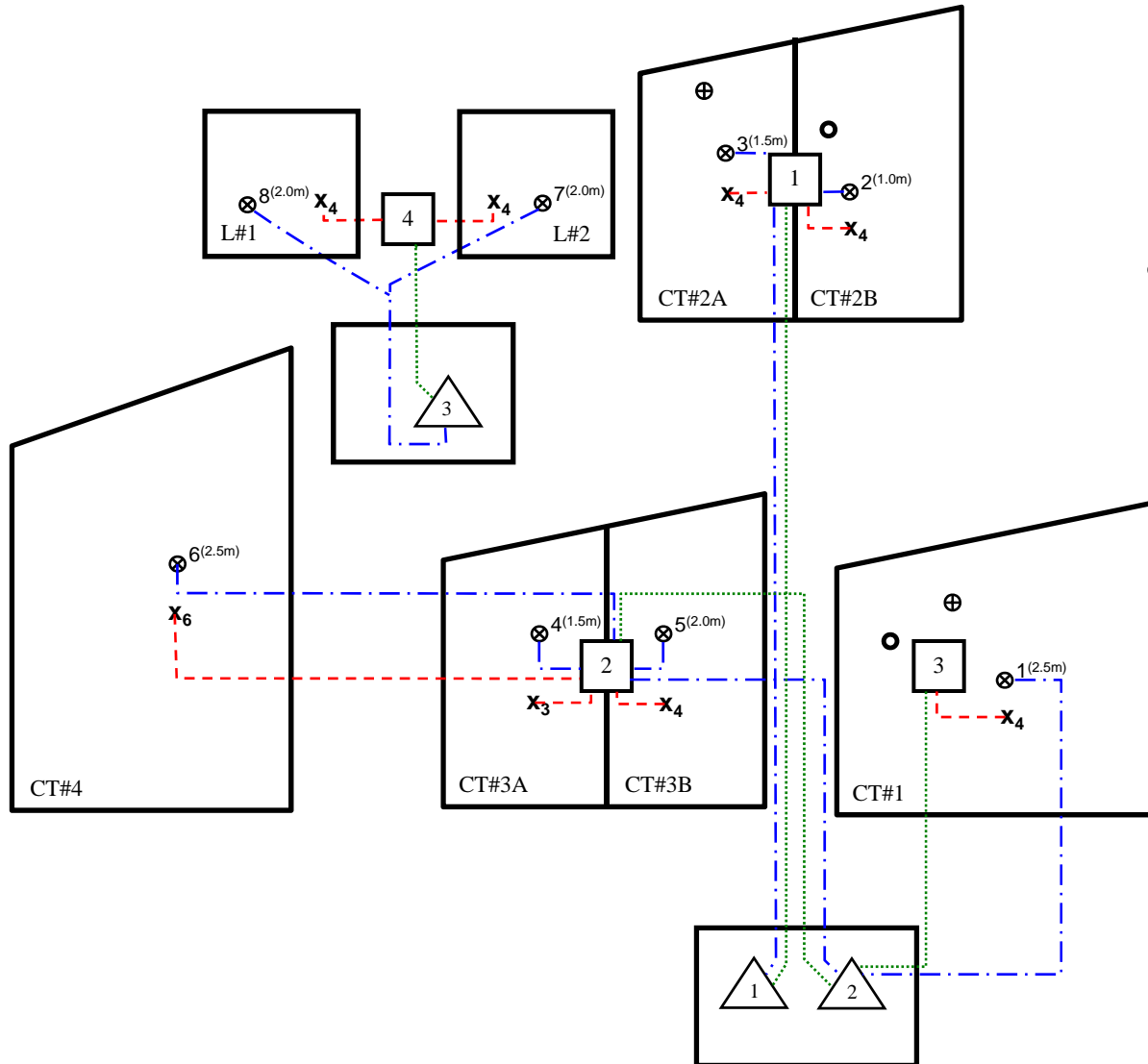
EnviroSCAN Probe #(#m rail) & Communication Wire



CS229 Thermal Conductivity Sensor (# sensors in profile) & Lead wires



Multiplexer Communication Wire



Job No: 1CY001.030.600
 Filename: Fig2_4-9_Trial covers_20100113.ppt



Faro Mine Complex

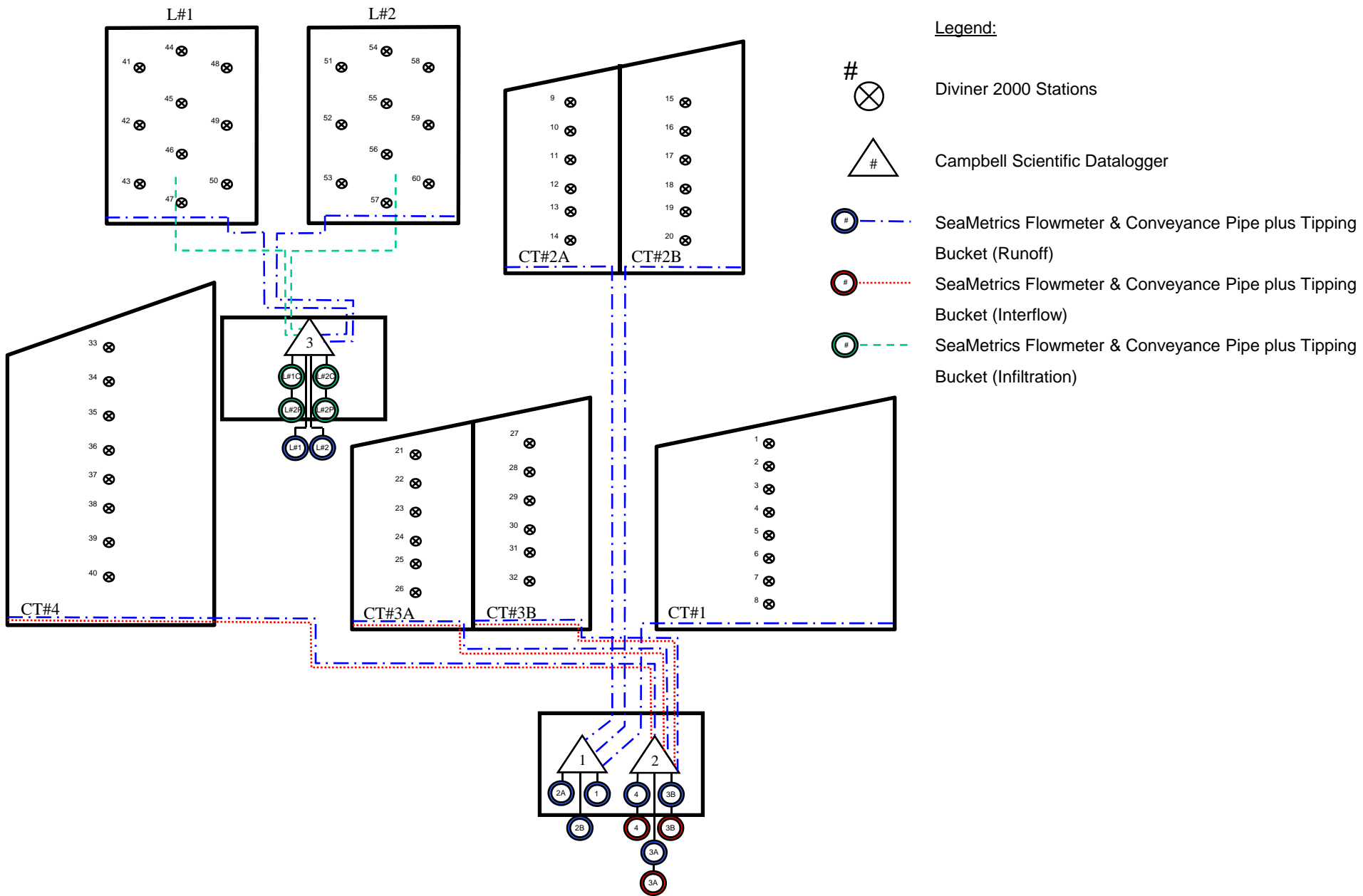
Monitor Mine Area Waste Rock Trial Covers
 2009 Data Summary

Schematic Trial Cover and Lysimeter Layout
 Showing Automated Soil Suction, Moisture
 Instrumentation, Datalogger as well as Weather
 and Satellite Station Locations

Date:
 Jan. 2010

Approved:
 JM

Figure:
4



Legend:

- # ⊗ Diviner 2000 Stations
- △ # Campbell Scientific Datalogger
- ⊙ # SeaMetrics Flowmeter & Conveyance Pipe plus Tipping Bucket (Runoff)
- ⊙ # SeaMetrics Flowmeter & Conveyance Pipe plus Tipping Bucket (Interflow)
- ⊙ # SeaMetrics Flowmeter & Conveyance Pipe plus Tipping Bucket (Infiltration)



Monitor Mine Area Waste Rock Trial Covers
2009 Data Summary

Schematic Trial Cover and Lysimeter Layout
Showing Diviner 2000 Stations, Surface Runoff,
and Interflow Measurement Locations

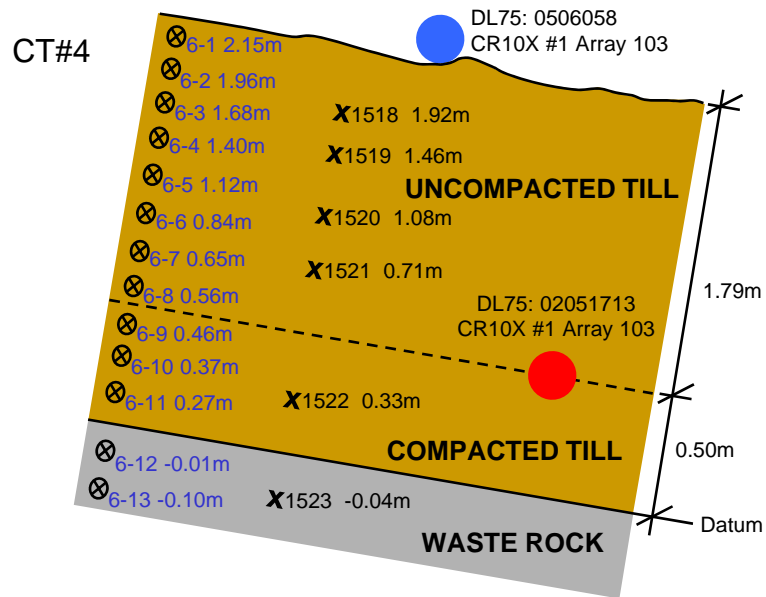
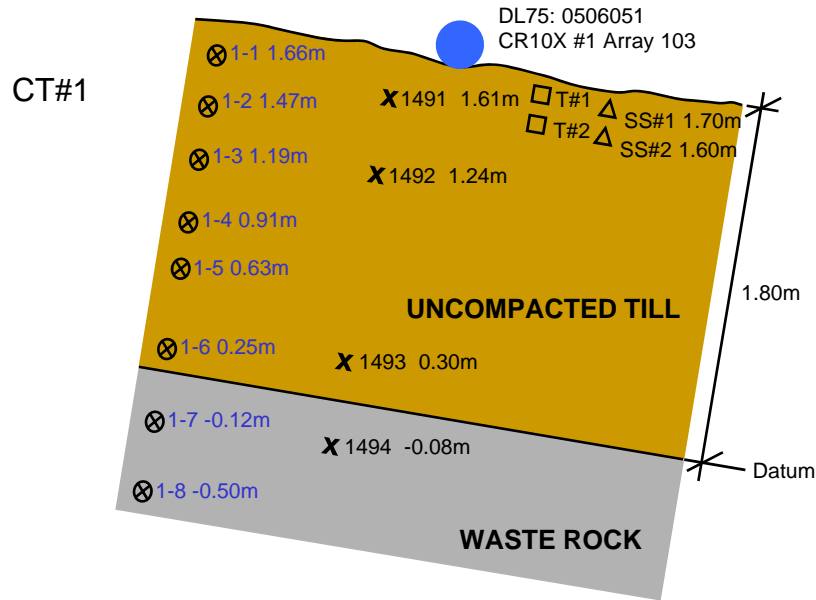
Job No: 1CY001.030.600
Filename: Fig2_4-9_Trial covers_20100113.ppt

Faro Mine Complex

Date: Jan. 2010

Approved: JM

Figure: **5**



- Legend:**
- ⊗ #-# #.##m EnviroSCAN Probe, s/n and depth
 - X # #.##m CS229 Thermal Conductivity Sensor, s/n and depth
 - T## #.##m Satellite Station Soil Temperature probe and depth
 - △ SS## #.##m Satellite Station Soil Moisture probe and depth
 - DL75: # CR10X #2 Array # Seametrics Datalogger with Flowmeter and Tipping Bucket (Interflow)
 - DL75: # Seametrics Datalogger with Flowmeter (Runoff)

Note:
 Depths measured from Datum
 - Positive = up
 - Negative = down



Monitor Mine Area Waste Rock Trial Covers
2009 Data Summary

Schematic Instrument Profiles for
CT#1 and CT#4

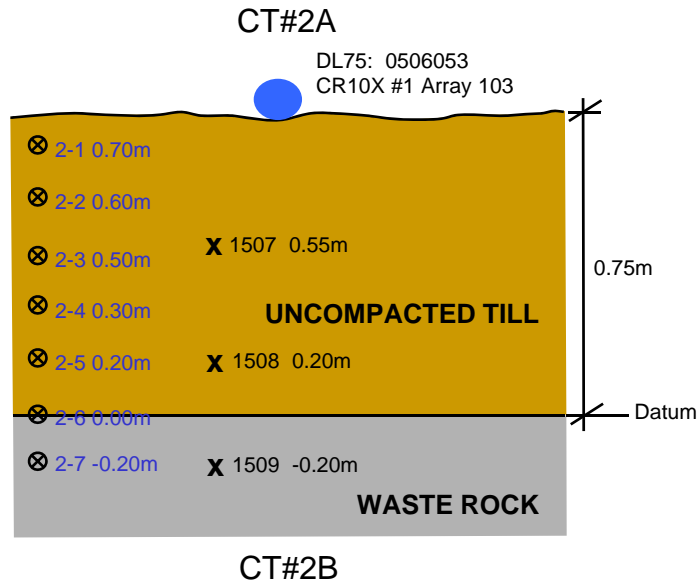
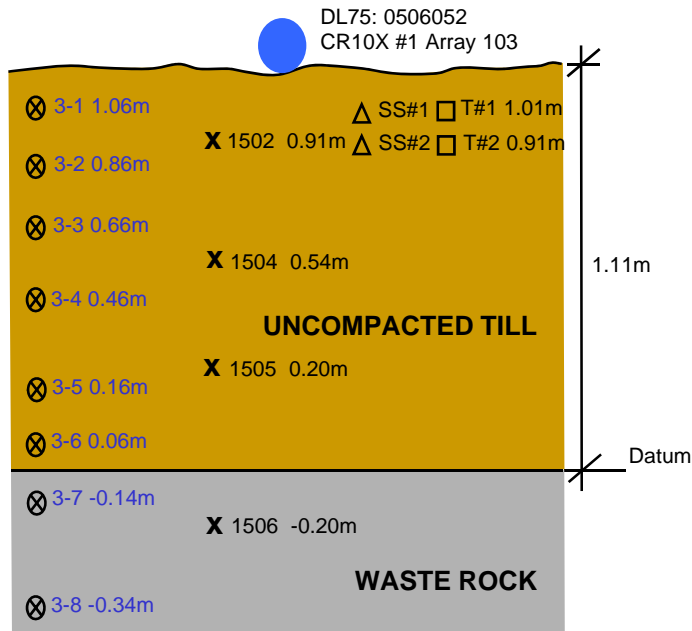
Job No: 1CY001.030.600
 Filename: Fig2_4-9_Trial covers_20100113.ppt

Faro Mine Complex

Date:
Jan. 2010

Approved:
JM

Figure: **6**



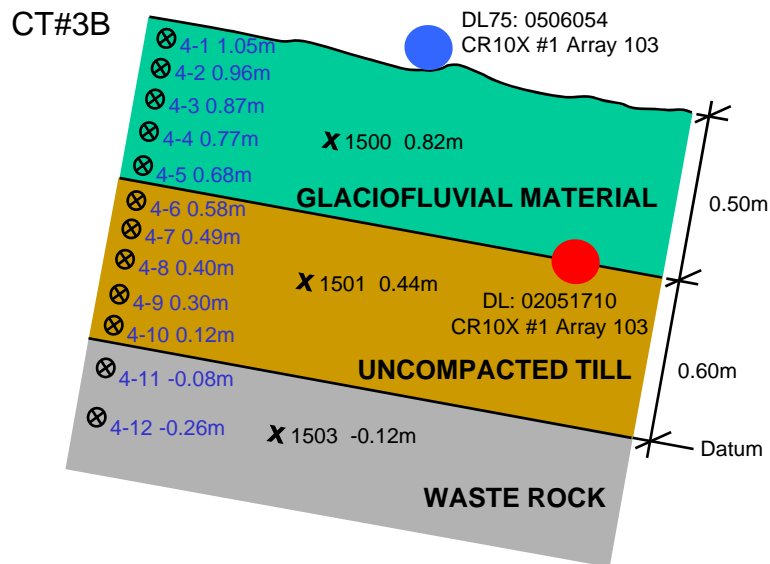
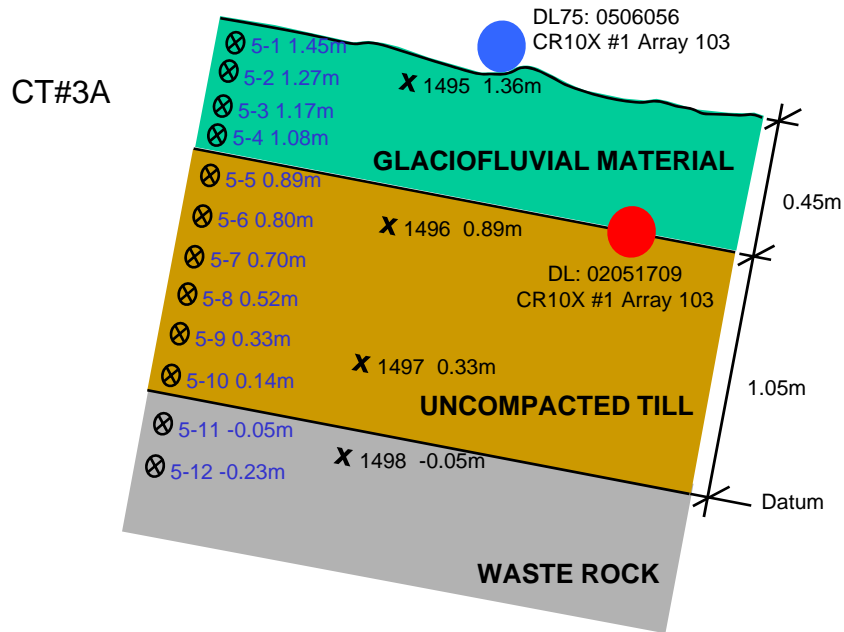
Legend:

- #-#-###m EnviroSCAN Probe with bead s/n and depth
- X** #-#-###m CS229 Thermal Conductivity Sensor bead s/n and depth
- T##-###m Satellite Station Temperature probe and depth
- SS##-###m Satellite Station Soil Moisture probe and depth
- DL75: # CR10X #2 Array # Seametrics Datalogger with Flowmeter and Tipping Bucket (Interflow)
- DL75: # Seametrics Datalogger with Flowmeter (Runoff)

Note:

- Depths measured from Datum
- Positive = up
- Negative = down

 SRK Consulting Engineers and Scientists VANCOUVER	 Faro Mine Closure Fermeture de la mine Faro	Monitor Mine Area Waste Rock Trial Covers 2009 Data Summary		
		Schematic Instrument Profiles for CT#2A and CT#2B		
Job No: 1CY001.030.600 Filename: Fig2_4-9_Trial covers_20100113.ppt	Faro Mine Complex	Date: Jan. 2010	Approved: JM	Figure: 7



Legend:

- ⊗ #-# #.##m EnviroSCAN Probe with bead s/n and depth
- X # #.##m CS229 Thermal Conductivity Sensor bead s/n and depth
- T## #.##m Satellite Station Temperature probe and depth
- △ SS## #.##m Satellite Station Soil Moisture probe and depth
- DL75: #
CR10X #2 Array # Seametrics Datalogger with Flowmeter and Tipping Bucket (Interflow)
- DL75: # Seametrics Datalogger with Flowmeter (Runoff)

Note:

Depths measured from Datum
 - Positive = up
 - Negative = down



Monitor Mine Area Waste Rock Trial Covers
2009 Data Summary

Schematic Instrument Profiles for
CT#3A and CT#3B

Job No: 1CY001.030.600

Filename: Fig2_4-9_Trial covers_20100113.ppt

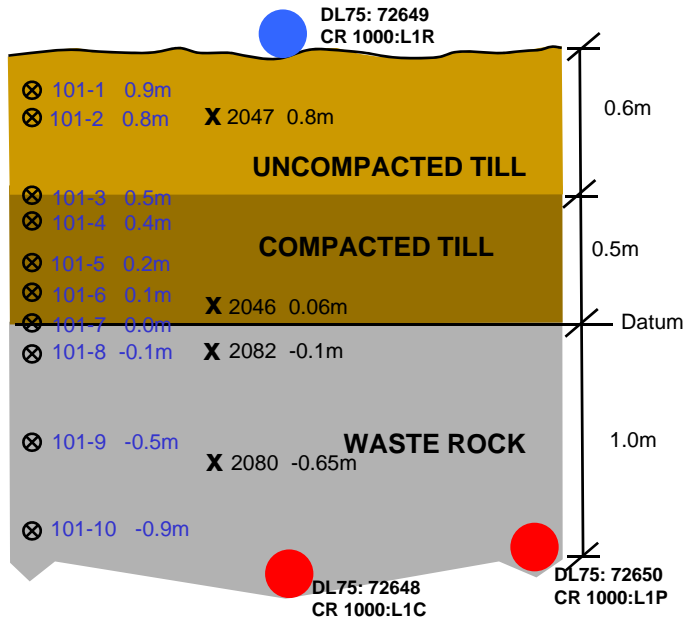
Faro Mine Complex

Date:
Jan. 2010

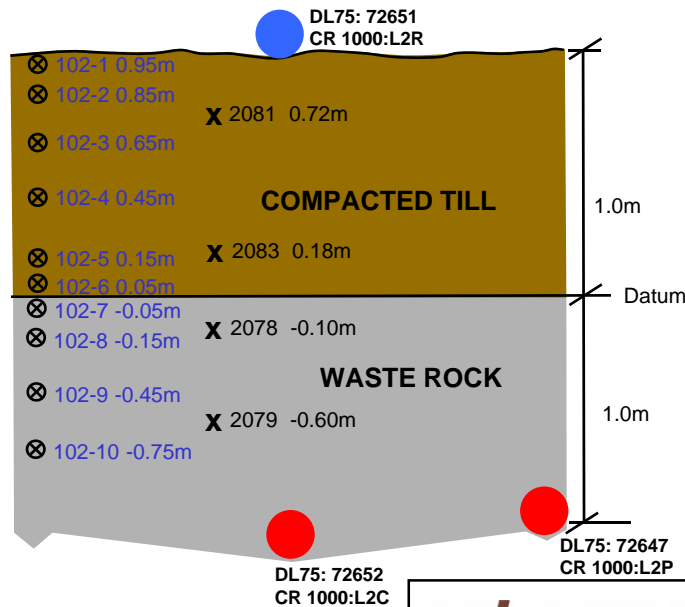
Approved:
JM

Figure: **8**

L#1



L#2



Legend:

- ⊗ #-#-#.#m EnviroSCAN Probe with bead s/n and depth
- X #-#-#.#m CS229 Thermal Conductivity Sensor bead s/n and depth
- T##-#.#m Satellite Station Temperature probe and depth
- △ SS##-#.#m Satellite Station Soil Moisture probe and depth
- DL75: 72650 CR 1000:L1P Seametrics Datalogger with Flowmeter and Tipping Bucket (Interflow)
- DL75: # Seametrics Datalogger with Flowmeter (Runoff)

Note:

- Depths measured from Datum
- Positive = up
- Negative = down



Monitor Mine Area Waste Rock Trial Covers
2009 Data Summary

Schematic Instrument Profiles for
L#1 and L#2

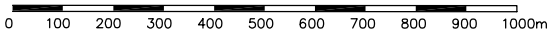
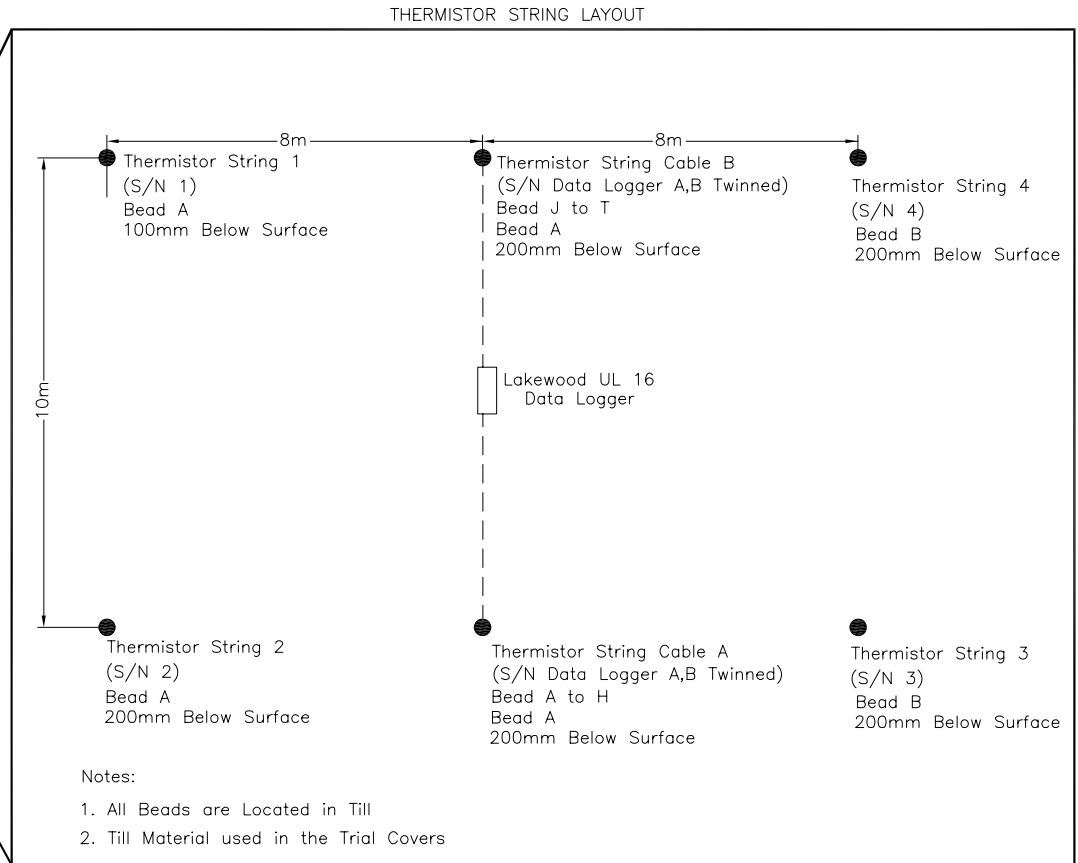
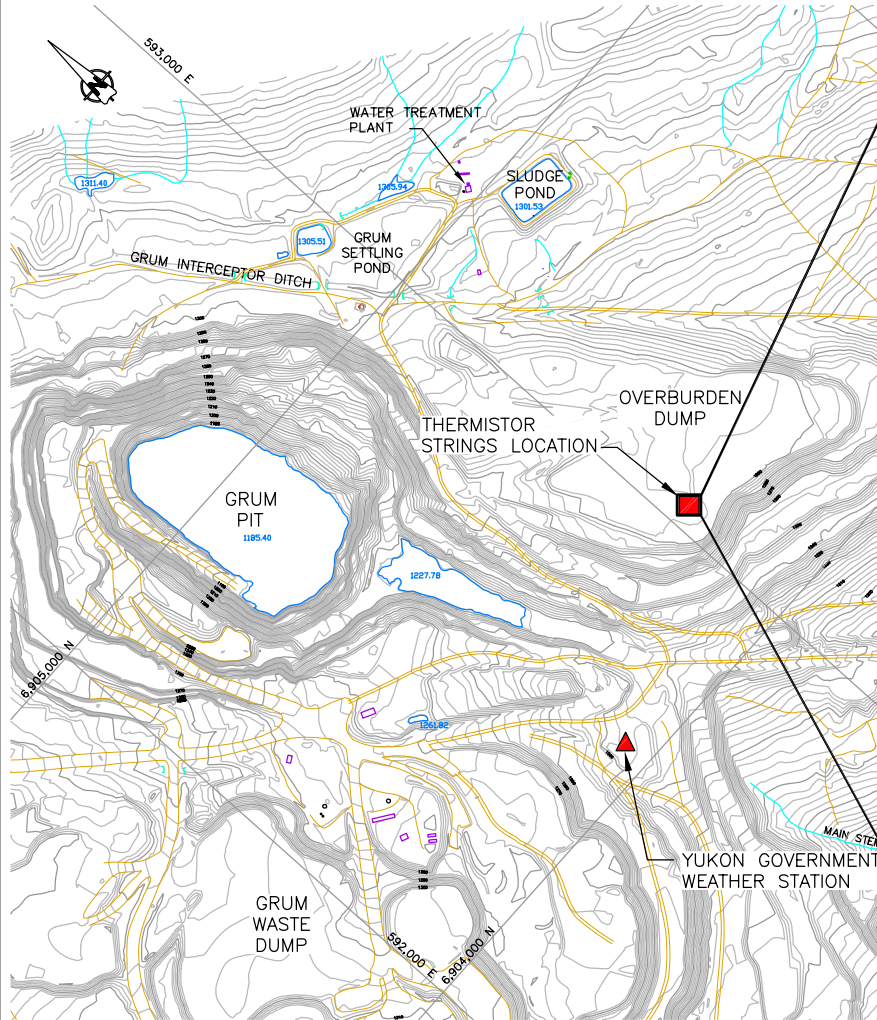
Job No: 1CY001.030.600
Filename: Fig2_4-9_Trial covers_20100113.ppt

Faro Mine Complex

Date:
Jan. 2010

Approved:
JM

Figure: **9**



THERMISTOR STRING PROFILES

Thermistor String 1 (S/N 1)		Thermistor String 2 (S/N 2)		Thermistor String 3 (S/N 3)		Thermistor String 4 (S/N 4)		Thermistor String Cable A (S/N Datalogger A,B Twinned)		Thermistor String Cable B (S/N Datalogger A,B Twinned)	
Bead	Depth (m)	Bead	Depth (m)	Bead	Depth (m)	Bead	Depth (m)	Bead	Depth (m)	Bead	Depth (m)
A	0.1	A	0.2	A	-0.65	A	0.2	A	0.2	J	0.2
B	0.6	B	0.7	B	-0.15	B	0.7	B	0.7	K	0.7
C	1.1	C	1.2	C	0.35	C	1.2	C	1.2	L	1.2
D	2.1	D	2.2	D	1.35	D	2.2	D	2.2	N	2.2
E	3.1	E	3.2	E	2.35	E	3.2	E	3.2	P	3.2
F	4.1	F	4.2	F	3.35	F	4.2	F	4.2	R	4.2
G	5.1	G	5.2	G	4.35	G	5.2	G	5.2	S	5.2
H	6.1	H	6.2	H	5.35	H	6.2	H	6.2	T	6.2



Monitor Mine Area Waste Rock Trial Covers
2009 Data Summary

Location Plan and Schematic
Thermistor Layout on
Grum Overburden Dump

SRK JOB NO.: 1CY001.030.600

FILE NAME: site_plan_Thermistor.dwg

Faro Mining Complex

DATE: Jan 2010

APPROVED: JM

FIGURE: 10

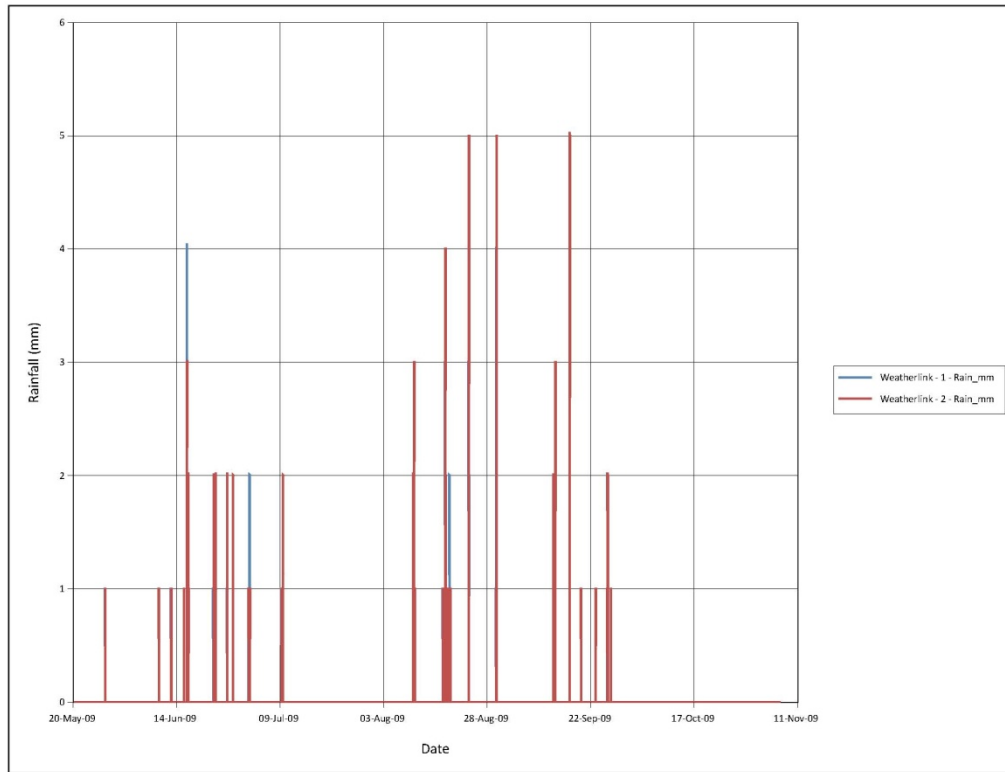


Figure 11: Total hourly rainfall on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

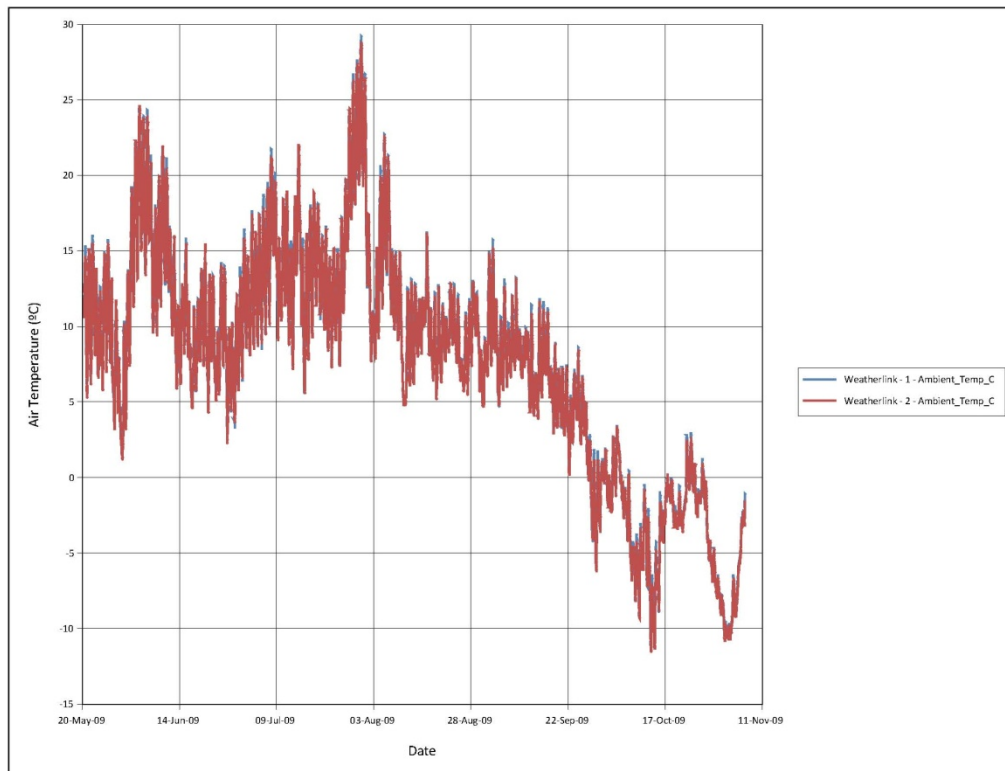


Figure 12: Mean hourly air temperature on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations and satellite stations.

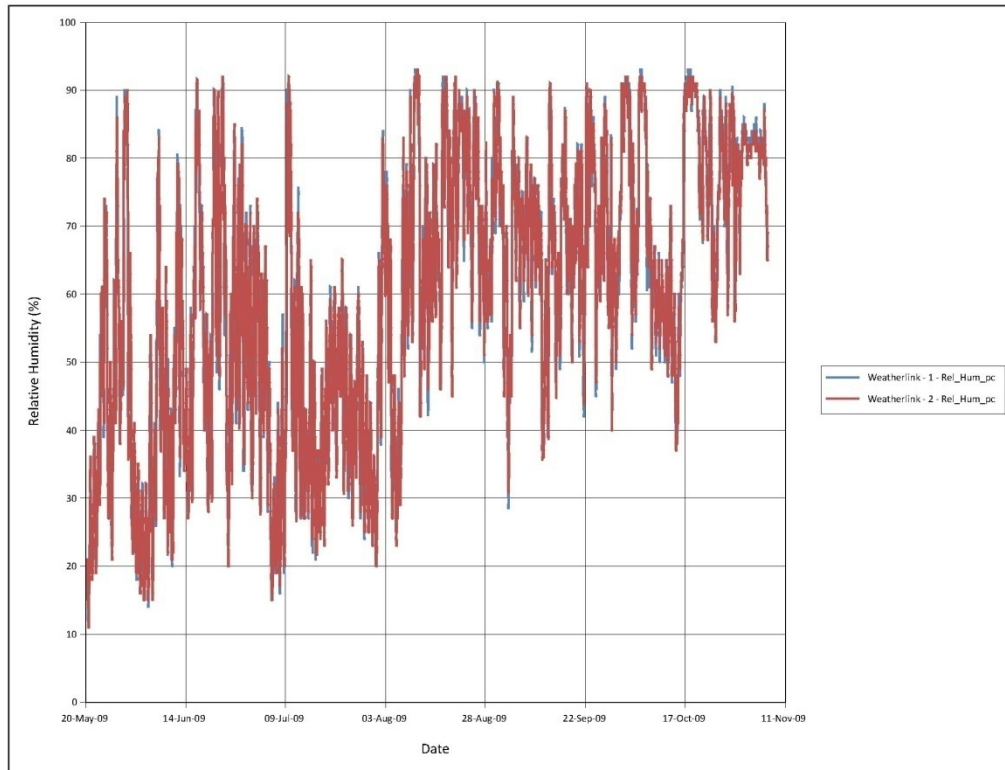


Figure 13: Mean hourly relative humidity on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations and satellite stations.

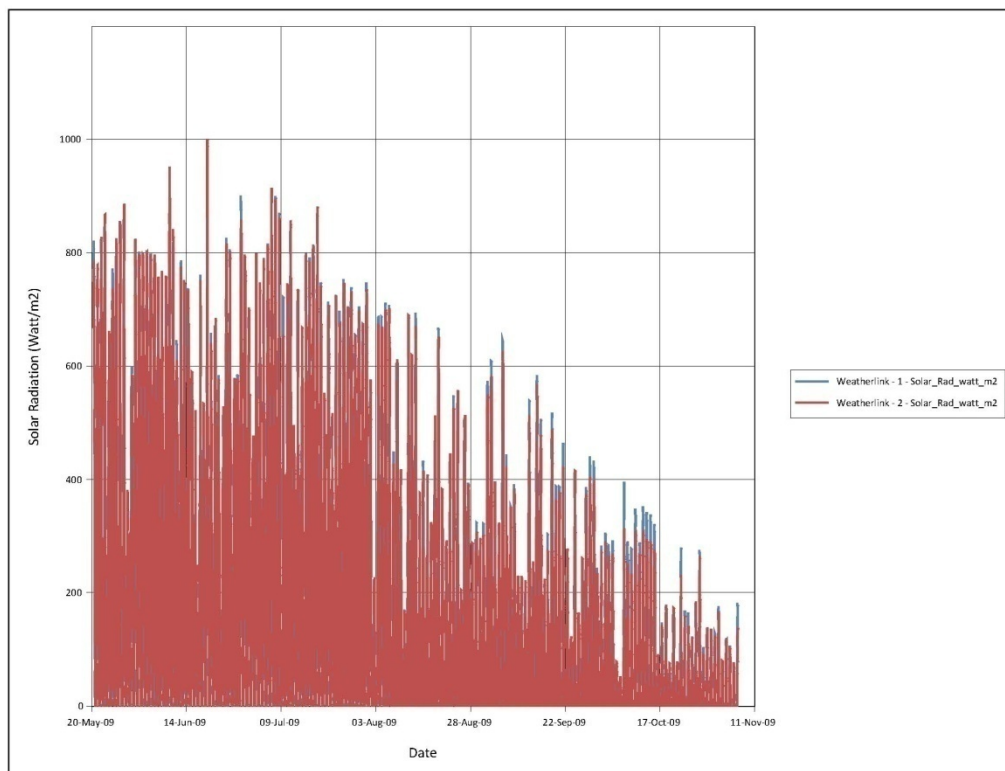


Figure 14: Mean hourly solar radiation on CT#1 & CT2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

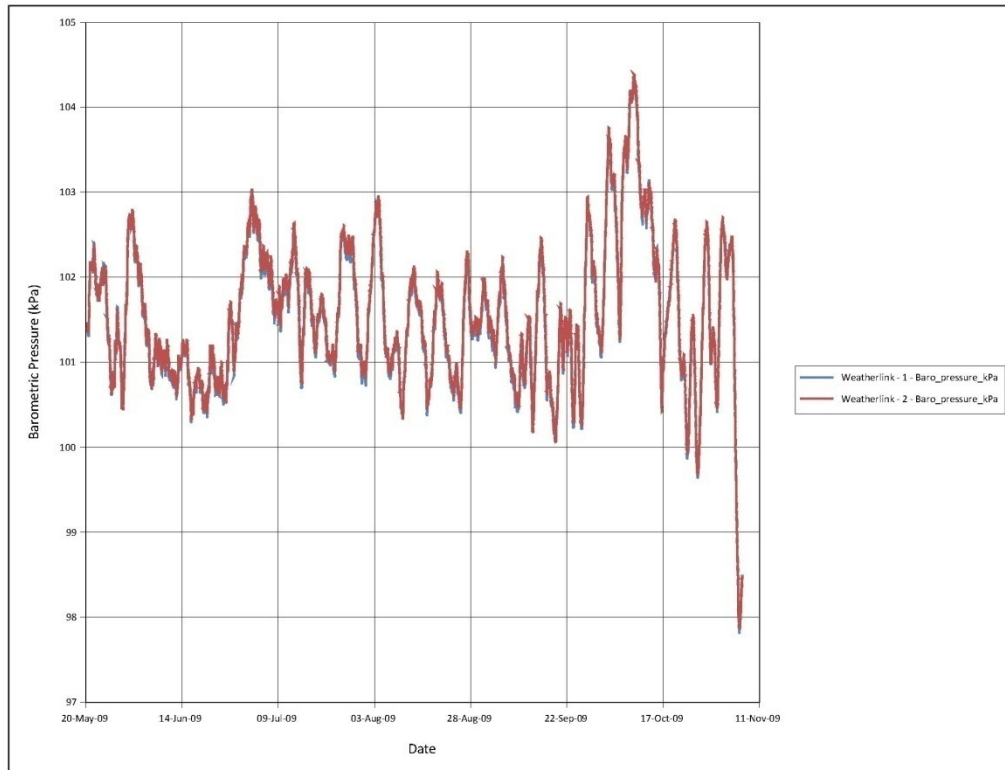


Figure 15: Mean hourly barometric pressure on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

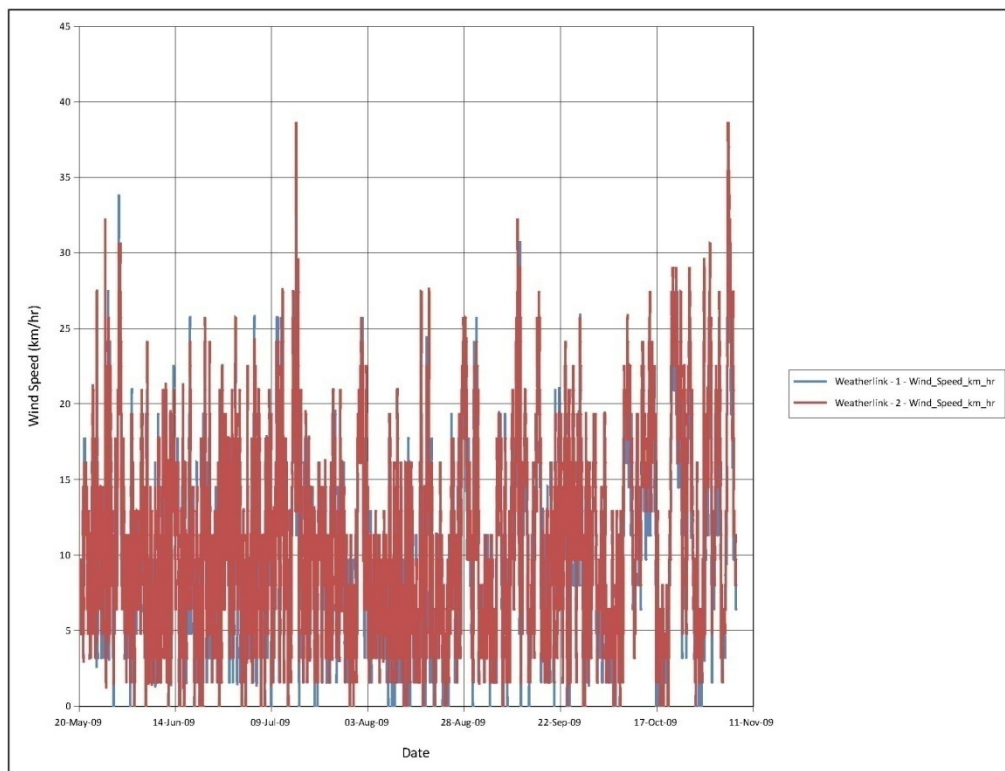


Figure 16: Mean hourly wind speed on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

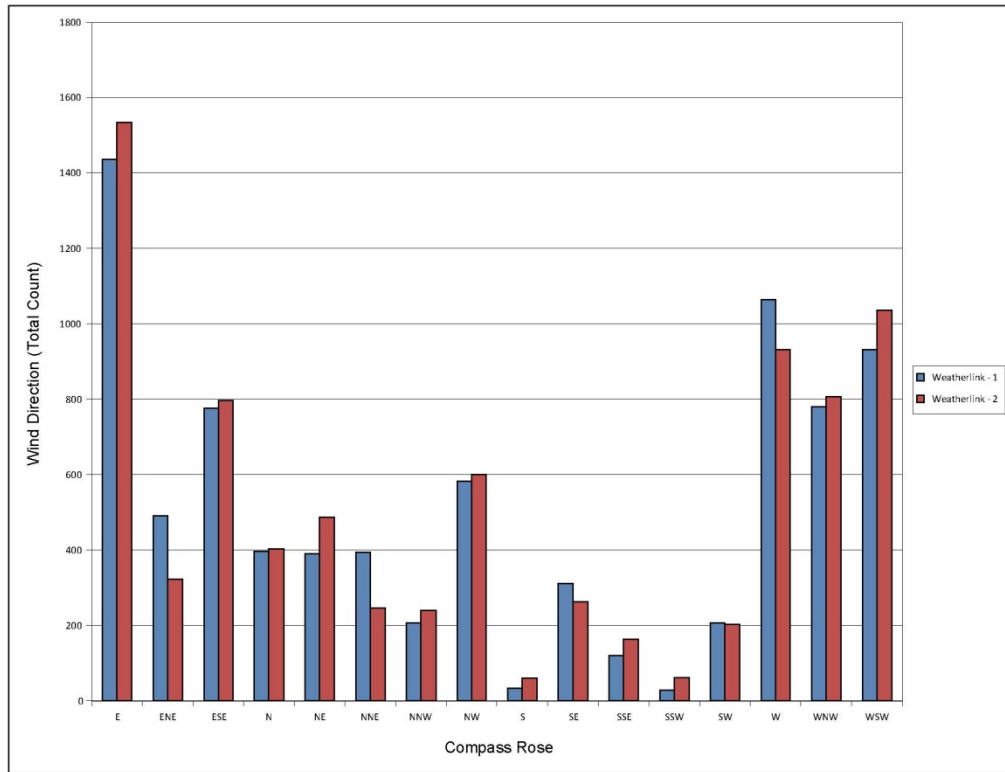


Figure 17: Wind direction totals (measured hourly) on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

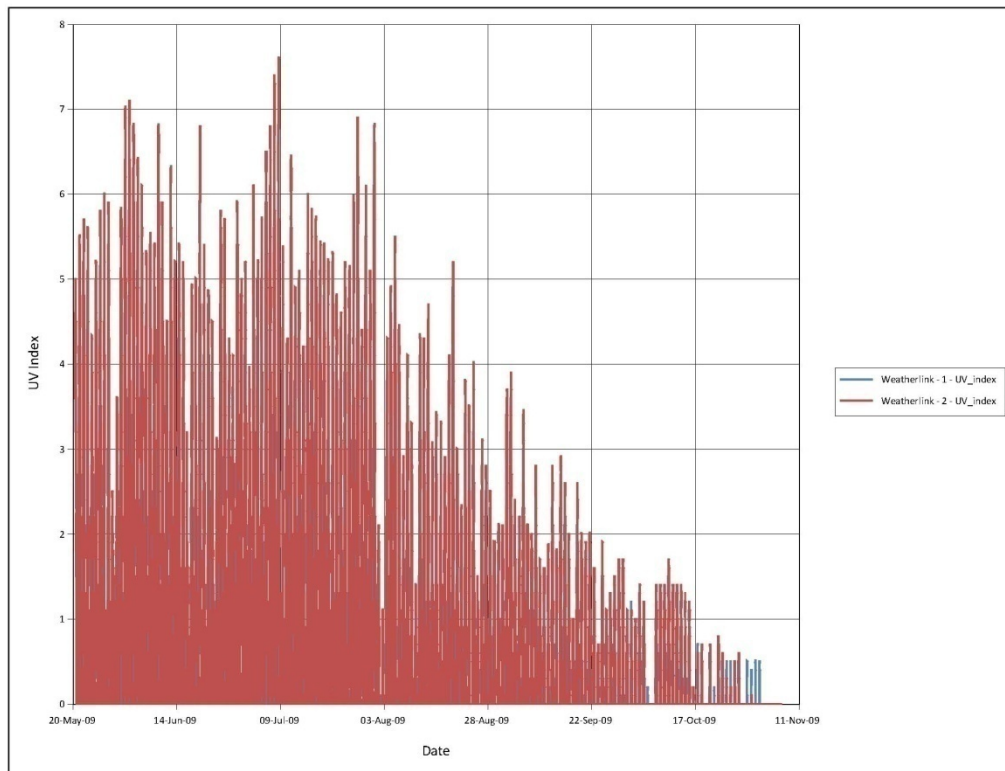


Figure 18: Mean hourly UV Index on CT#1 & CT#2A, 2B recorded by the Davis Instruments Vantage Pro Weather Stations.

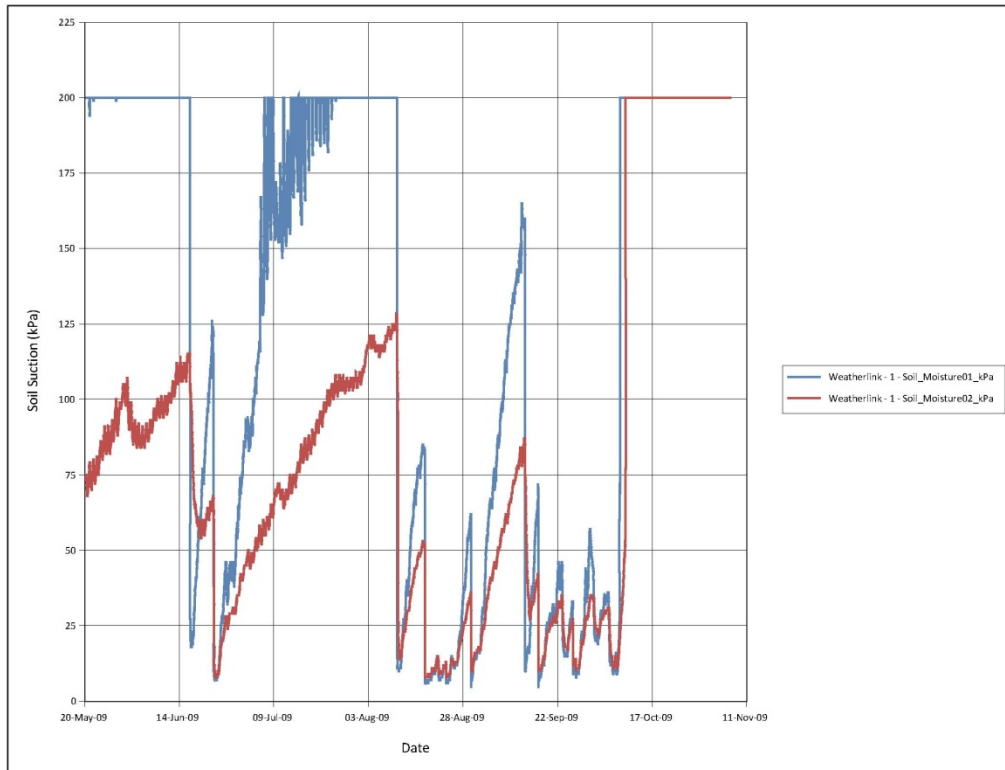


Figure 19: Mean hourly Matric Suction in CT#1 recorded by the Davis Instruments Vantage Pro satellite station.

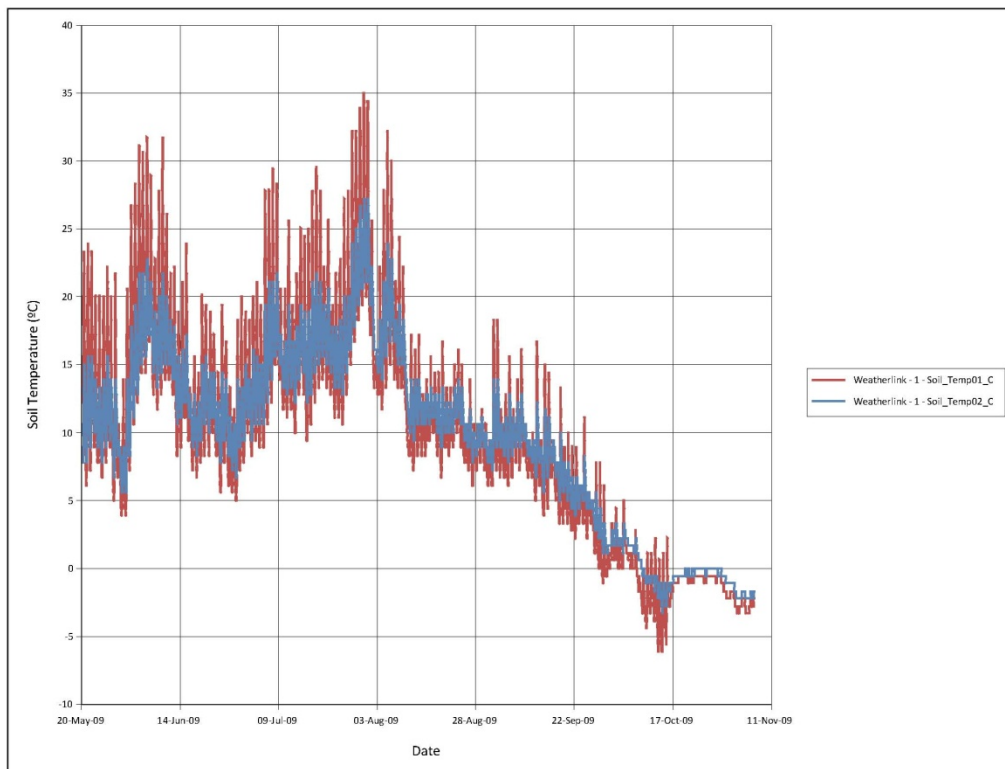


Figure 20: Mean hourly soil temperature in CT#1 recorded by the Davis Instruments Vantage Pro satellite station.

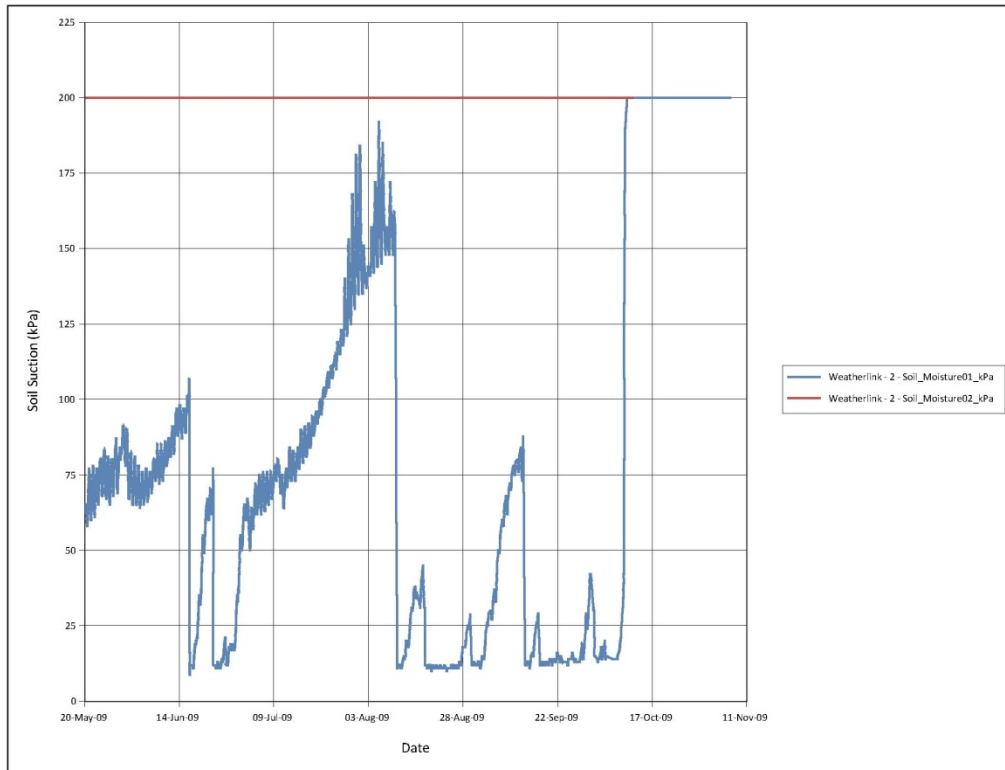


Figure 21: Mean hourly Matric Suction in CT#2A recorded by the Davis Instruments Vantage Pro satellite station.

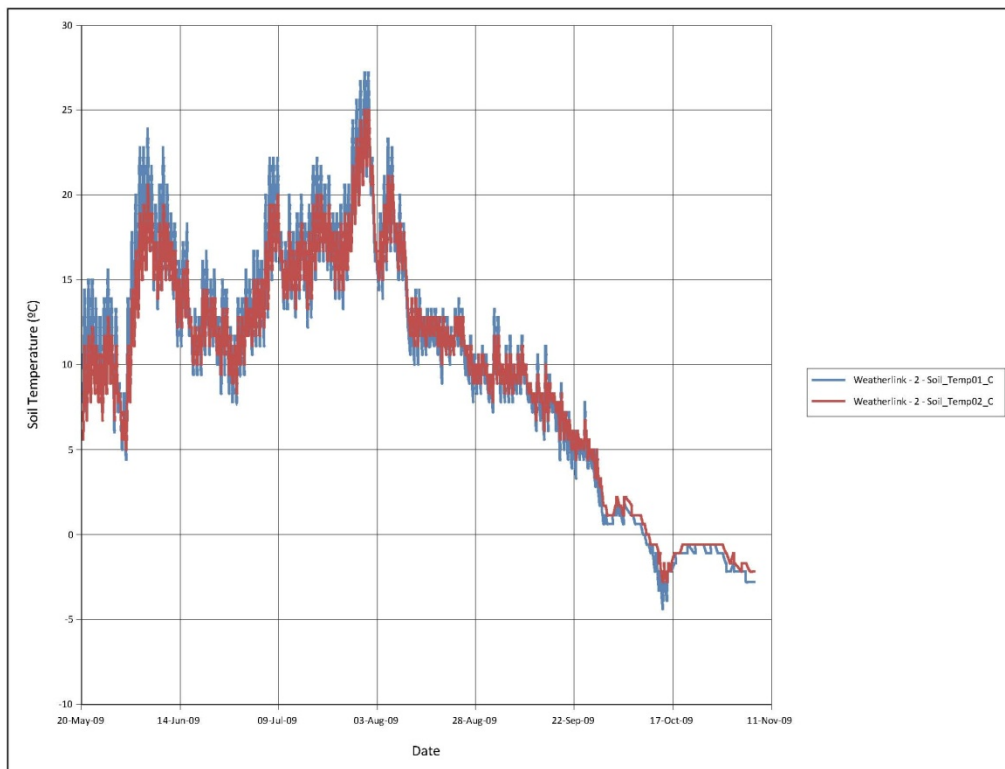


Figure 22: Mean hourly soil temperature in CT#2A recorded by the Davis Instruments Vantage Pro satellite station.

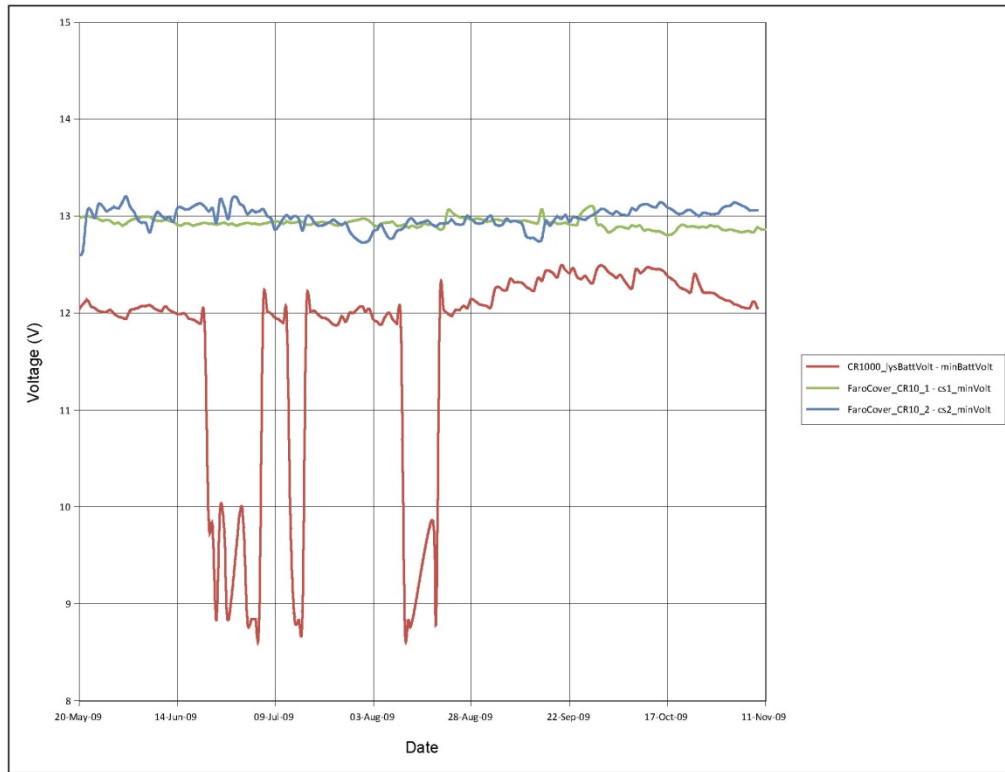


Figure 23: Daily battery voltage of the Campbell Scientific CR10X #1, CR10X#2, and CR1000 data loggers.

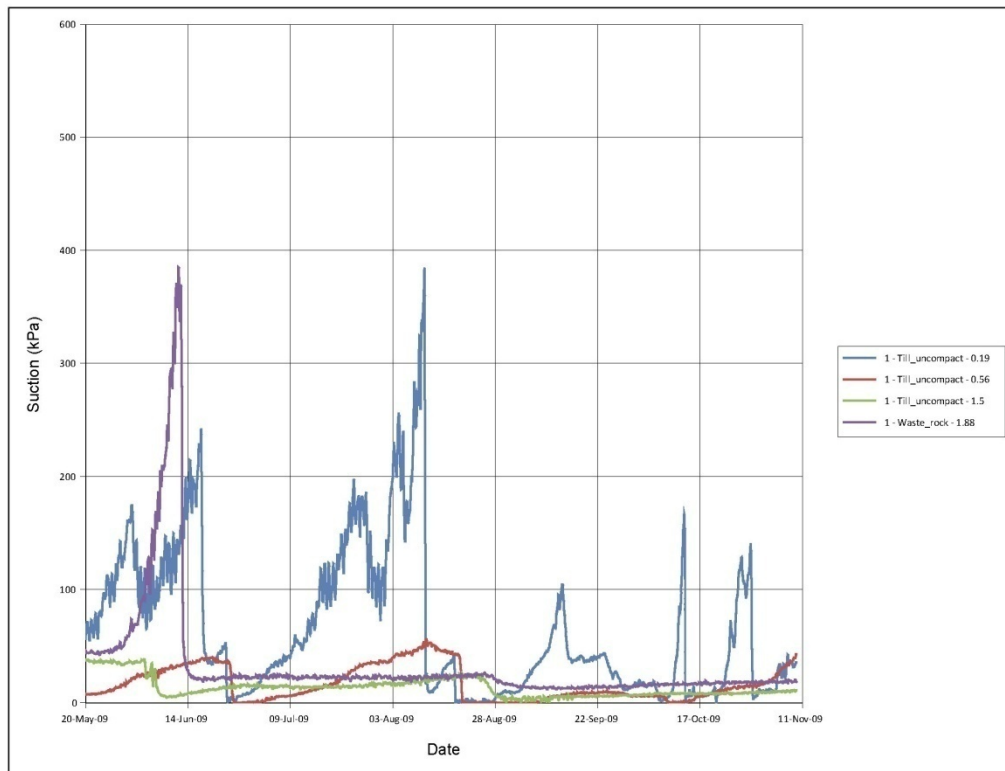


Figure 24: Soil matric suction measurements (taken every six hours) in CT#1 recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

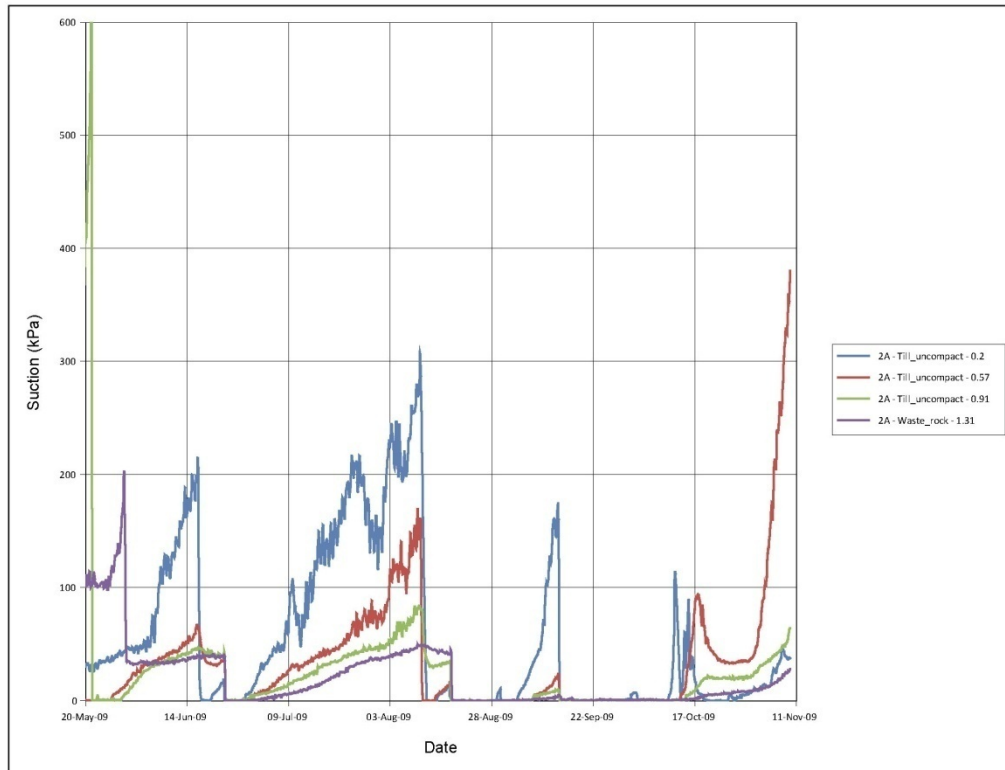


Figure 25: Soil matric suction measurements (taken every six hours) in CT#2A recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

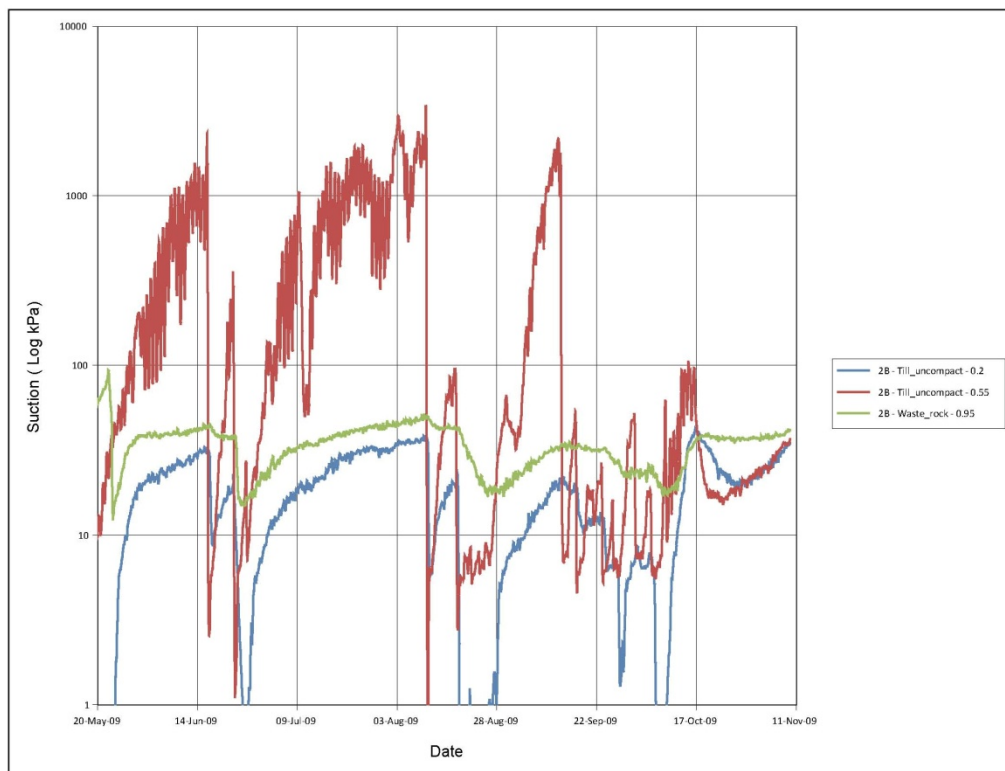


Figure 26: Soil matric suction measurements (taken daily) in CT#2B recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

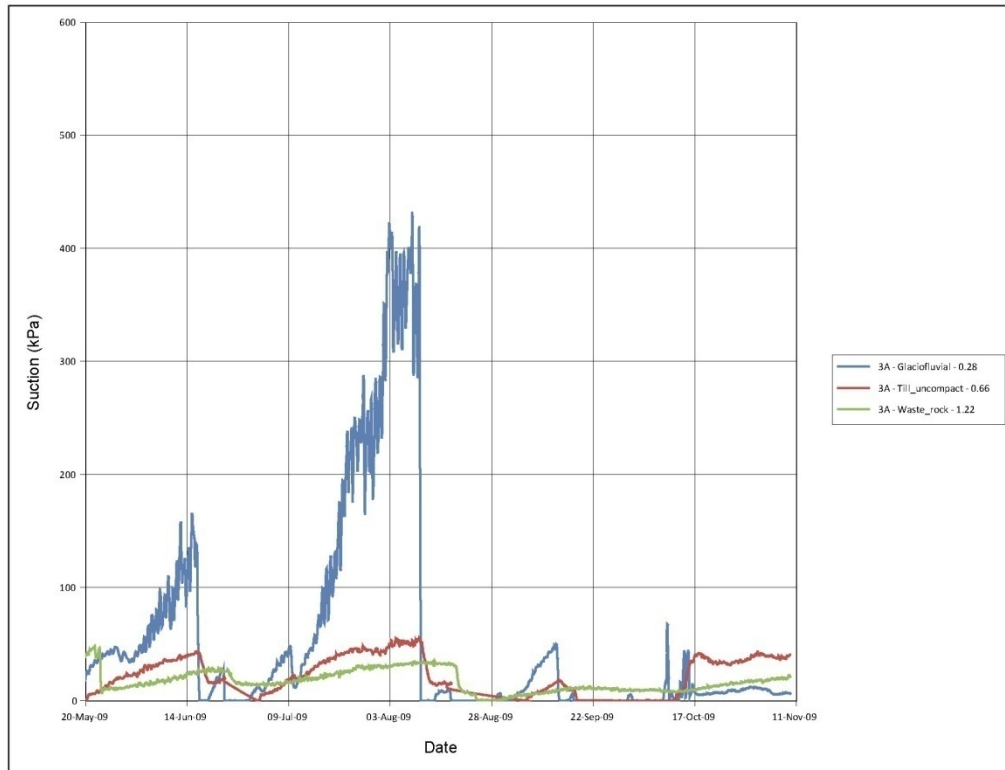


Figure 27: Soil matric suction measurements (taken every six hours) in CT#3A recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

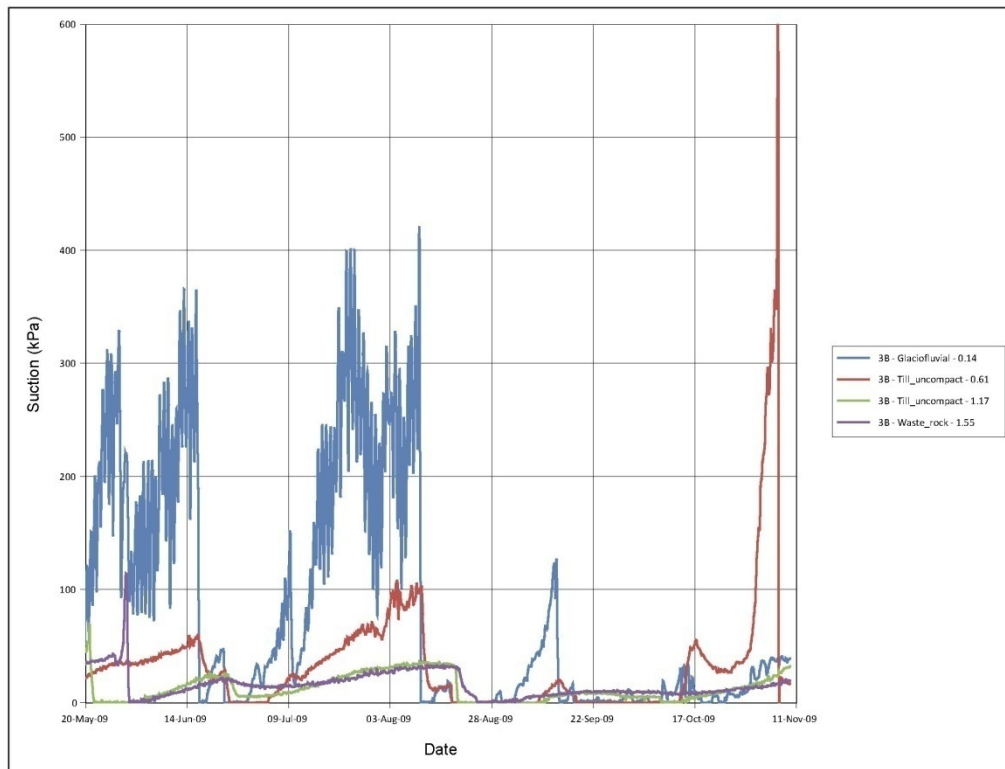


Figure 28: Soil matric suction measurements (taken every six hours) in CT#3B recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

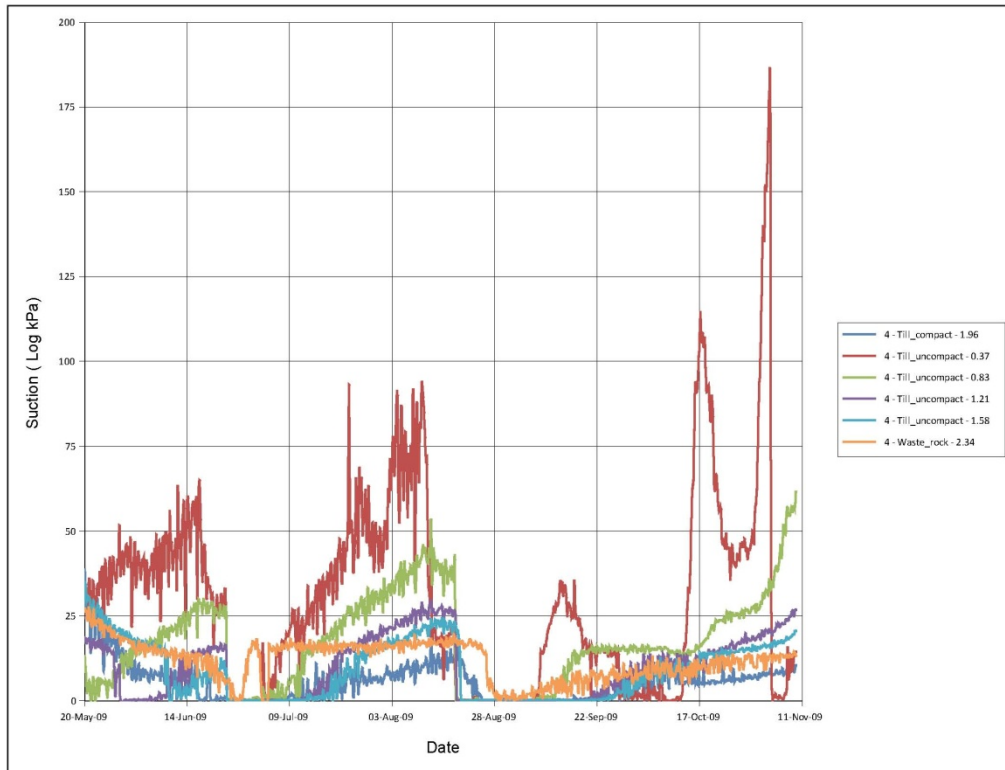


Figure 29: Soil matric suction measurements (taken every six hours) in CT#4 recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

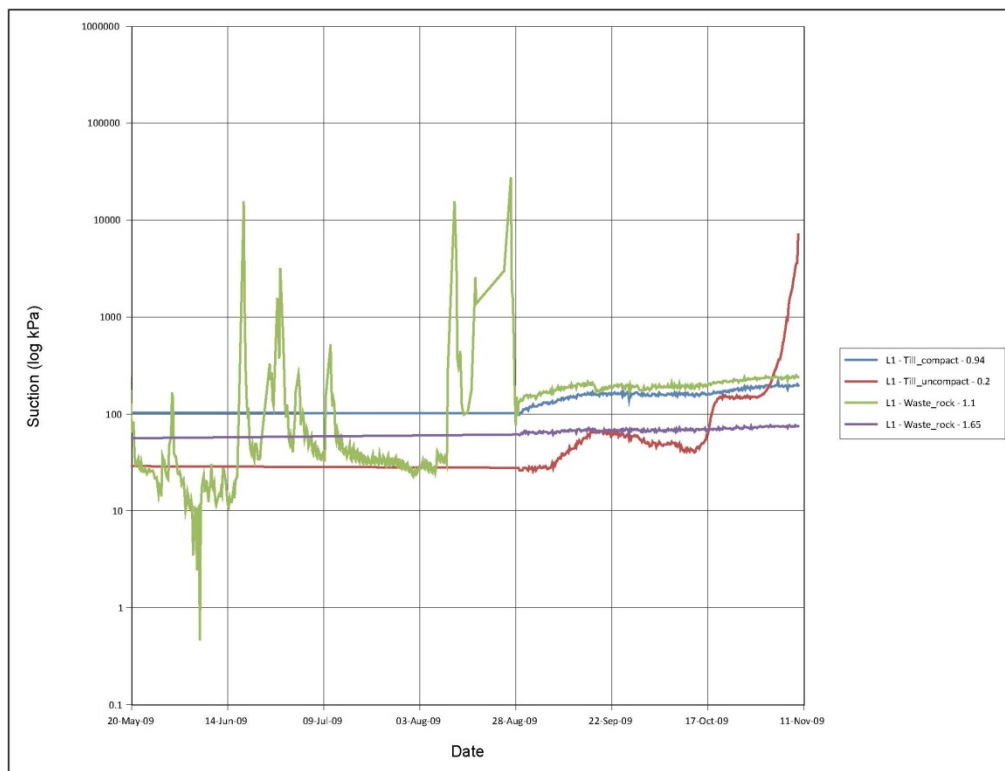


Figure 30: Soil matric suction measurements (taken every six hours) in L#1 recorded by CS229 sensors connected to Campbell Scientific CR1000 data logger.

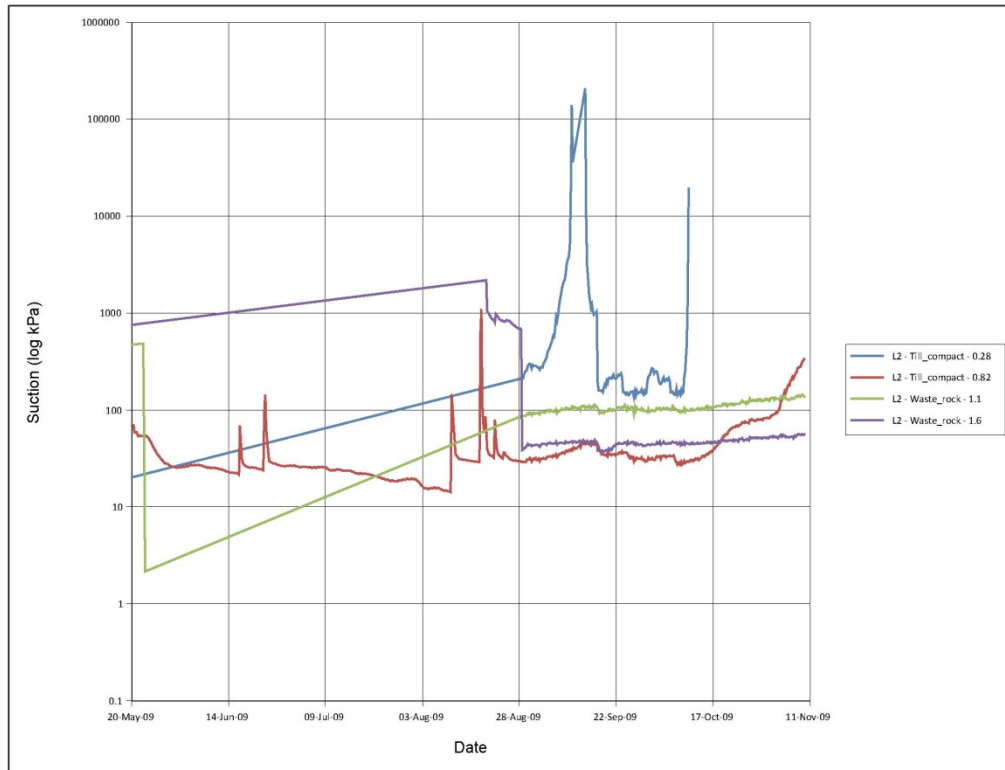


Figure 31: Soil matric suction measurements (taken every six hours) in L#2 recorded by CS229 sensors connected to Campbell Scientific CR1000 data logger.

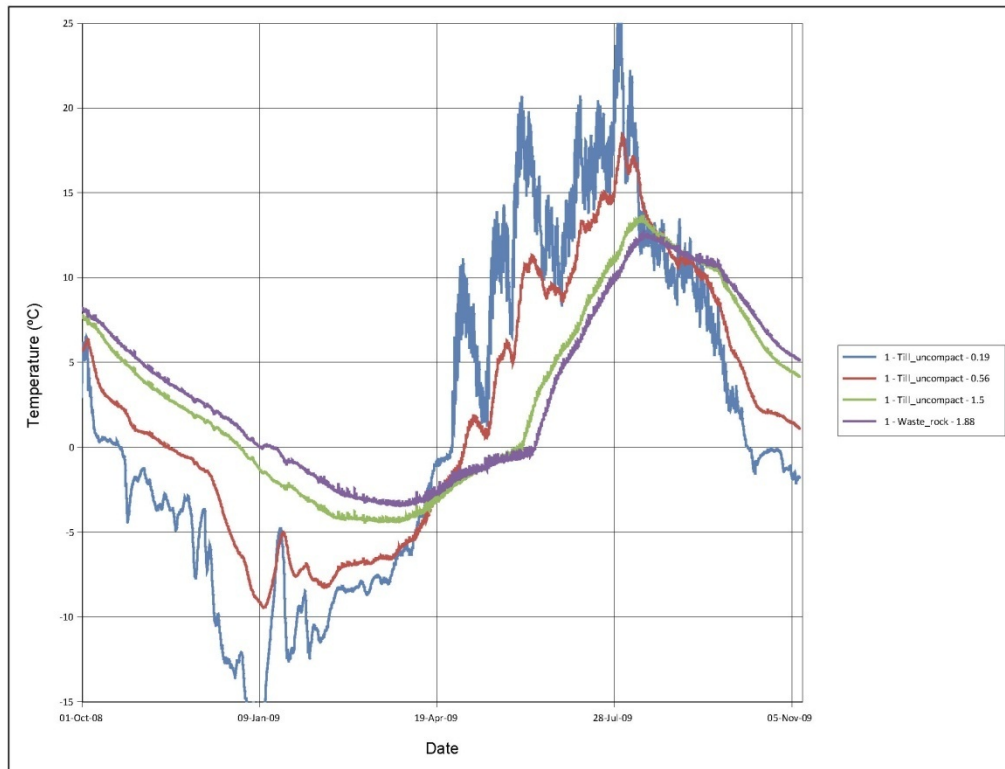


Figure 32: Soil temperature measurements (taken every six hours) in CT#1 recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

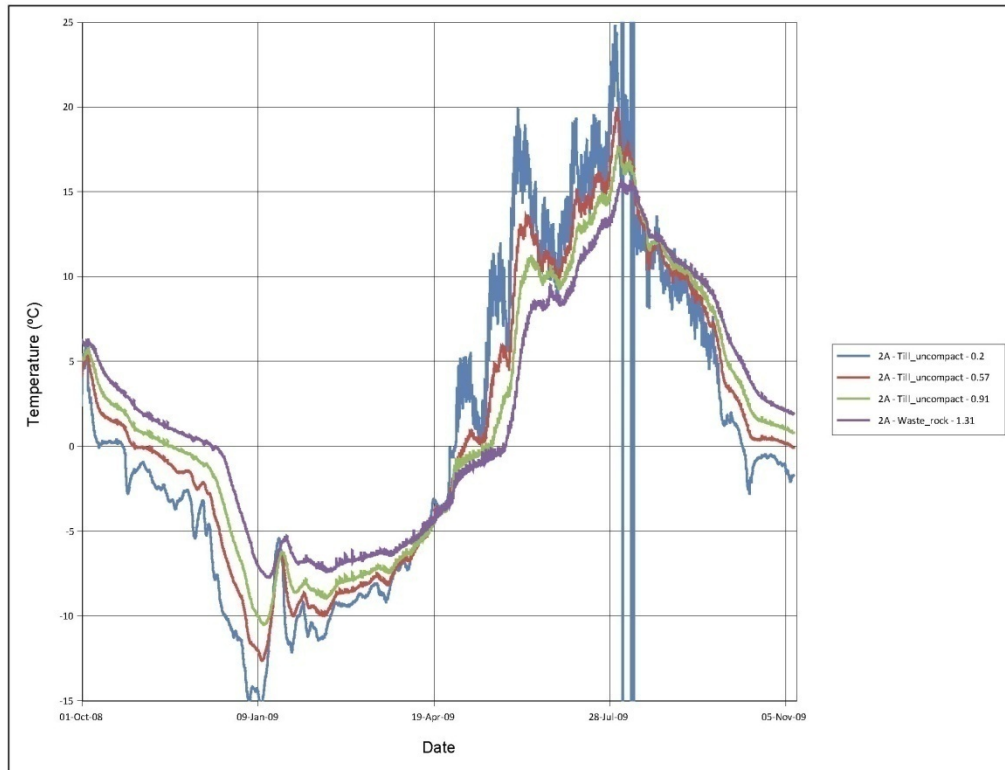


Figure 33: Soil temperature measurements (taken every six hours) in CT#2A recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #1 (Array 168).

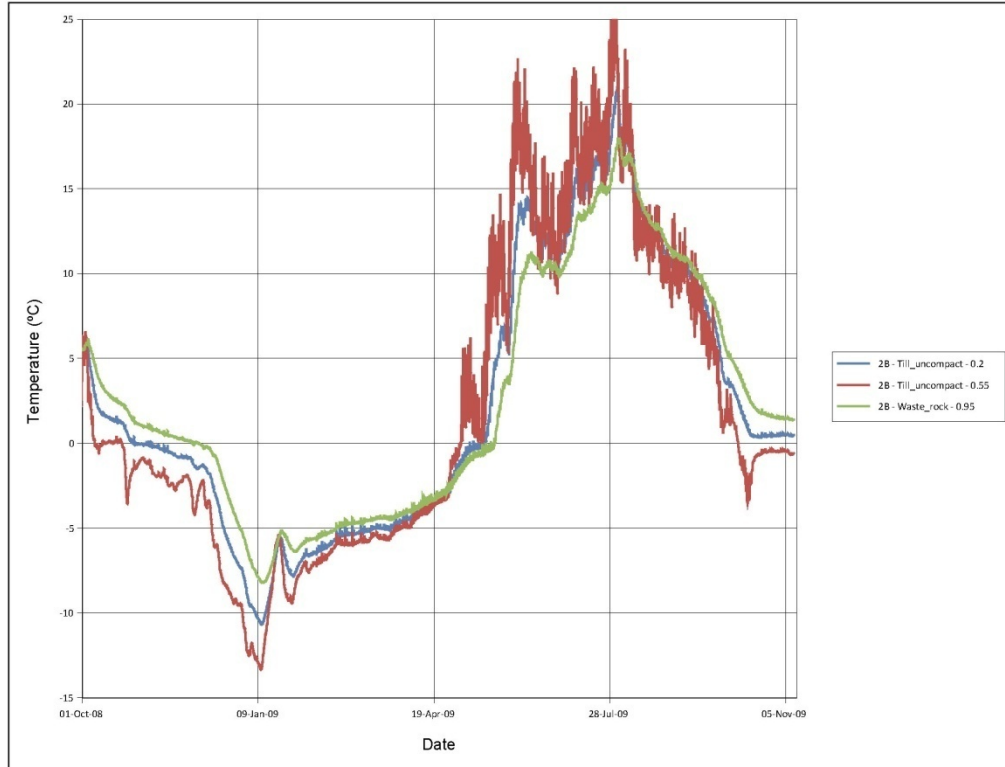


Figure 34: Soil temperature measurements (taken every six hours) in CT#2B recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #1 (Array 1681cy001.030).

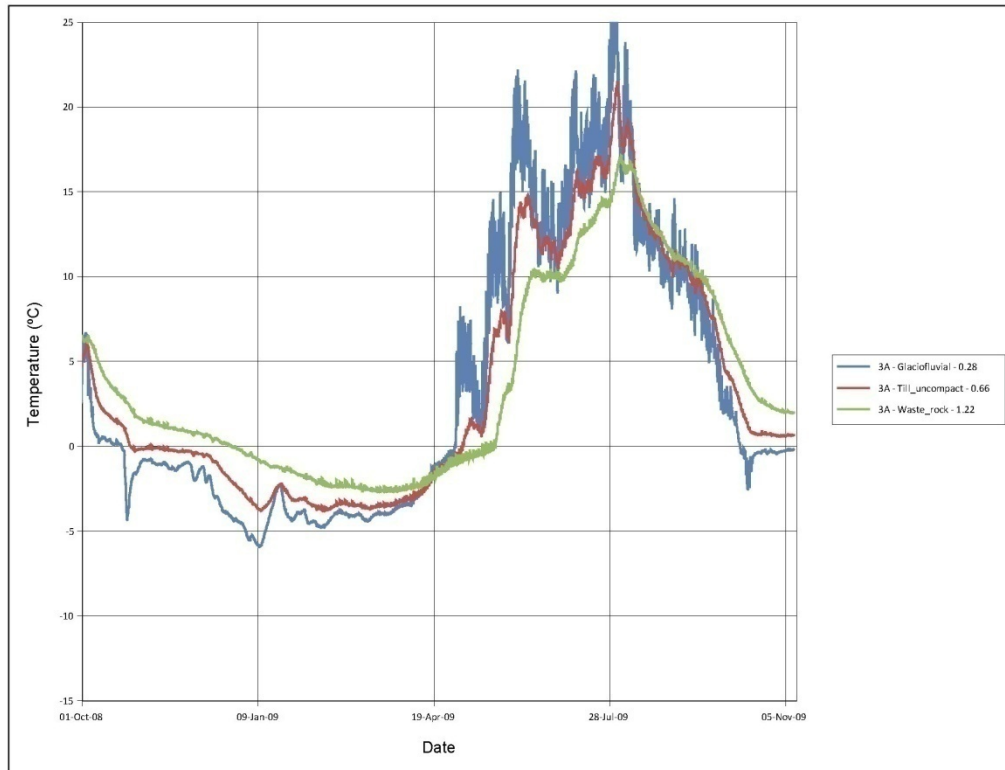


Figure 35: Soil temperature measurements (taken every six hours) in CT#3A recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

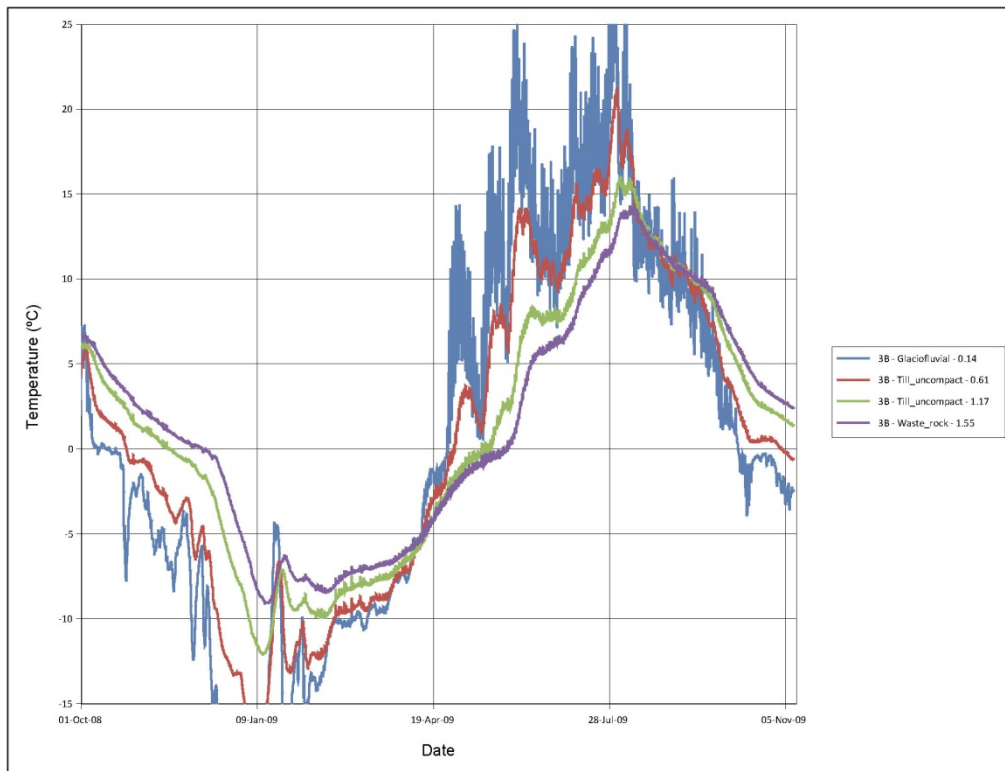


Figure 36: Soil temperature measurements (taken every six hours) in CT#3B recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

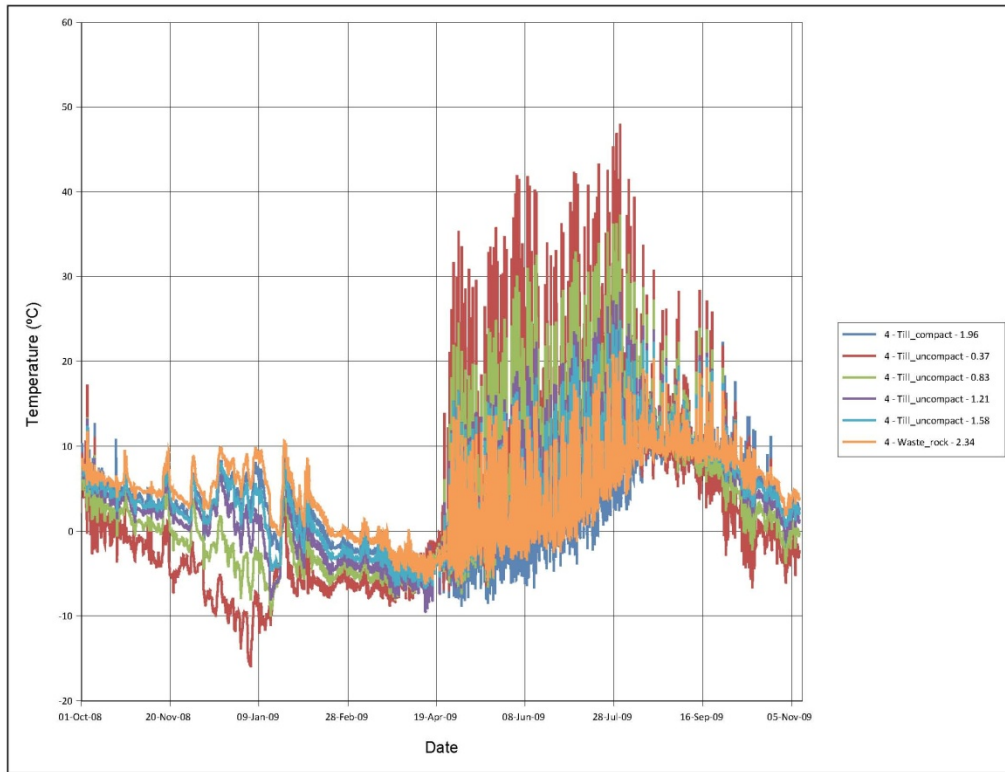


Figure 37: Soil temperature measurements (taken every six hours) in CT#4 recorded by CS229 sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

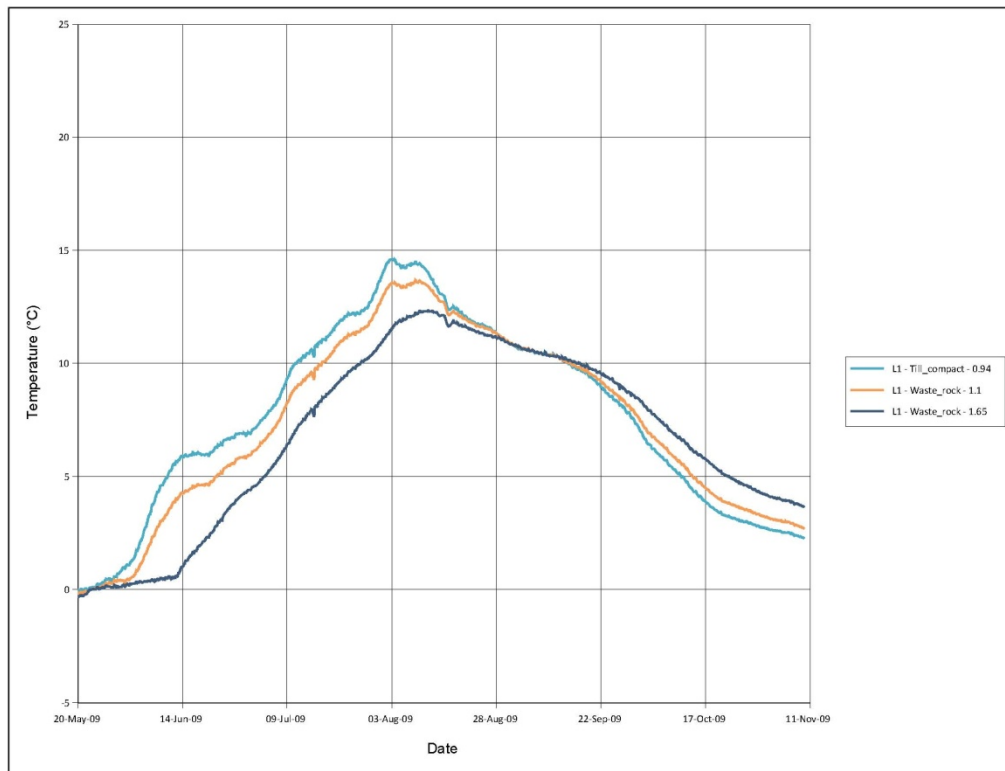


Figure 38: Soil temperature measurements (taken every six hours) in L#1 recorded by CS229 sensors connected to Campbell Scientific data logger CR1000.

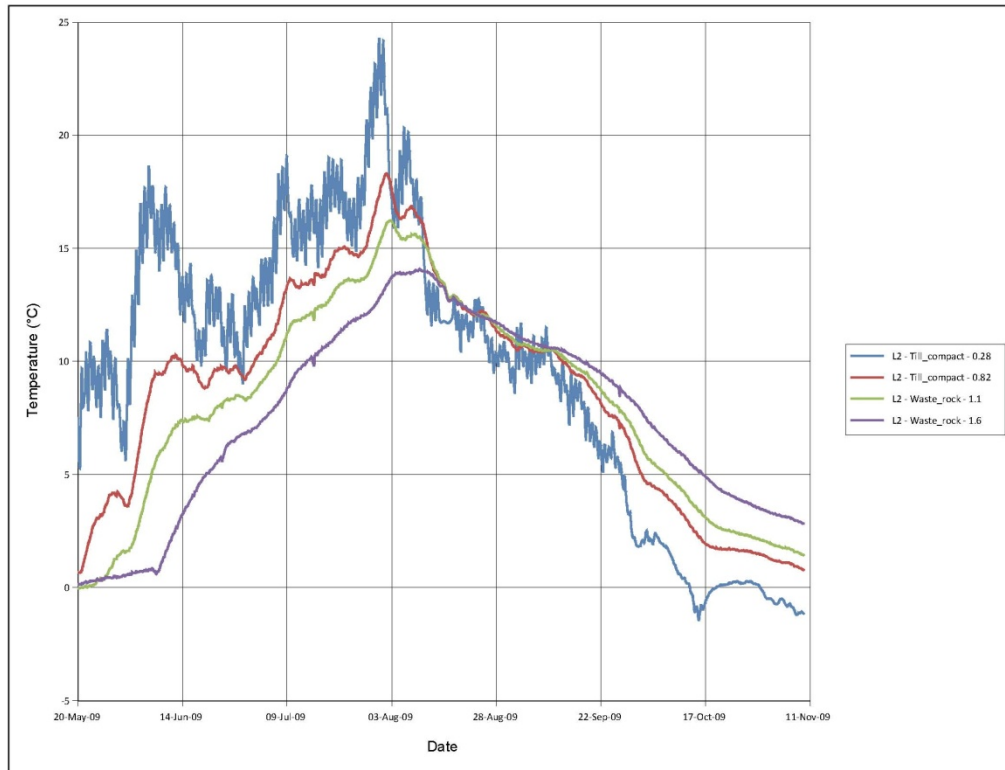


Figure 39: Soil temperature measurements (taken every six hours) in L#2 recorded by CS229 sensors connected to Campbell Scientific data logger CR1000.

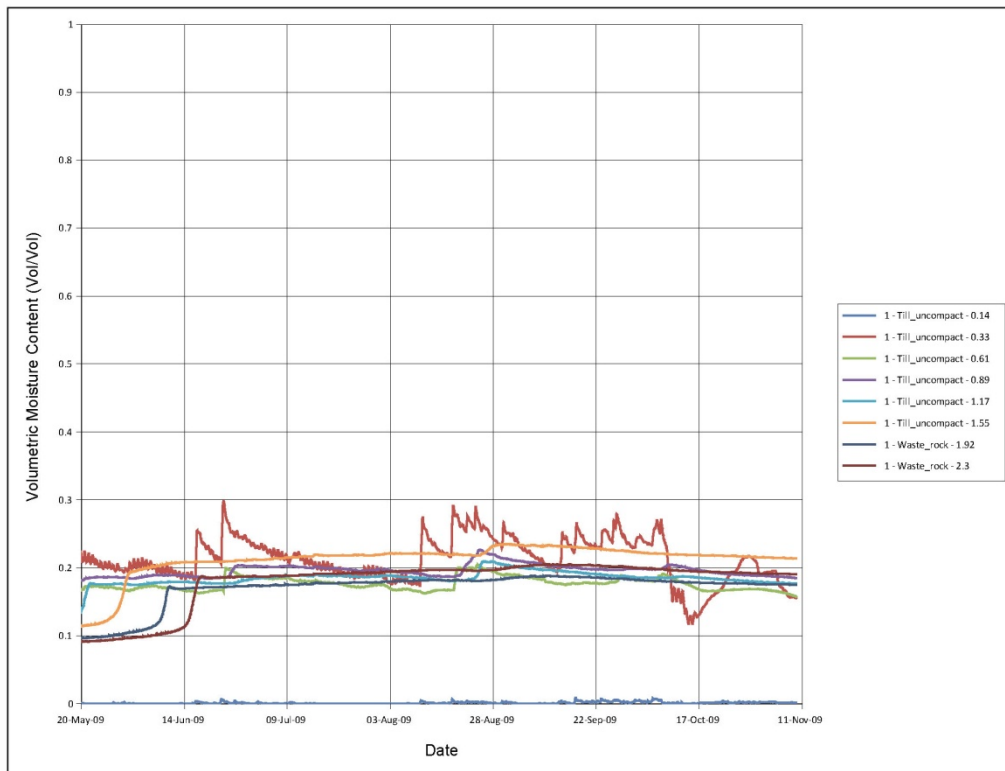


Figure 40: Volumetric moisture content measurements (taken every six hours) in CT#1 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

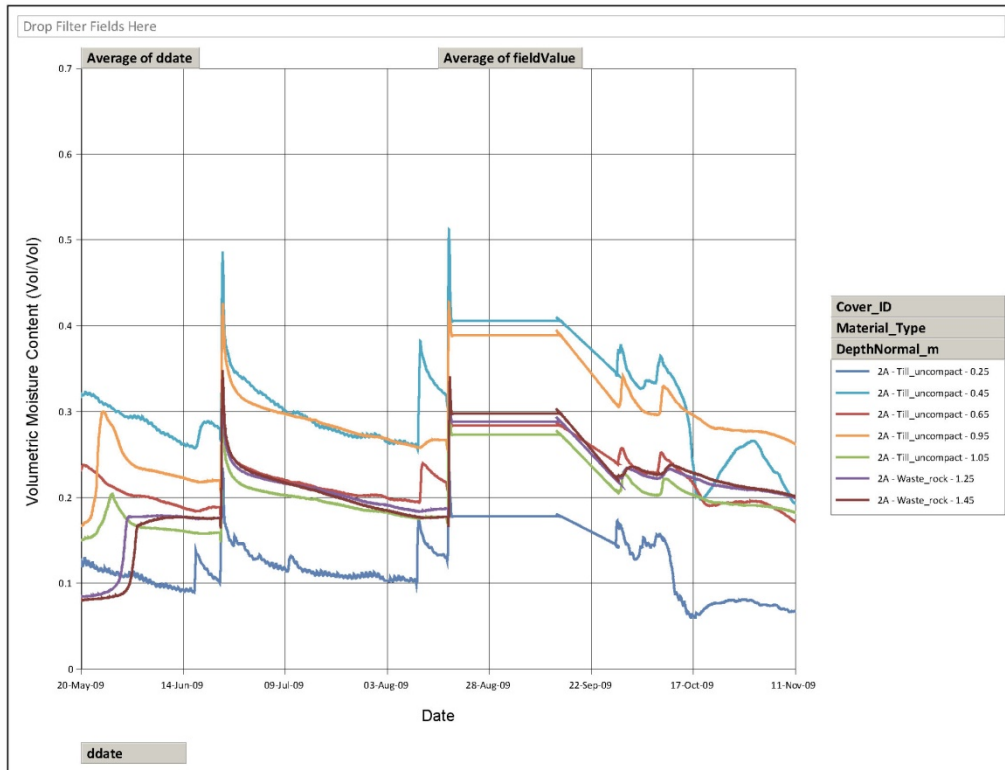


Figure 41: Volumetric moisture content measurements (taken every six hours) in CT#2A recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #1 (Array 130).

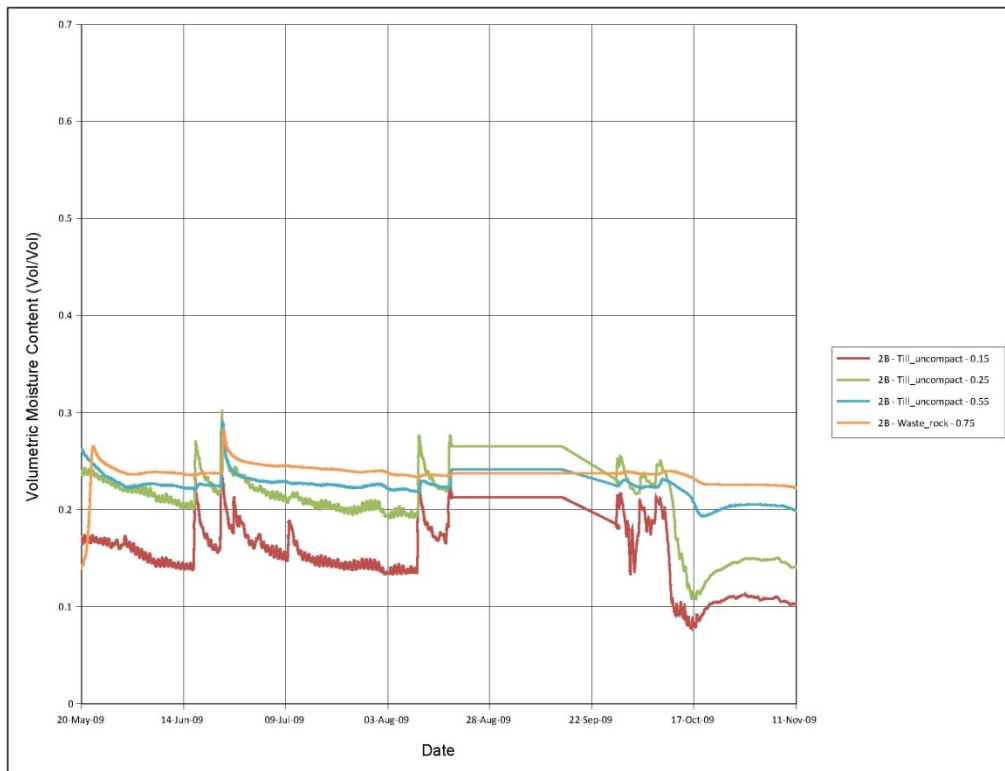


Figure 42: Volumetric moisture content measurements (taken every six hours) in CT#2B recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #1 (Array 130).

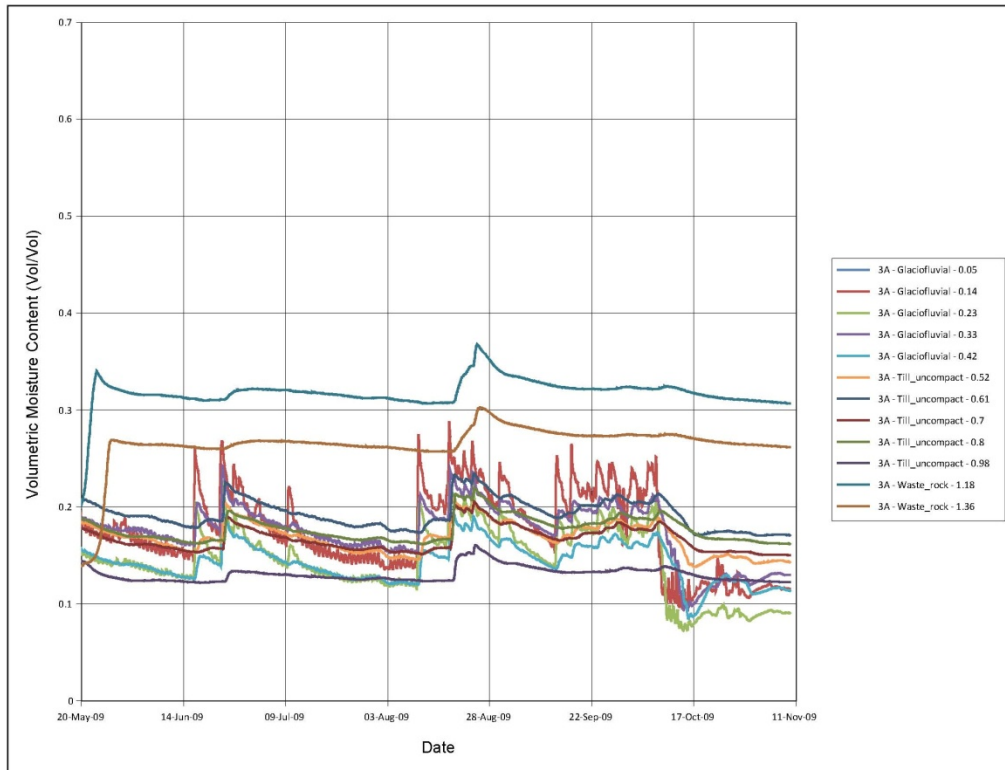


Figure 43: Volumetric moisture content measurements (taken every six hours) in CT#3A recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

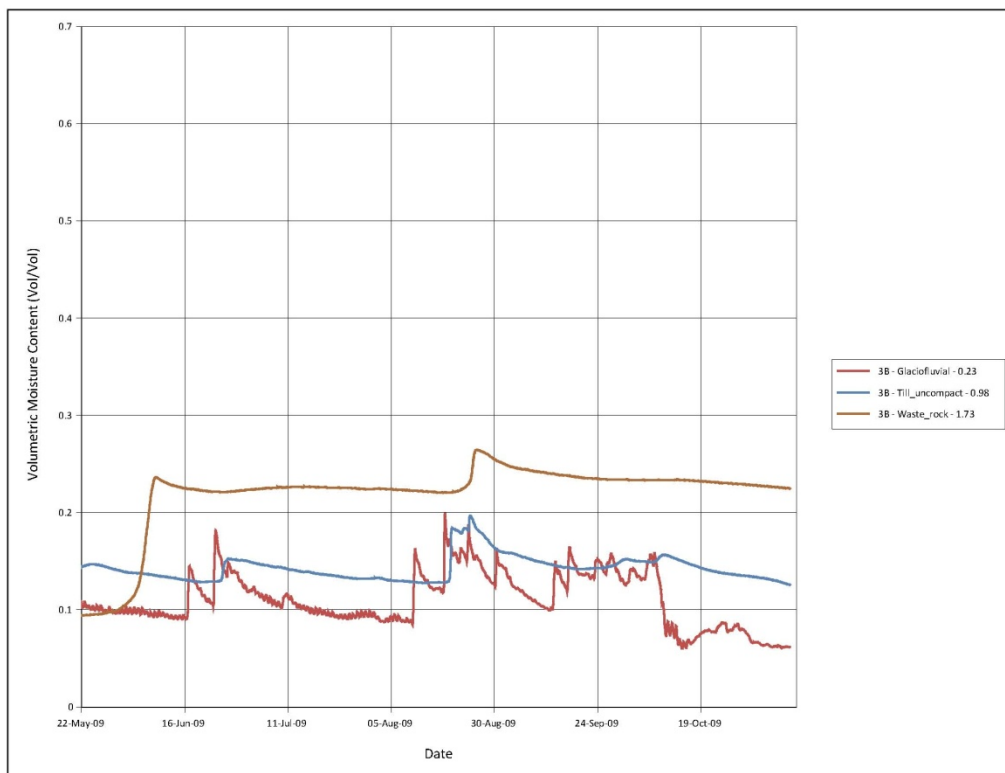


Figure 44: Volumetric moisture content measurements (taken every six hours) in CT#3B recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

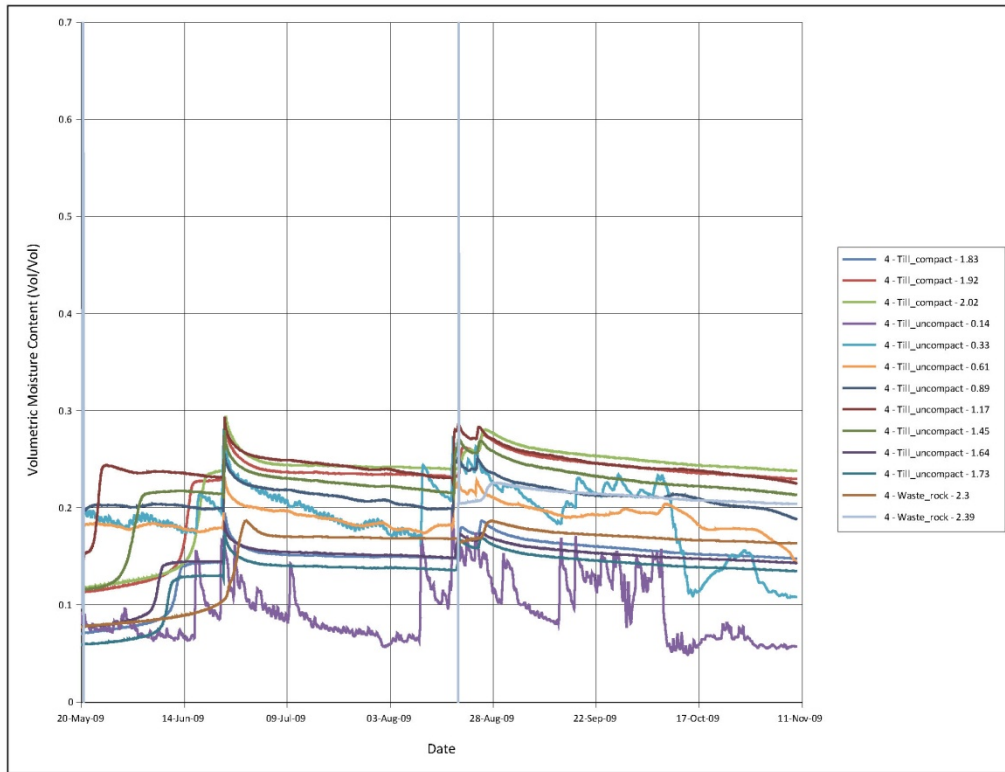


Figure 45: Volumetric moisture content measurements (taken every six hours) in CT#4 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR10X #2 (Array 168).

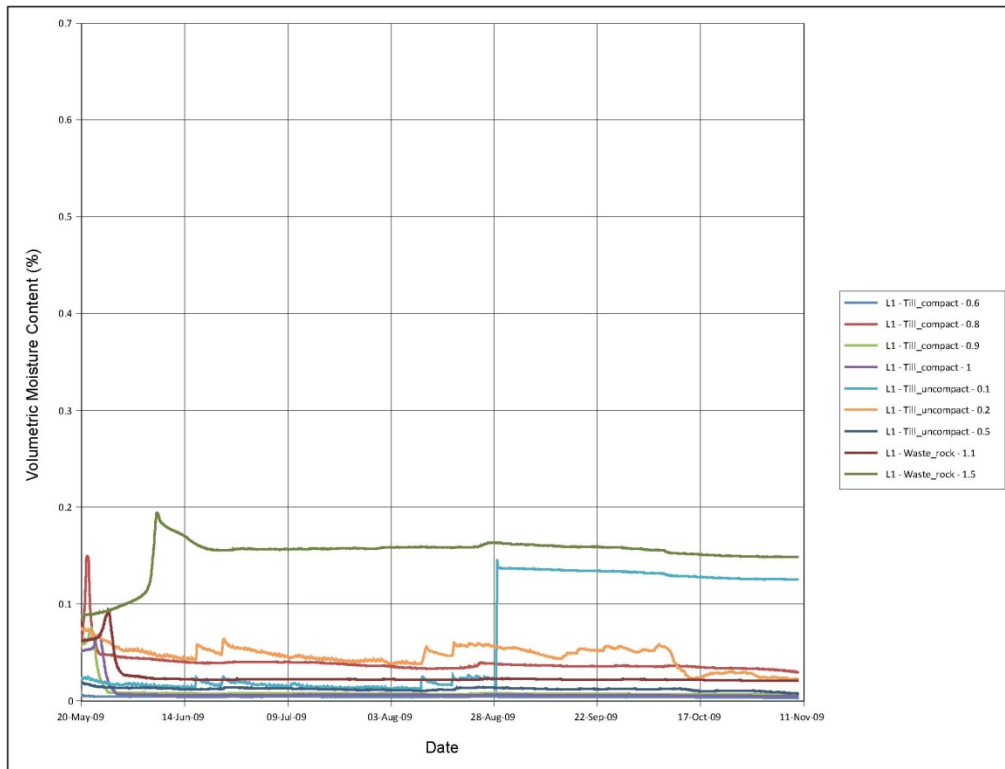


Figure 46: Volumetric moisture content measurements (taken every six hours) in L#1 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR1000.

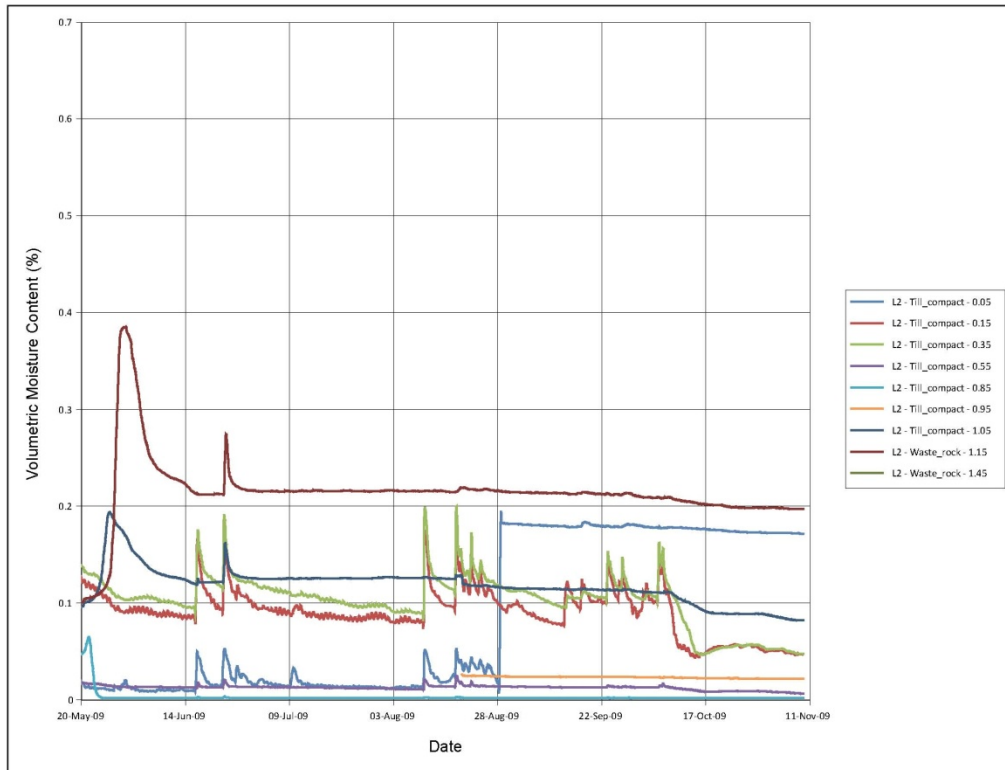


Figure 47: Volumetric moisture content measurements (taken every six hours) in L#2 recorded by EnviroScan sensors connected to Campbell Scientific data logger CR1000.

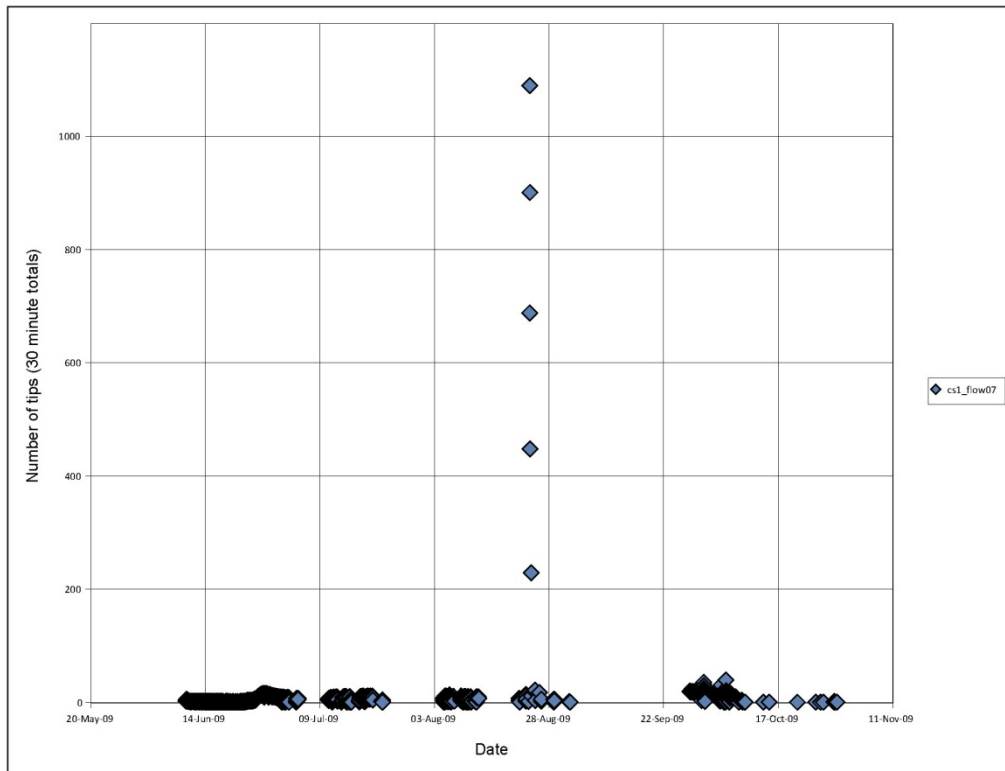


Figure 48: Interflow totals in CT#3A measured by a tipping bucket connected to Campbell Scientific data logger CR10X #1.

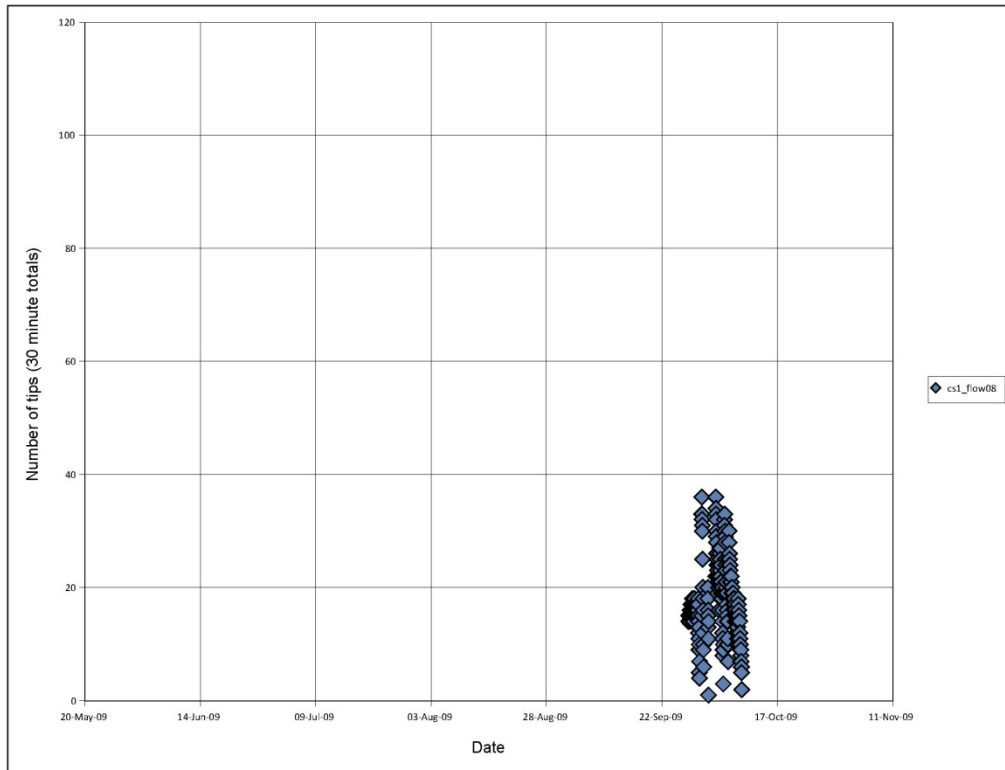


Figure 49: Interflow totals in CT#3B measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

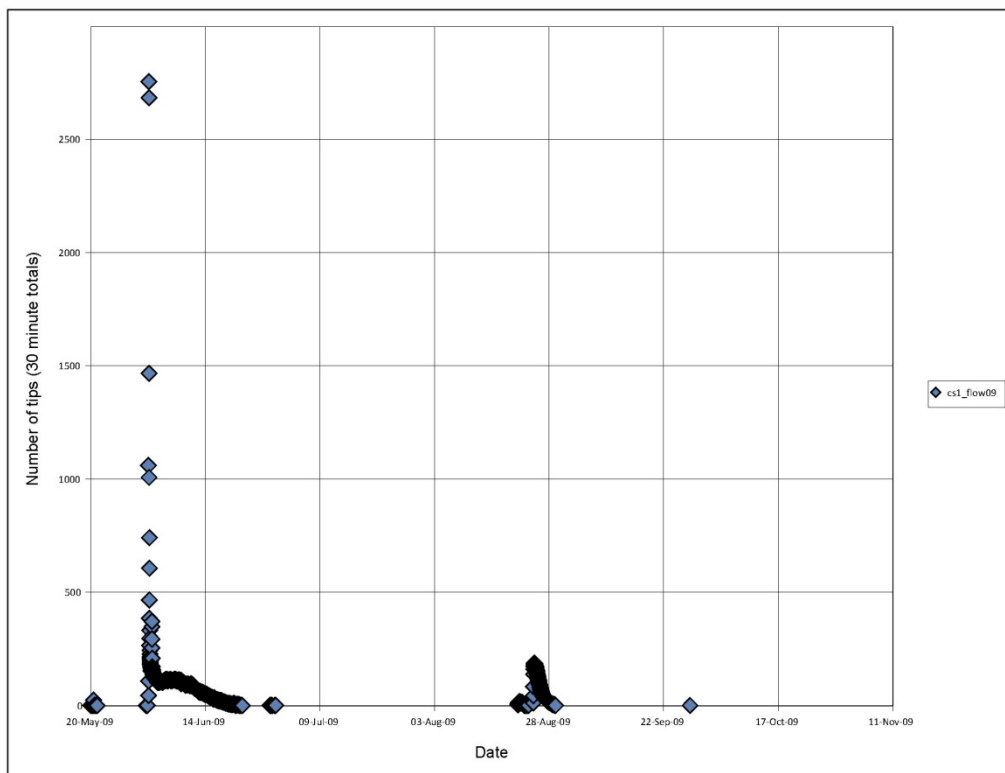


Figure 50: Interflow totals in CT#4 measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

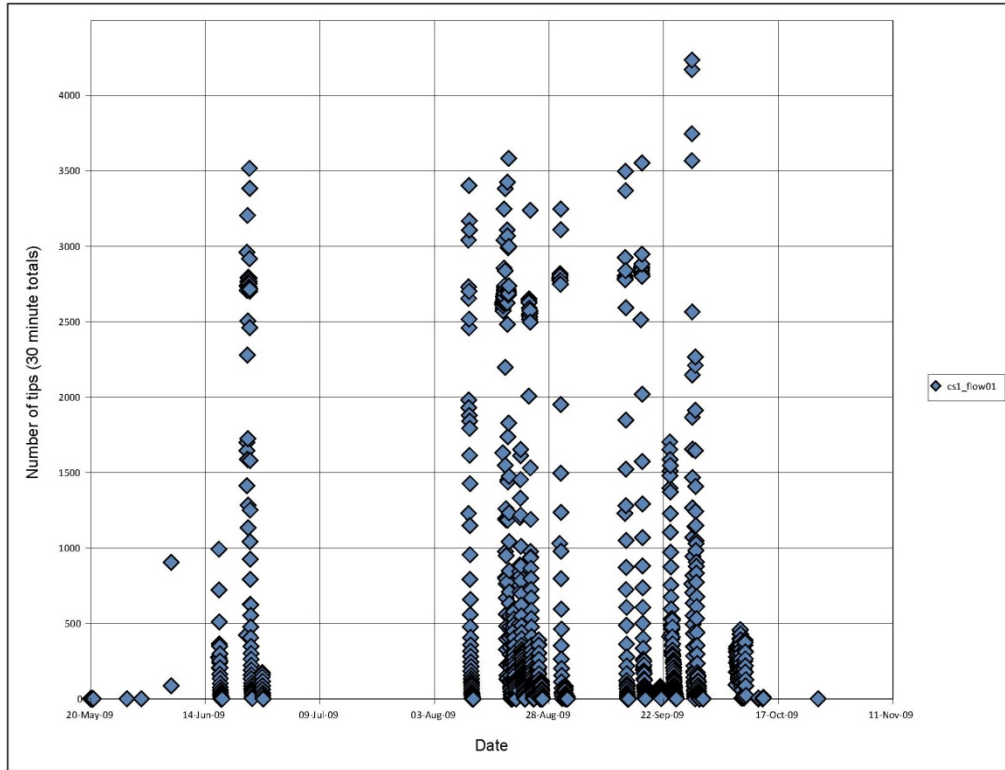


Figure 51: Surface flow totals in CT#1 measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

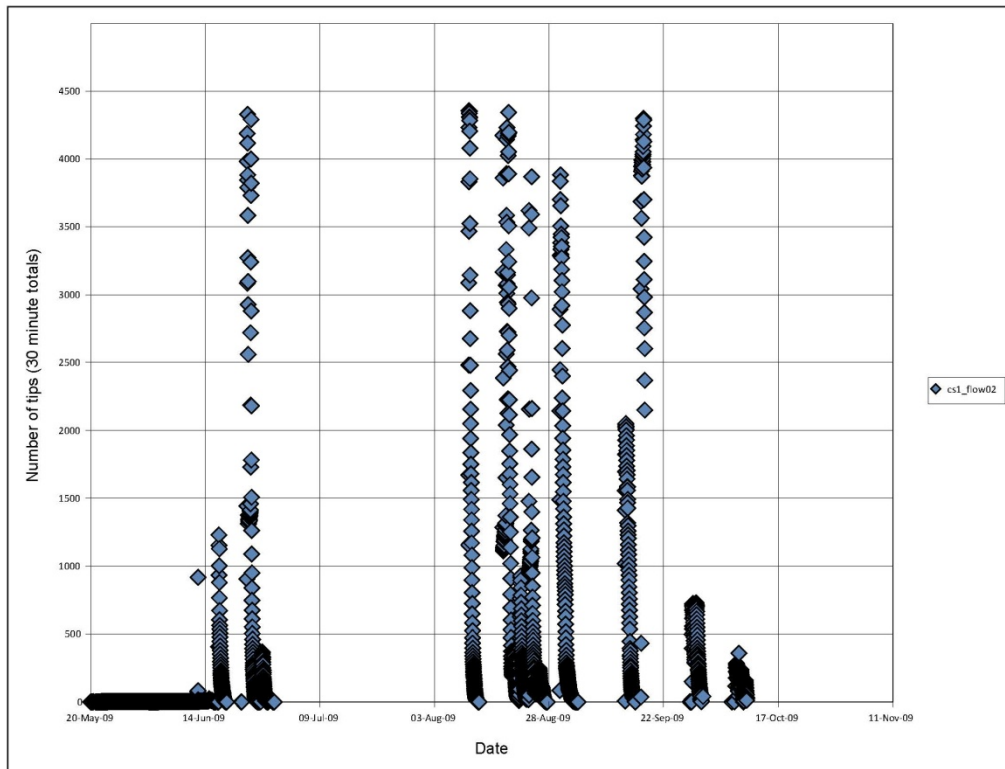


Figure 52: Surface flow totals in CT#2A measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

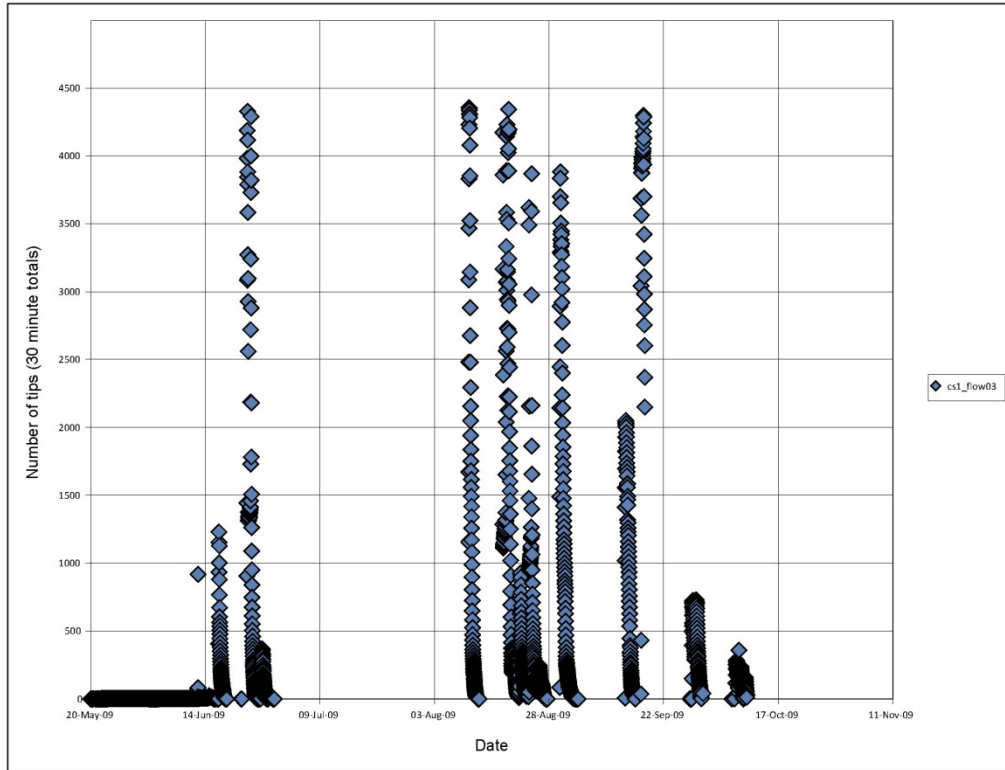


Figure 53: Surface flow totals in CT#2B measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

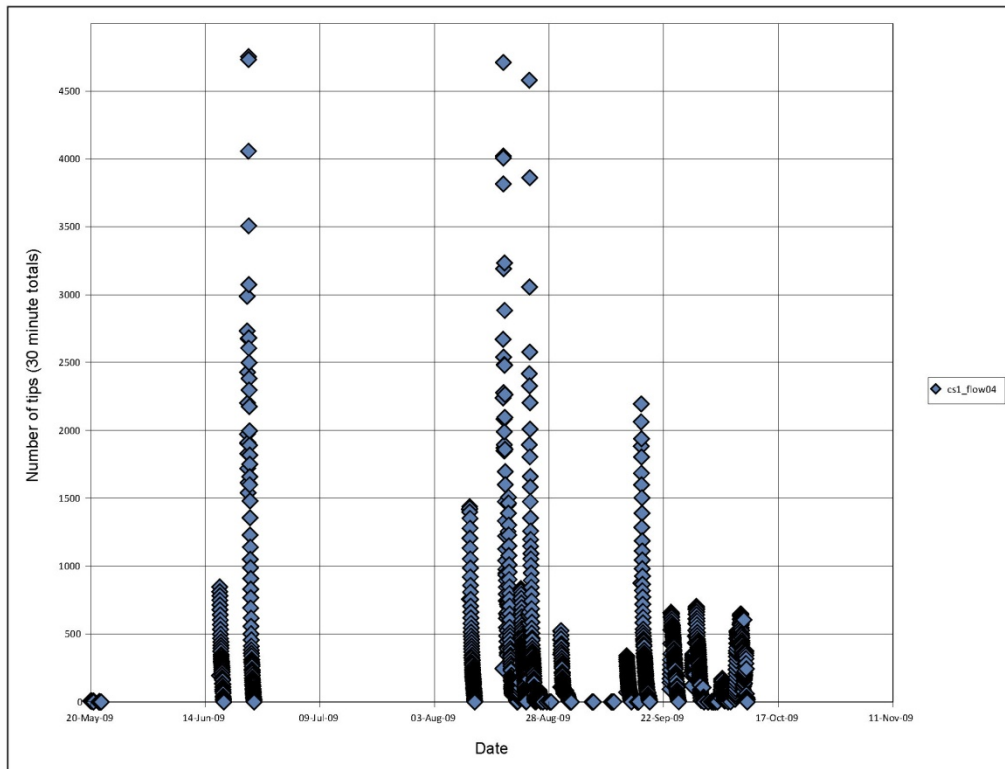


Figure 54: Surface flow totals in CT#3A measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

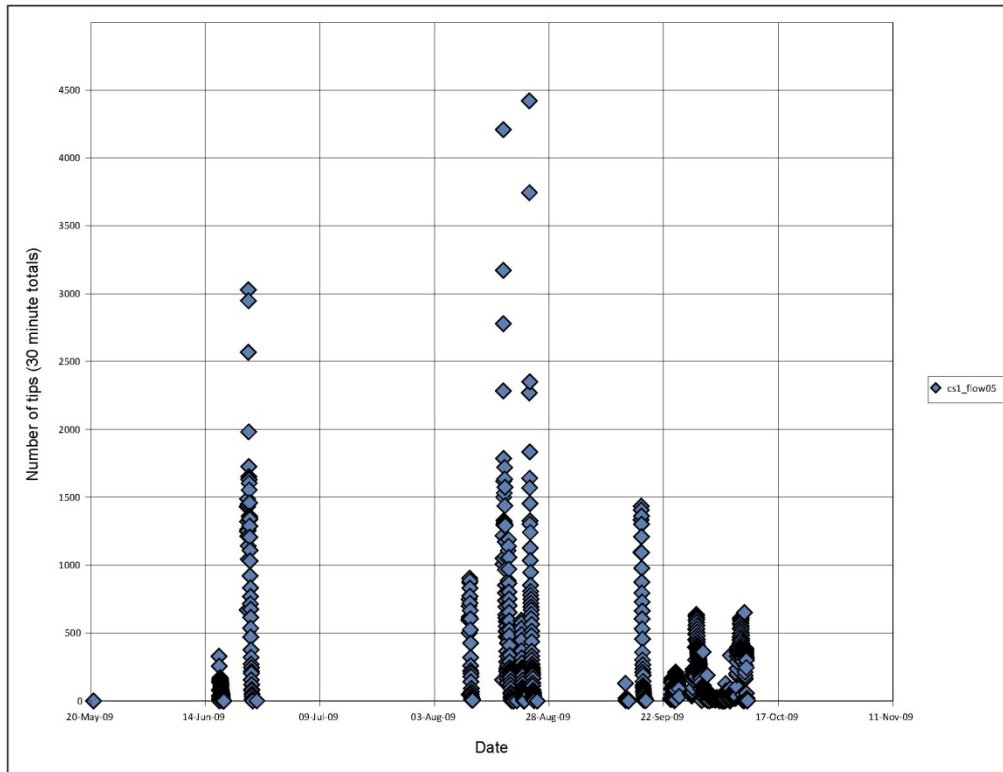


Figure 55: Surface flow totals in CT#3B measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

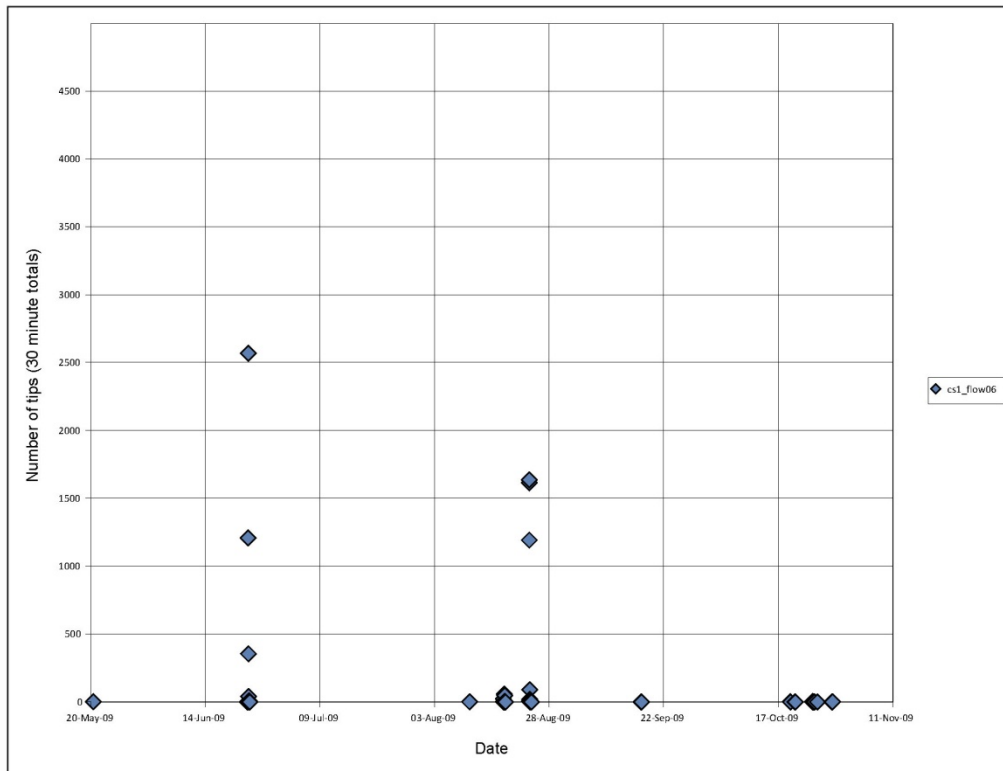


Figure 56: Surface flow totals in CT#4 measured by a tipping bucket connected to Campbell Scientific data logger CR10X #2.

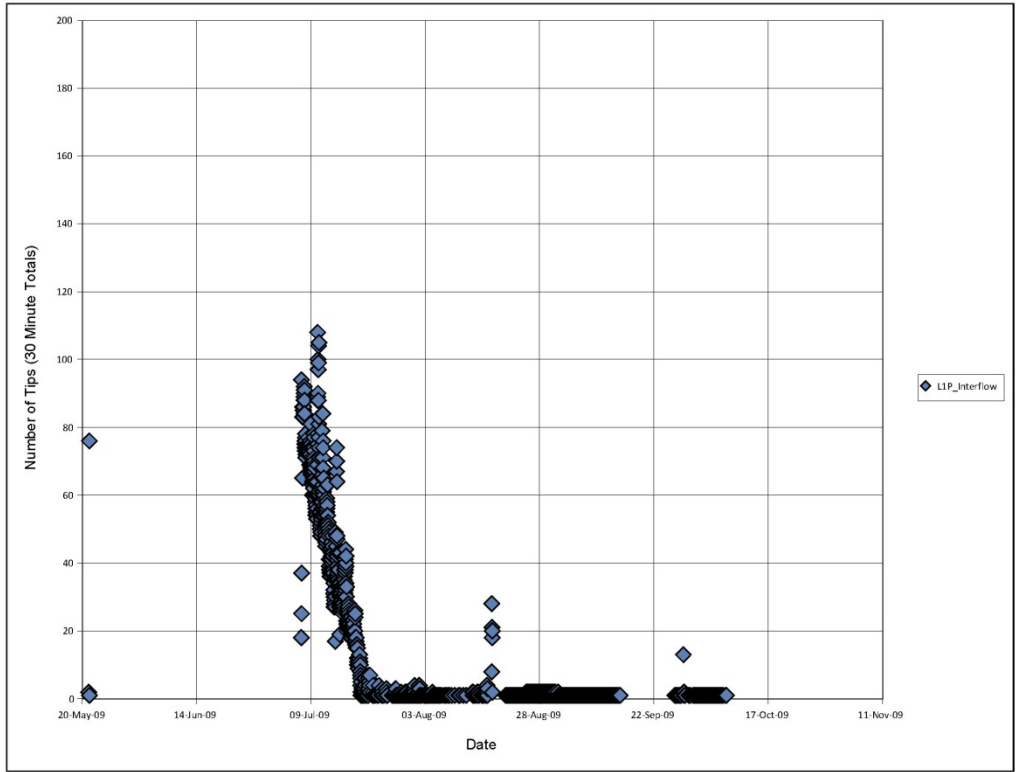


Figure 57: Peripheral interflow totals in L#1 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

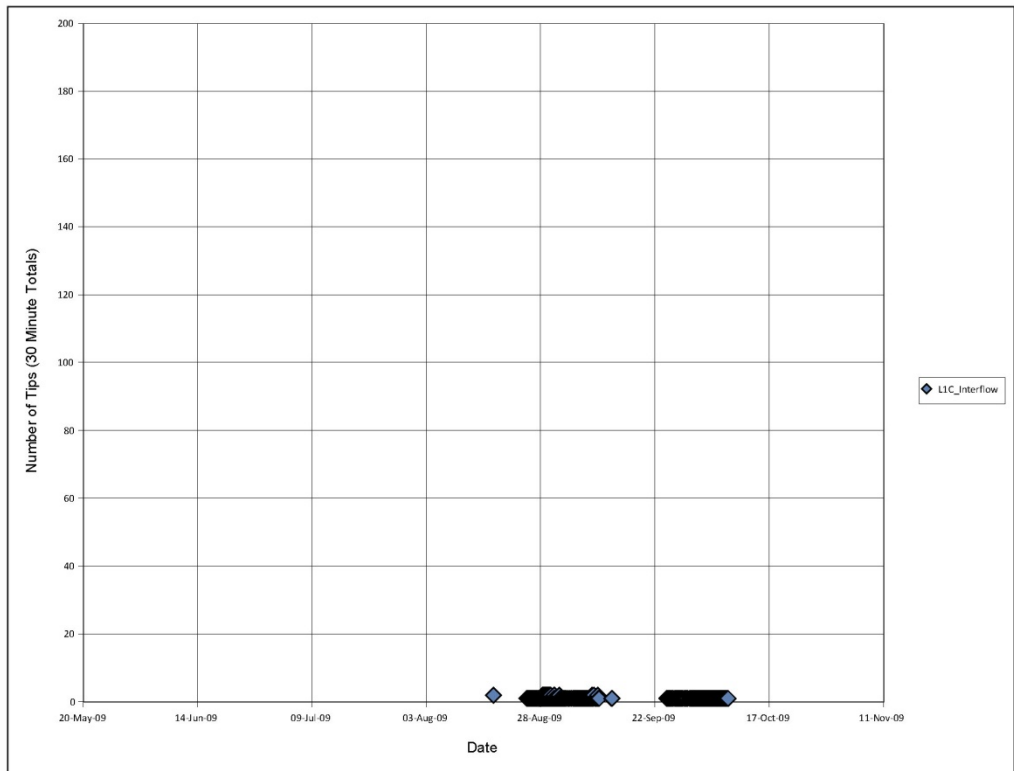


Figure 58: Central interflow totals in L#1 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

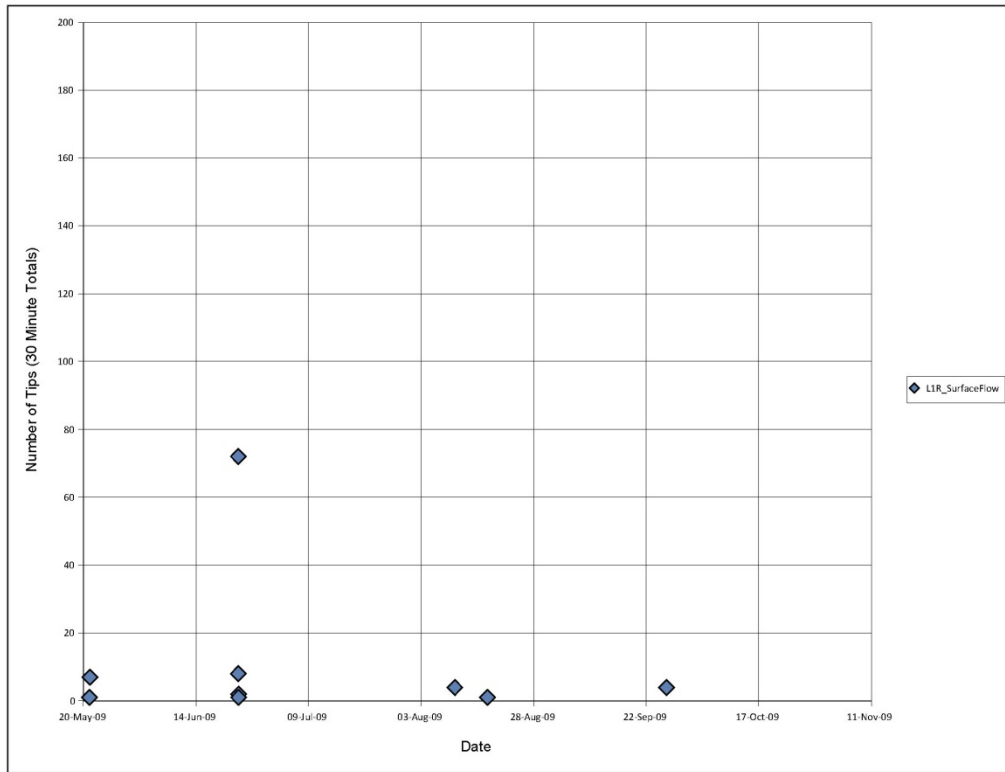


Figure 59: Surface flow totals in L#1 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

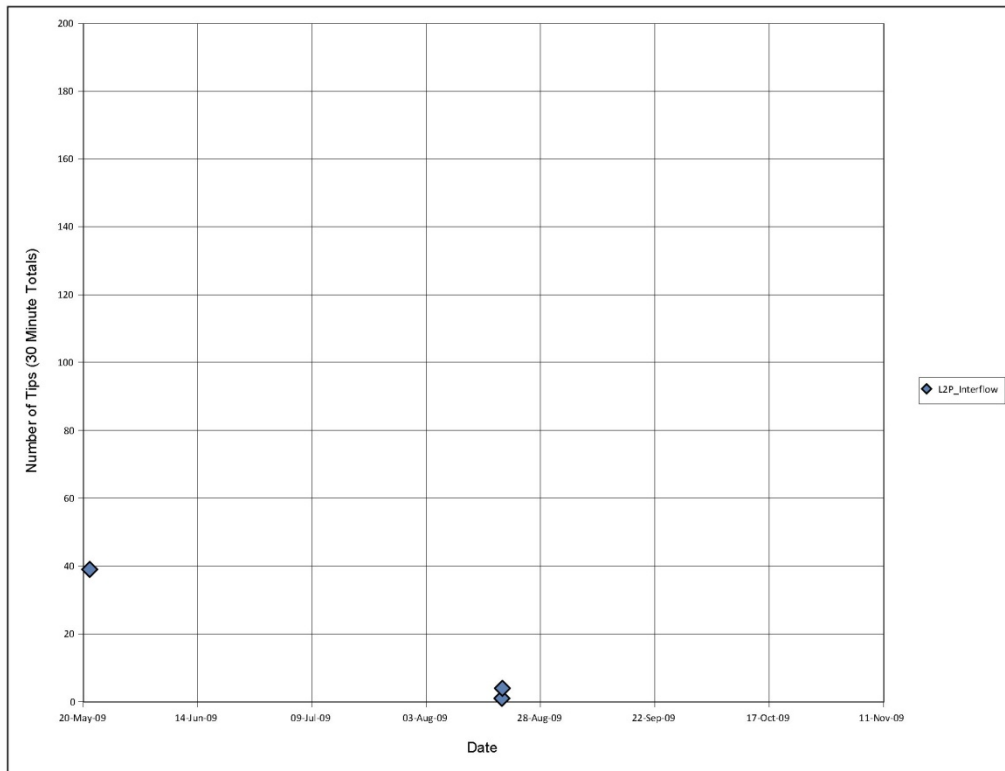


Figure 60: Peripheral interflow totals in L#2 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

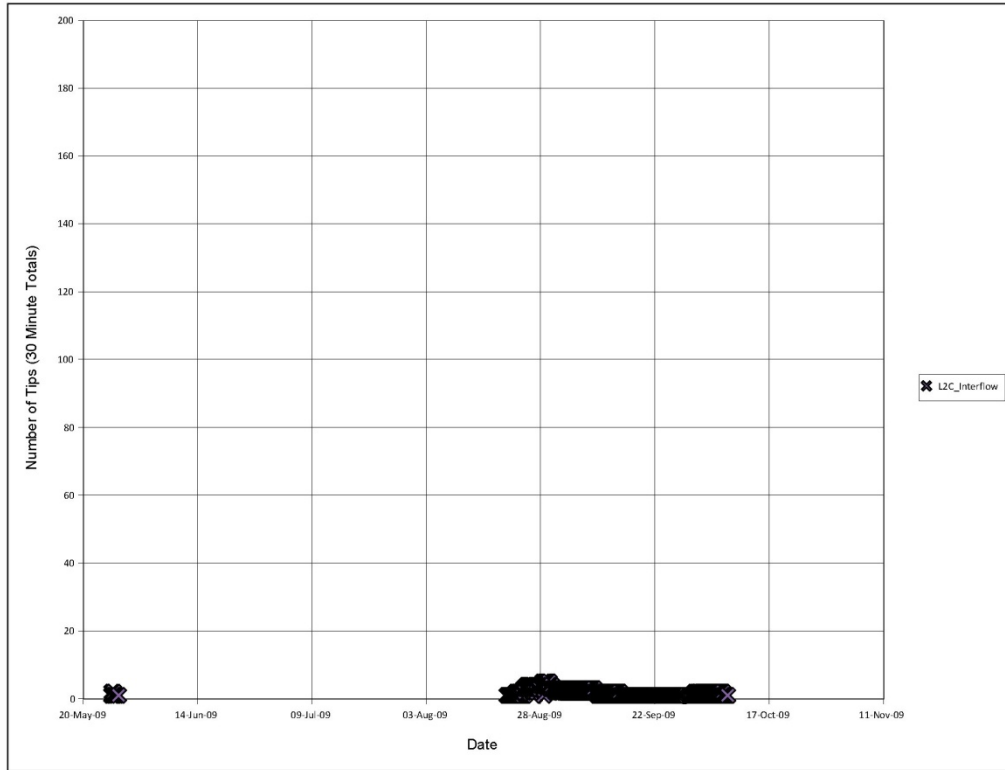


Figure 61: Central interflow totals in L#2 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

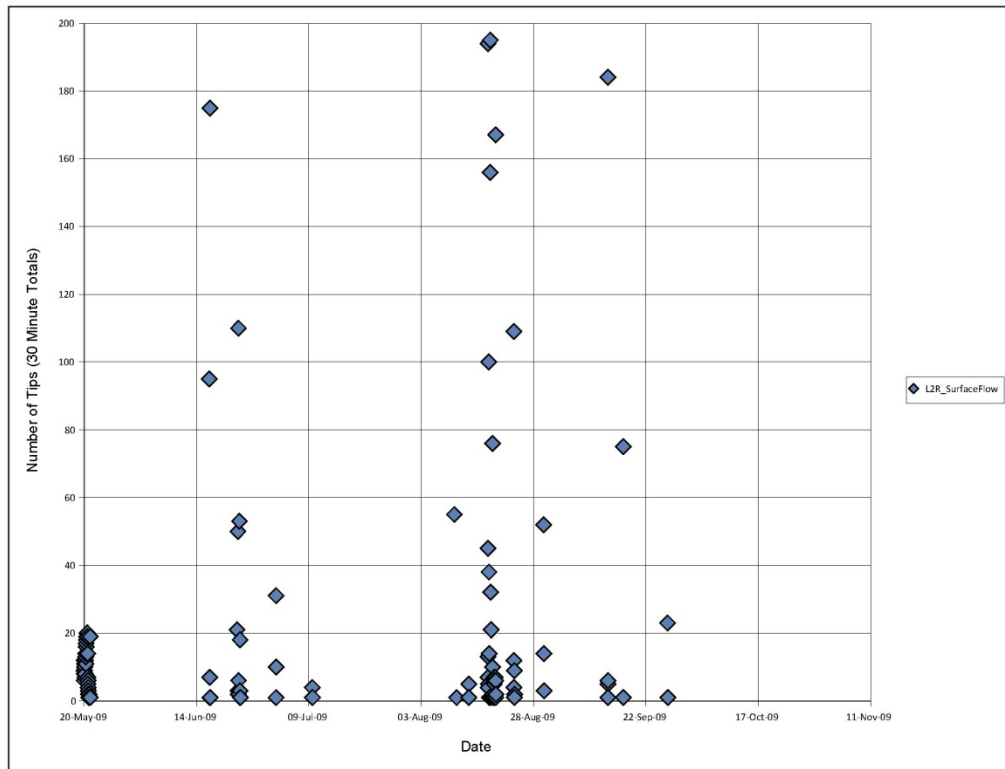


Figure 62: Surface flow totals in L#2 measured by a tipping bucket connected to Campbell Scientific data logger CR1000.

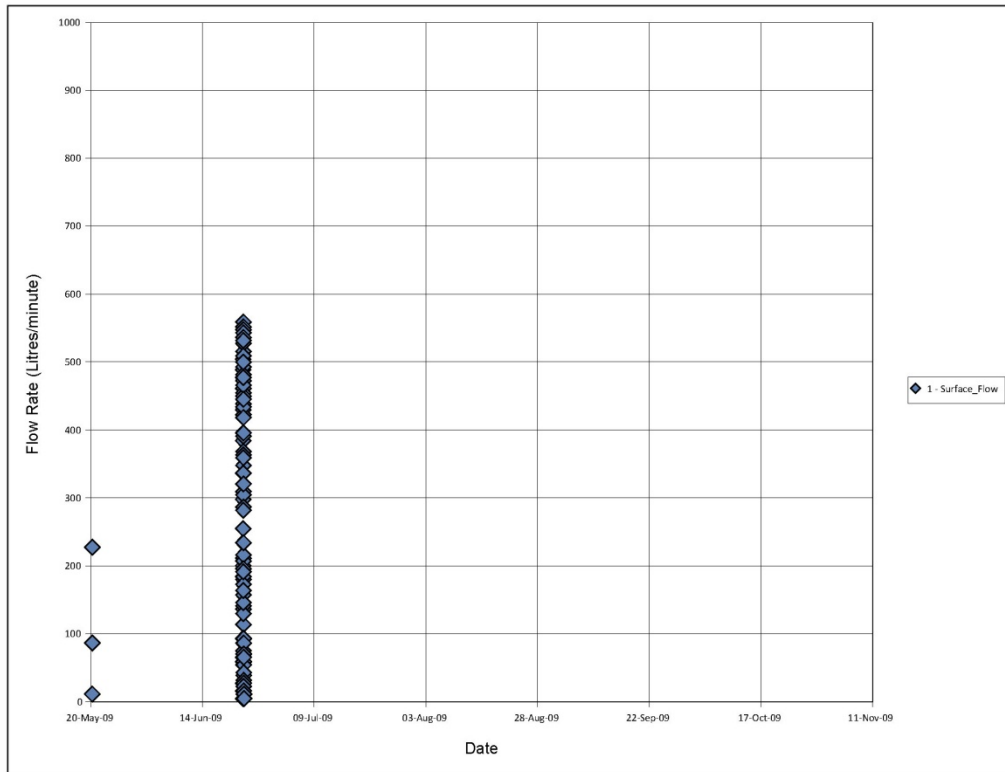


Figure 63: Surface runoff (measured every minute) on CT#1 by a Seametrics flowmeter connected to a Seametrics DL75 Data logger (File 0506051).

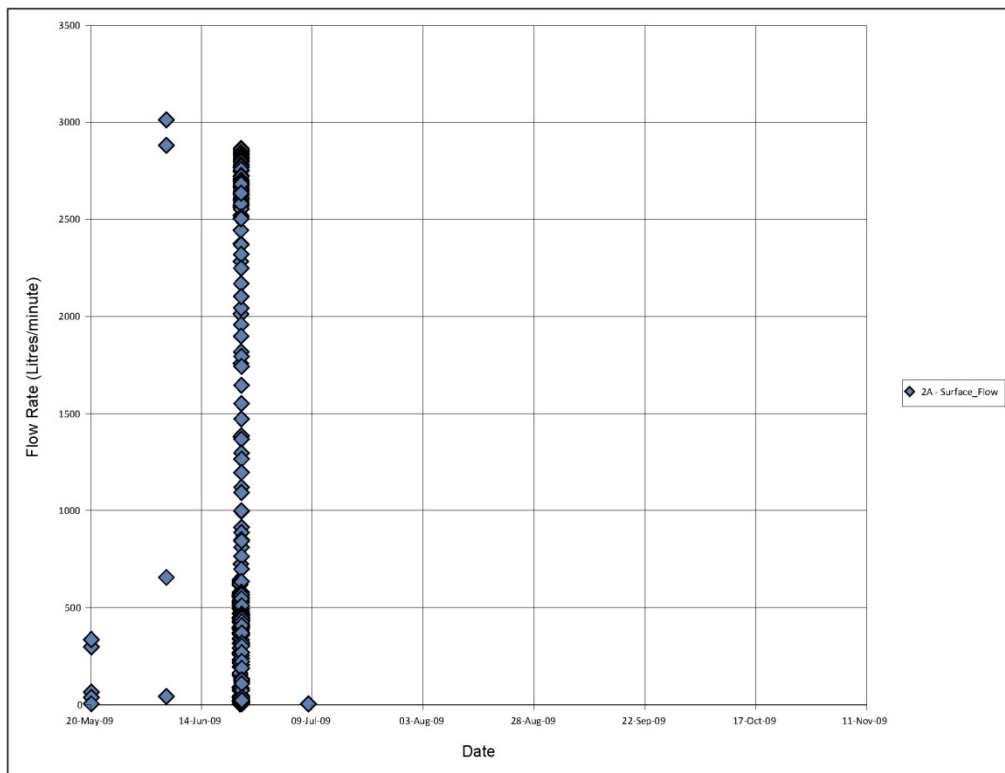


Figure 64: Surface runoff (measured every minute) on CT#2A by a Seametrics flowmeter connected to a Seametrics DL75 Data logger (File 0506052).

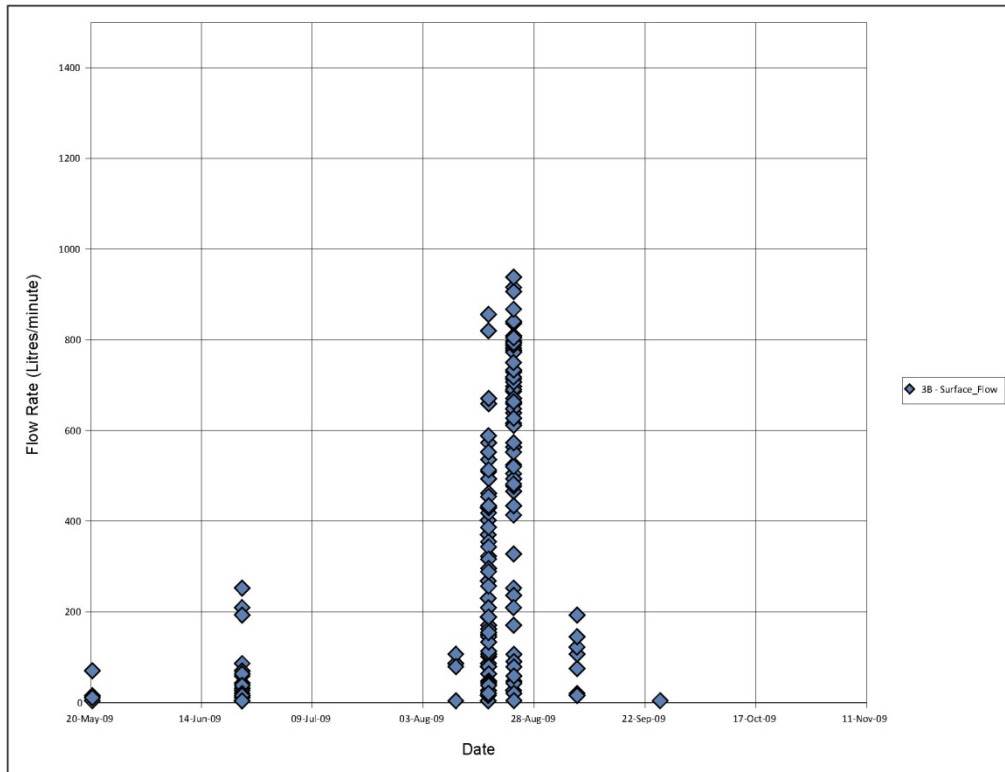


Figure 65: Surface runoff (measured every minute) on CT#3B by a Seametrics flowmeter connected to a Seametrics DL75 Data logger (File 0506056).

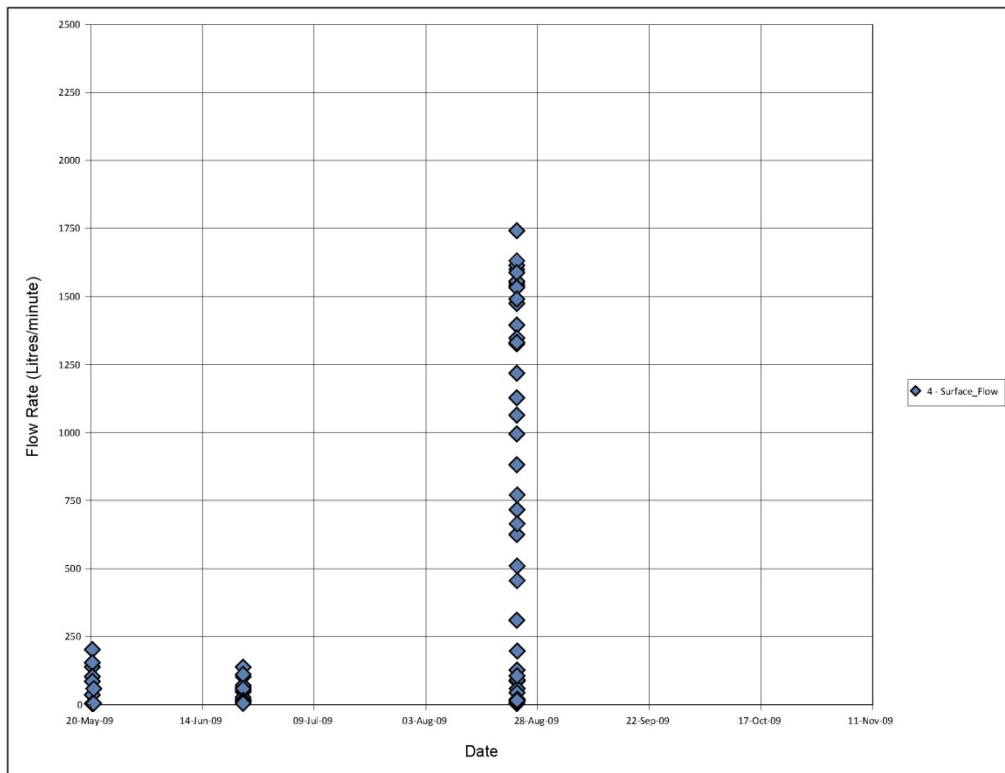


Figure 66: Surface runoff (measured every minute) on CT#4 by a Seametrics flowmeter connected to a Seametrics DL75 Data logger (File 0506058).

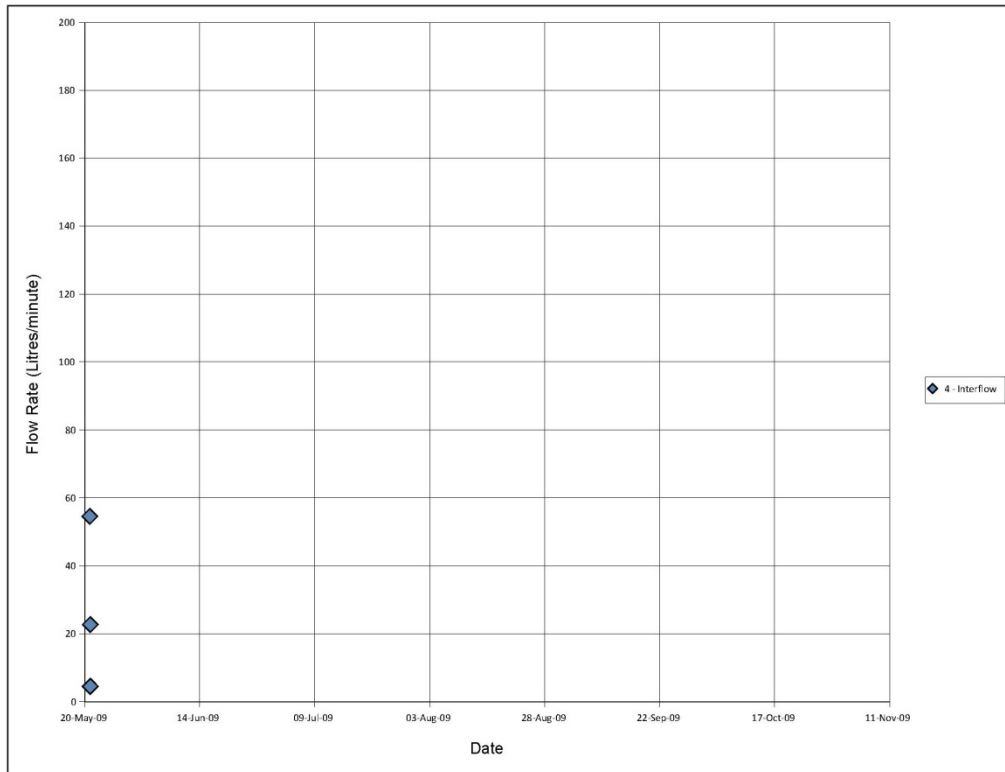


Figure 69: Interflow (measured every minute) in CT#4 by a Seametrics flowmeter connected to a Seametrics DL75 Data logger (File 0506059).

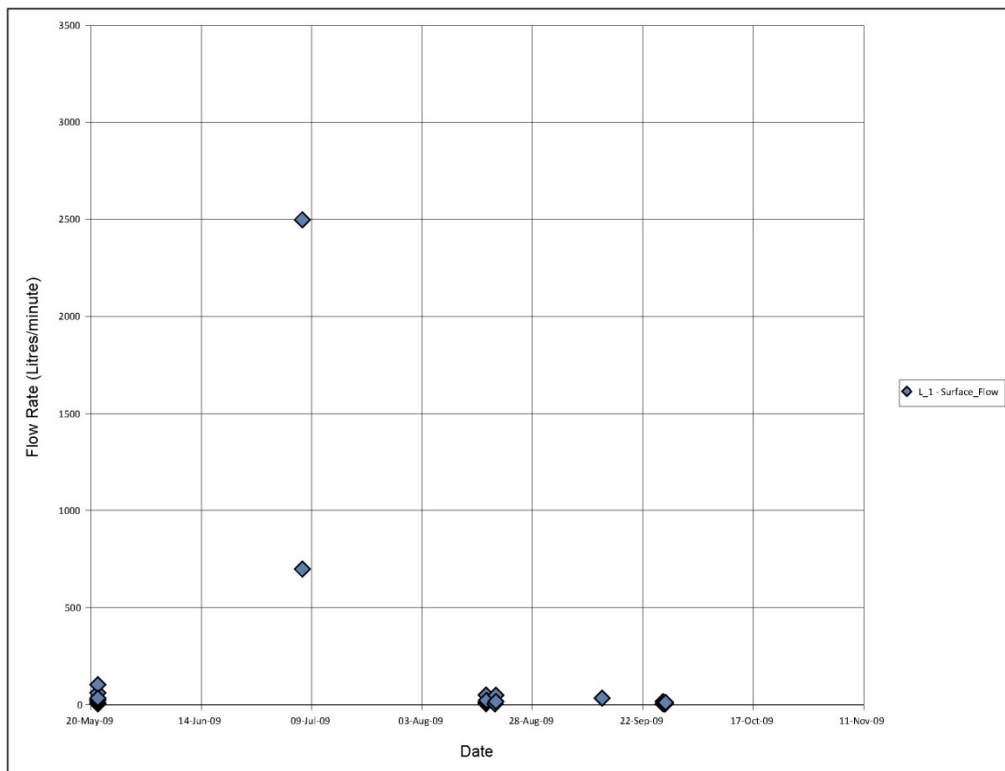


Figure 70: Surface runoff (measured every minute) on L#1 by a Seametrics flowmeter connected to a Seametrics DL75 Data logger (File 72649).

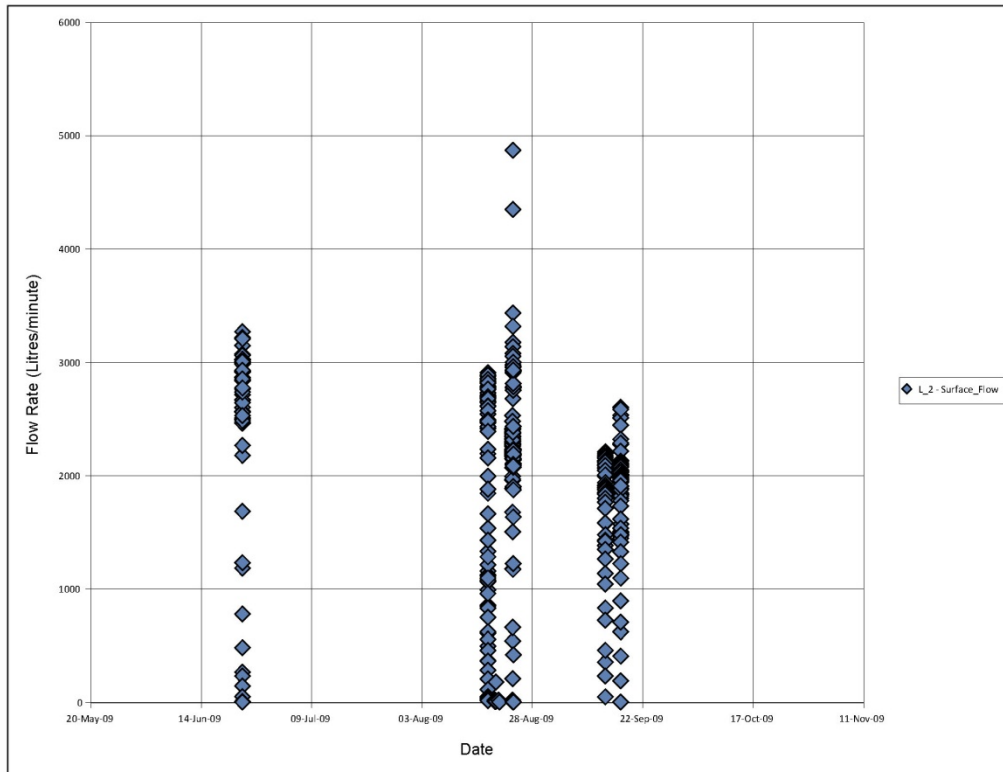


Figure 71: Surface runoff (measured every minute) in L#2 by a Seametrics flowmeter connected to a Seametrics DL75 Data logger (File 72651).

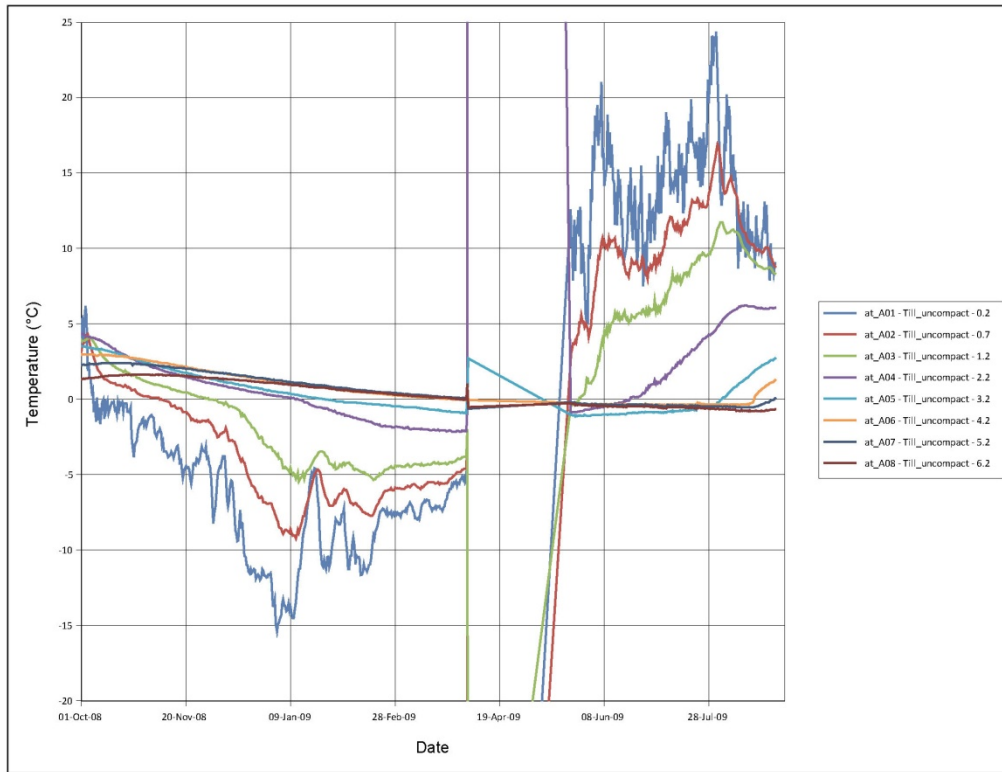


Figure 72: Soil temperature (measured every twelve hours) in Grum Overburden Dump by an M-squared thermistor string connected to a Lakewood Systems UL16 Data logger (Thermistor String A). Raw data displayed.

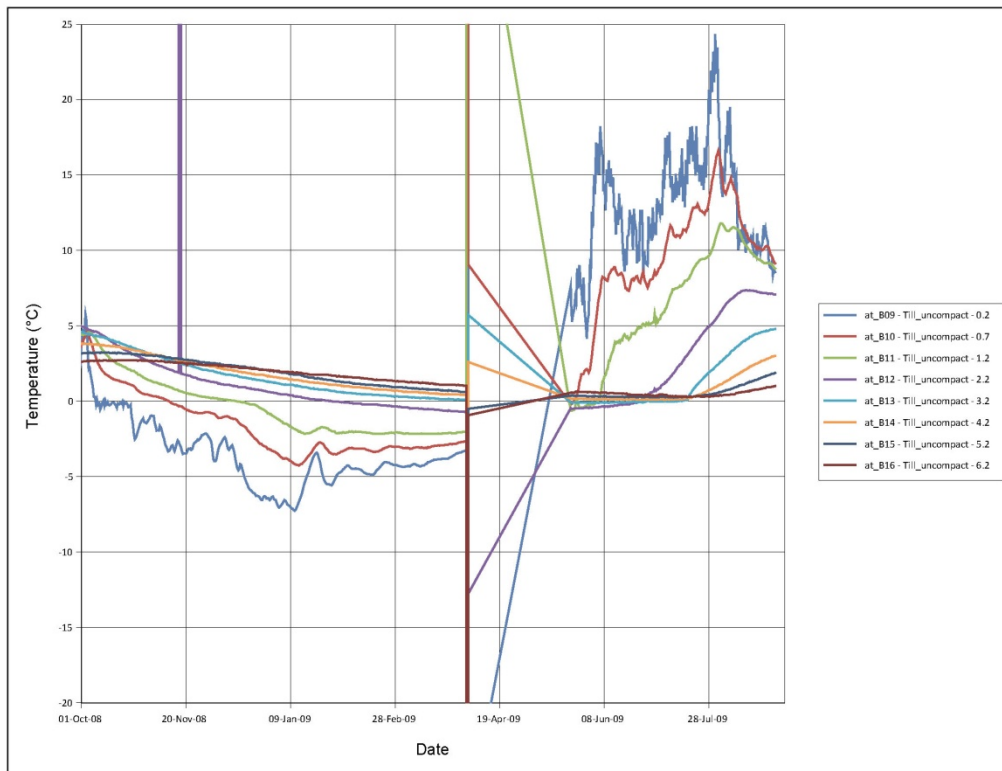


Figure 73: Soil temperature (measured every twelve hours) in Grum Overburden Dump by an M-squared thermistor string connected to a Lakewood Systems UL16 Data logger (Thermistor String B). Raw data displayed.

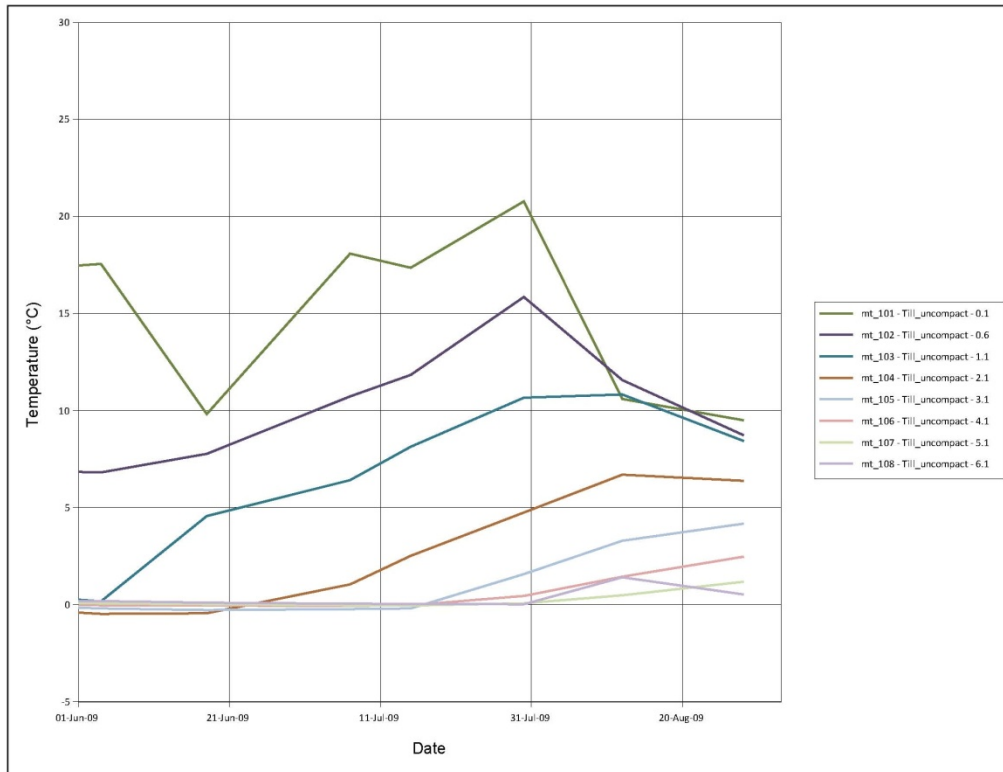


Figure 74: Monthly soil temperature measurements in Grum Overburden Dump by an M-Squared thermistor string measured manually (Thermistor String 1). Raw data expressed as resistances.

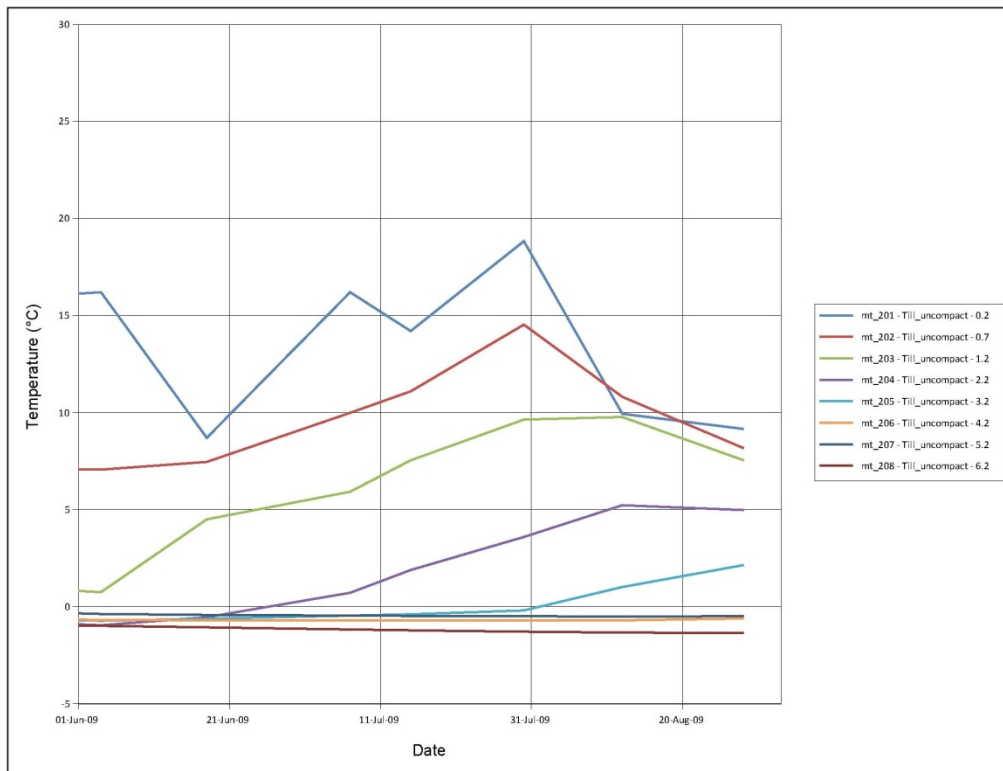


Figure 75: Monthly soil temperature measurements in Grum Overburden Dump by an M-Squared thermistor string measured manually (Thermistor String 2). Raw data expressed as resistances.

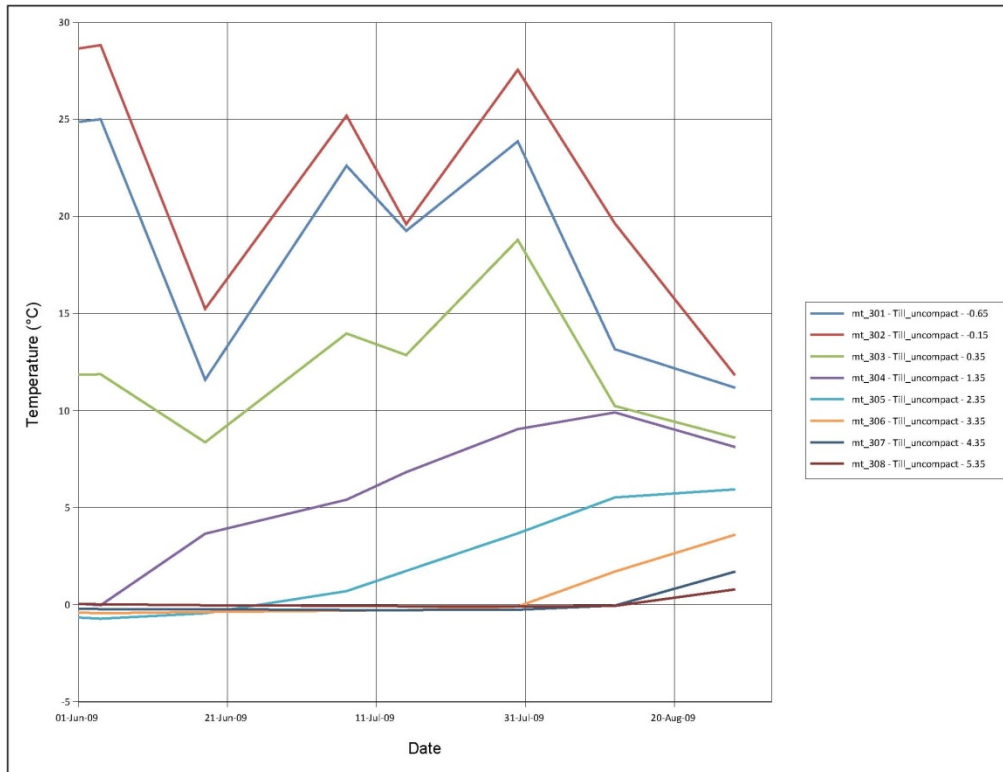


Figure 76: Monthly soil temperature measurements in Grum Overburden Dump by an M-Squared thermistor string measured manually (Thermistor String 3). Raw data expressed as resistances.

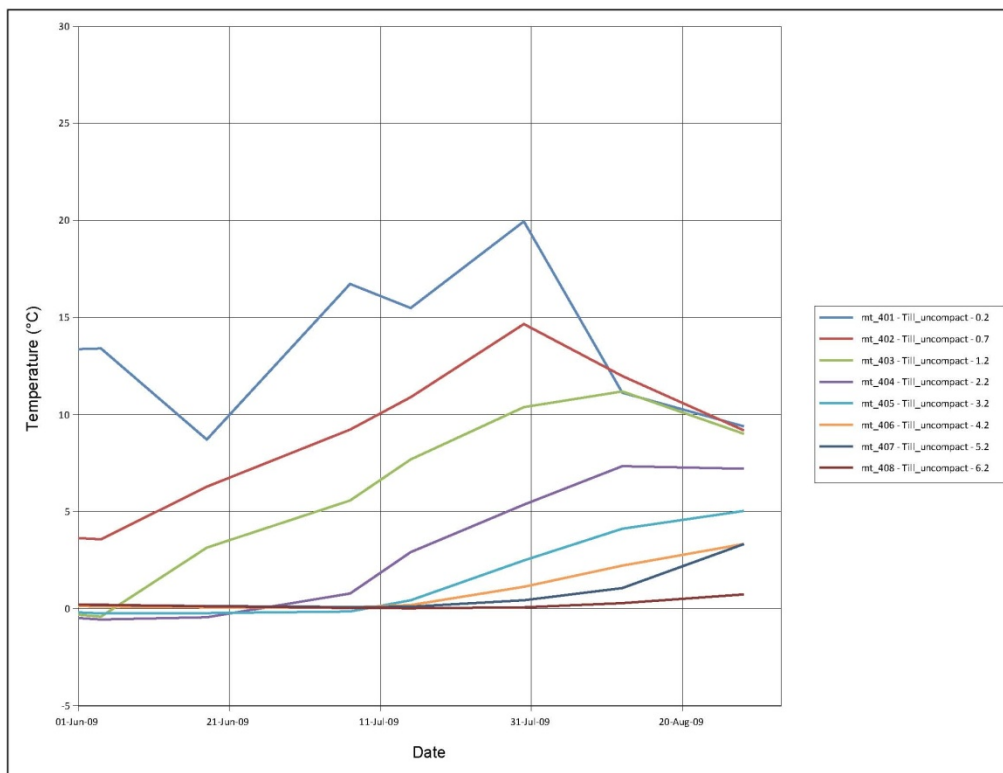


Figure 77: Monthly soil temperature measurements in Grum Overburden Dump by an M-Squared thermistor string measured manually (Thermistor String 4). Raw data expressed as resistances.

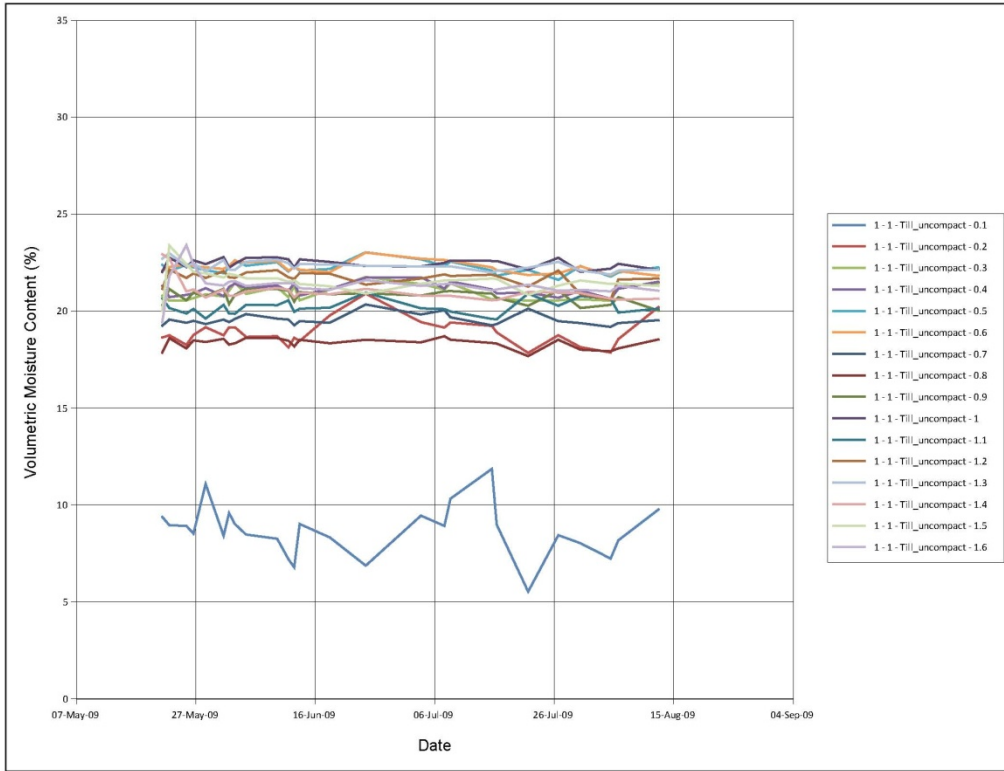


Figure 78: Daily volumetric moisture content in CT#1 (Station #1) measured manually by a Sentek Diviner 2000.

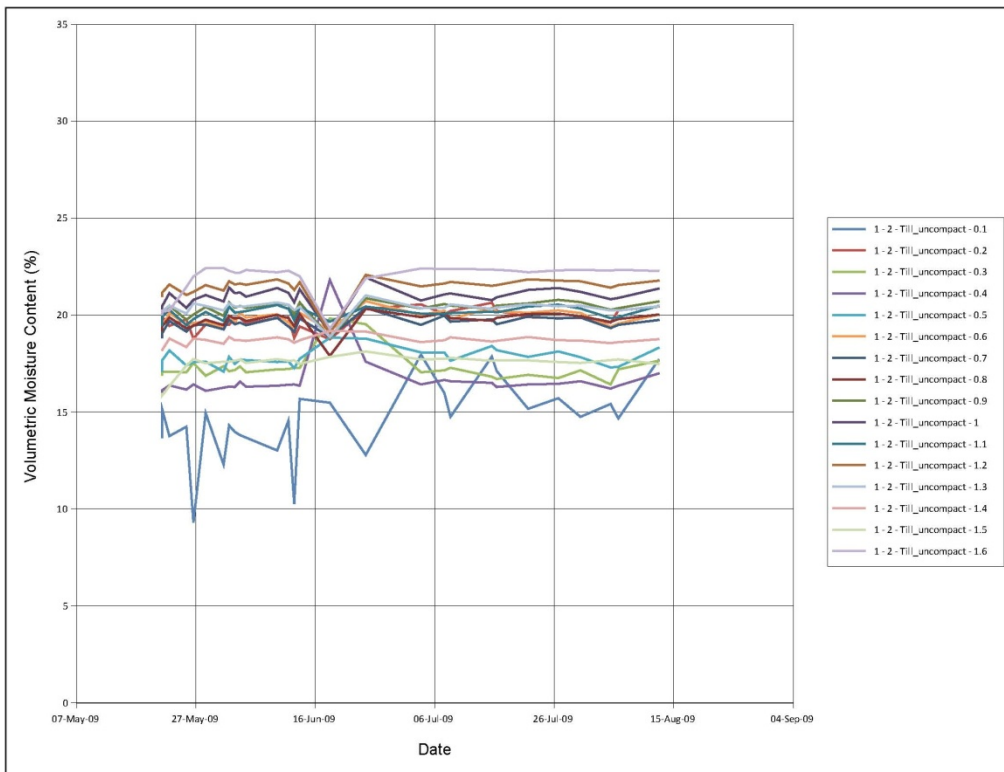


Figure 79: Daily volumetric moisture content in CT#1 (Station #2) measured manually by a Sentek Diviner 2000.

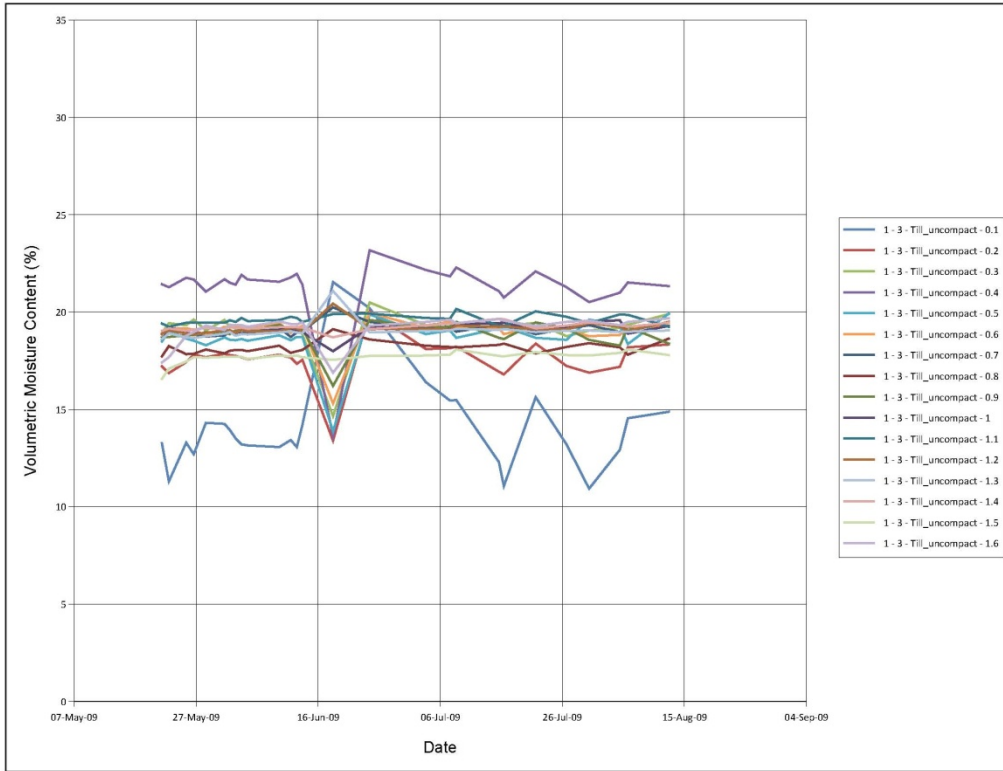


Figure 80: Daily volumetric moisture content in CT#1 (Station #3) measured manually by a Sentek Diviner 2000.

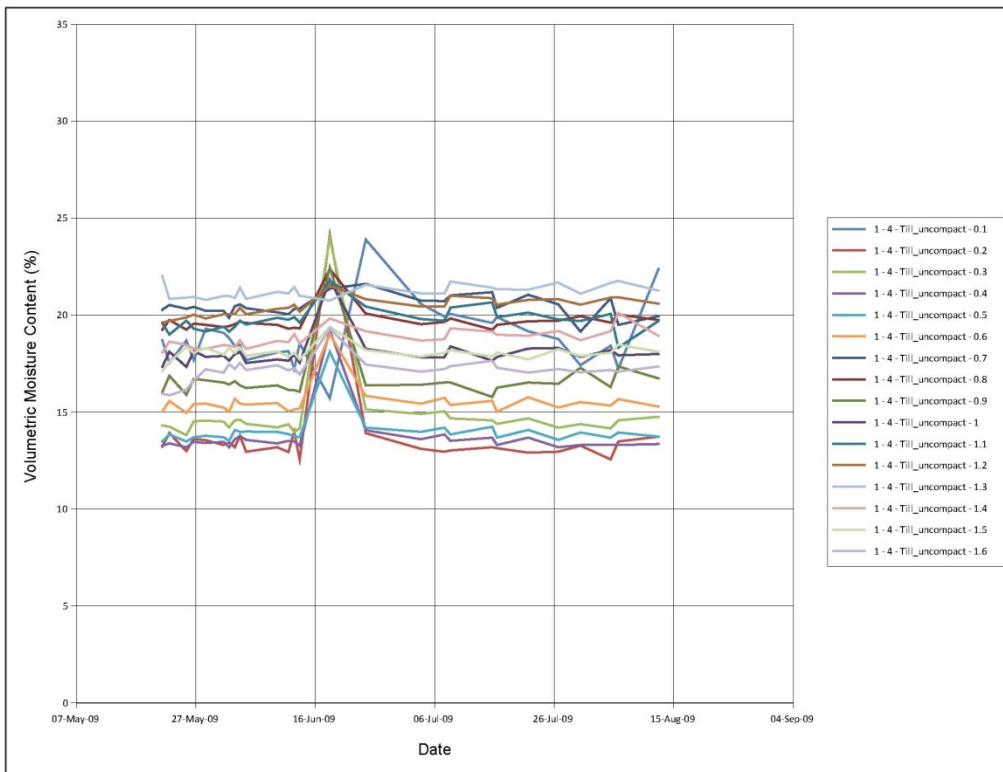


Figure 81: Daily volumetric moisture content in CT#1 (Station #4) measured manually by a Sentek Diviner 2000.

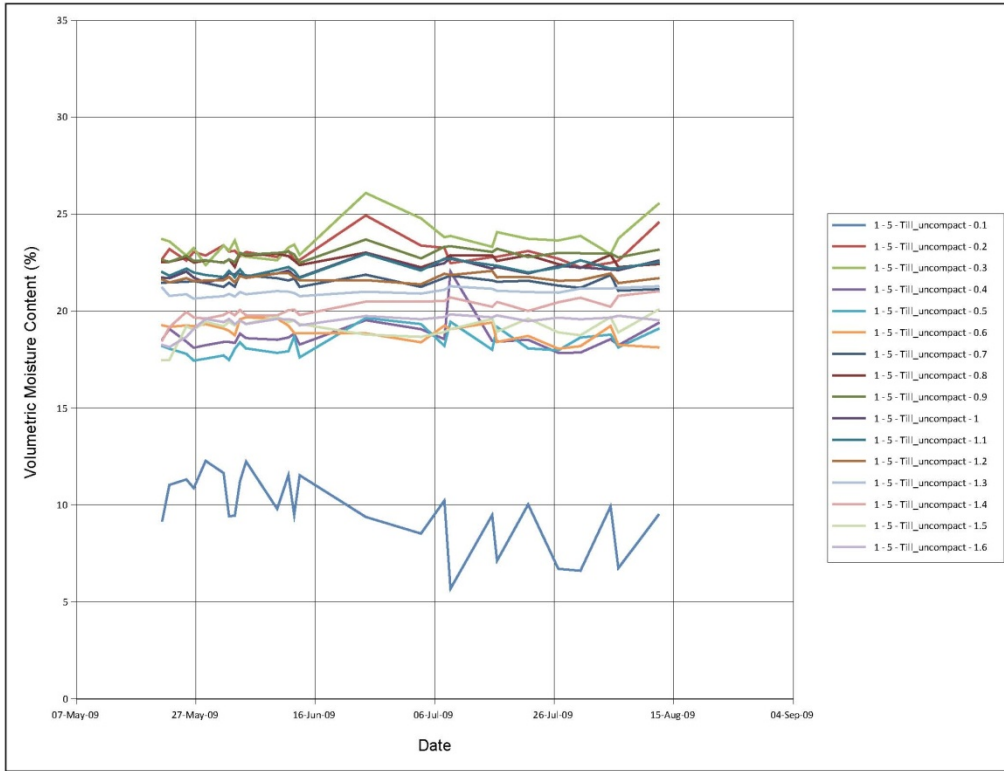


Figure 82: Daily volumetric moisture content in CT#1 (Station #5) measured manually by a Sentek Diviner 2000.

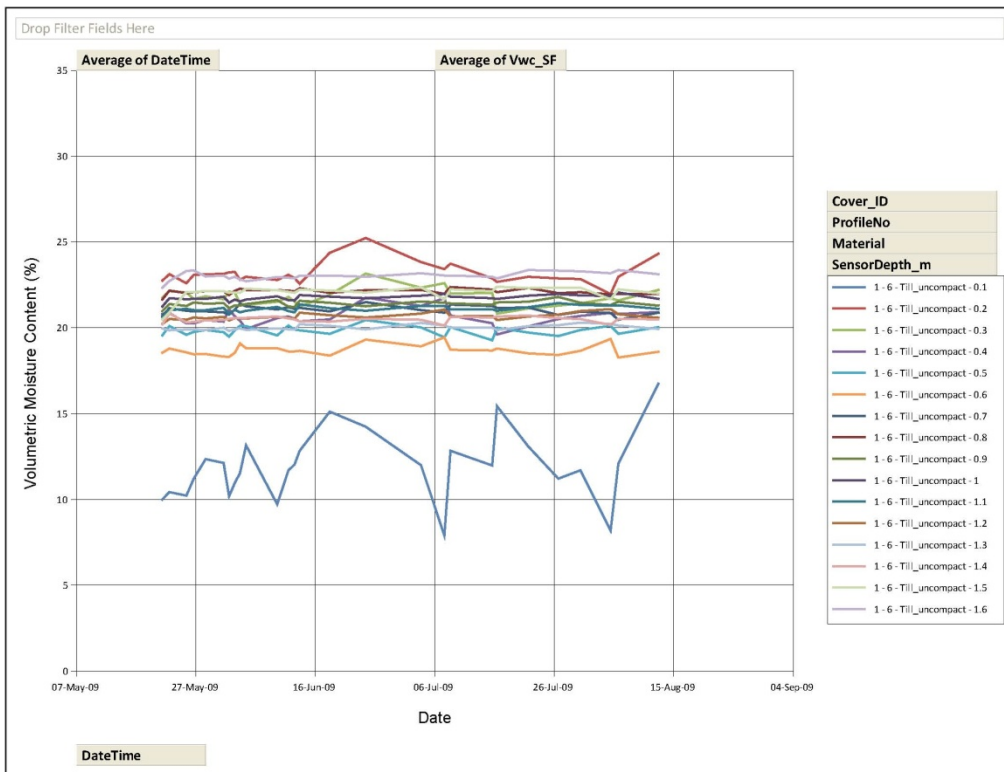


Figure 83: Daily volumetric moisture content in CT#1 (Station #6) measured manually by a Sentek Diviner 2000.

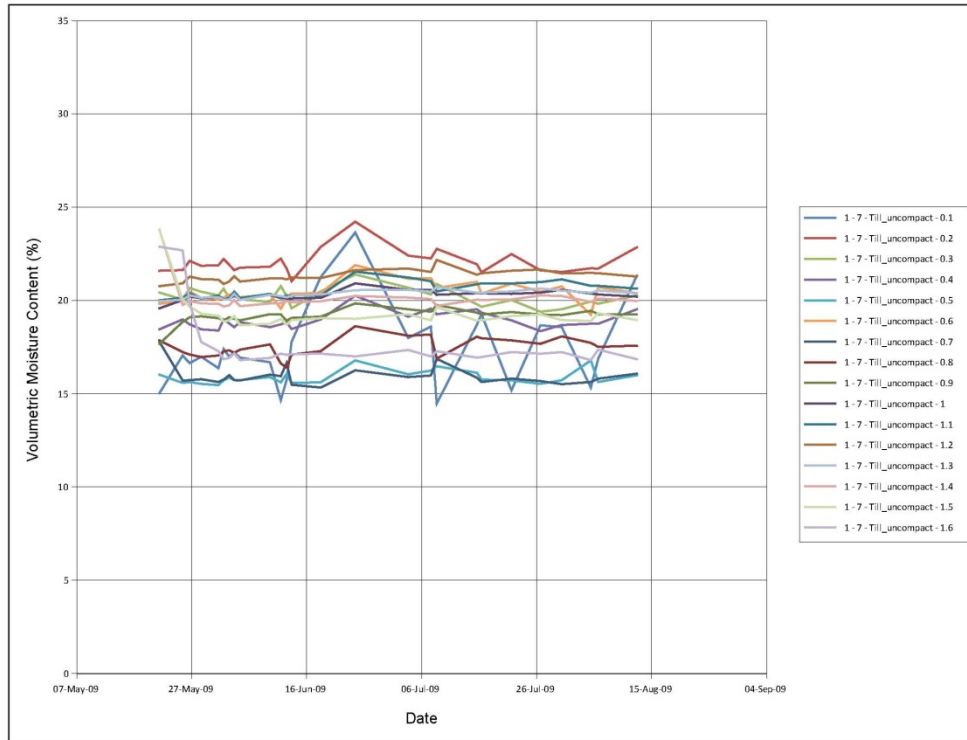


Figure 84: Daily volumetric moisture content in CT#1 (Station #7) measured manually by a Sentek Diviner 2000.

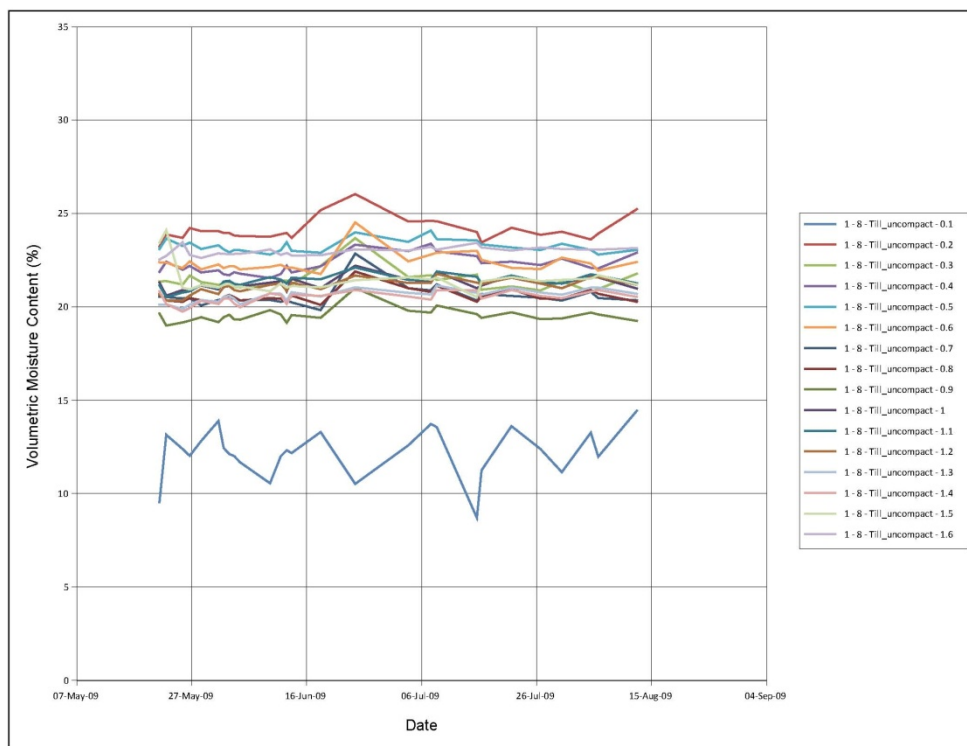


Figure 85: Daily volumetric moisture content in CT#1 (Station #8) measured manually by a Sentek Diviner 2000.

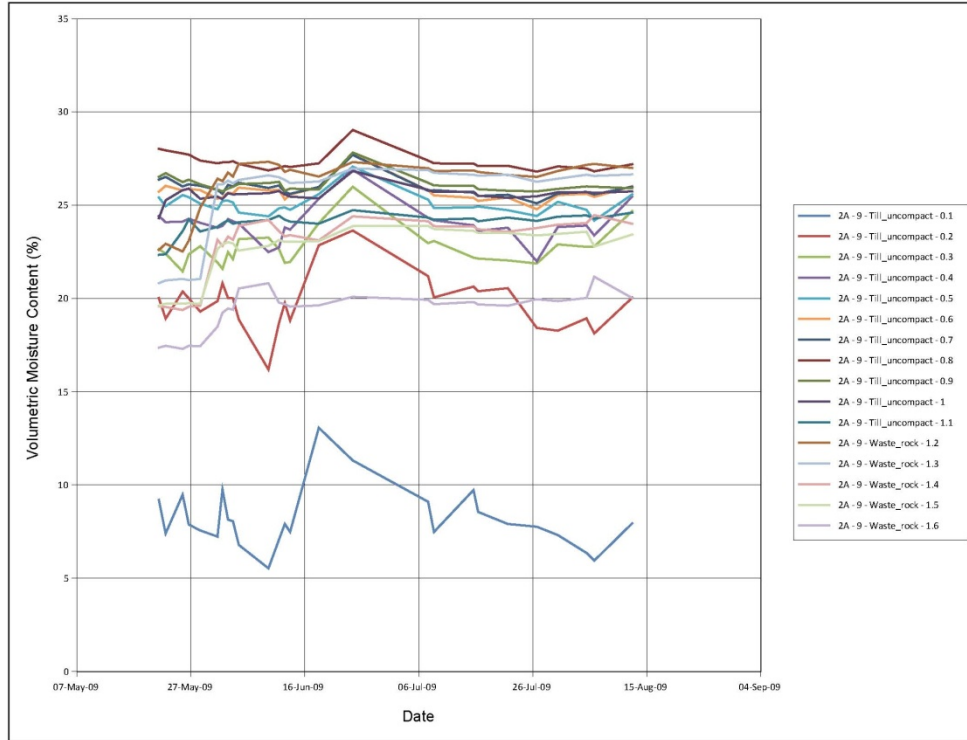


Figure 86: Daily volumetric moisture content in CT#2A (Station #9) measured manually by a Sentek Diviner 2000.

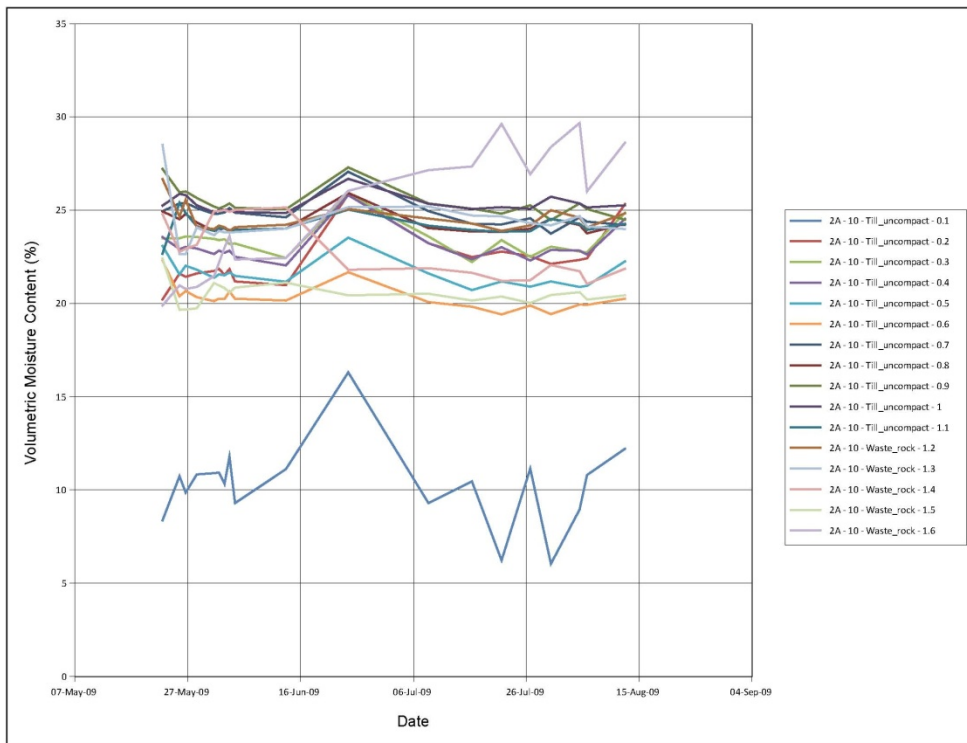


Figure 87: Daily volumetric moisture content in CT#2A (Station #10) measured manually by a Sentek Diviner 2000.

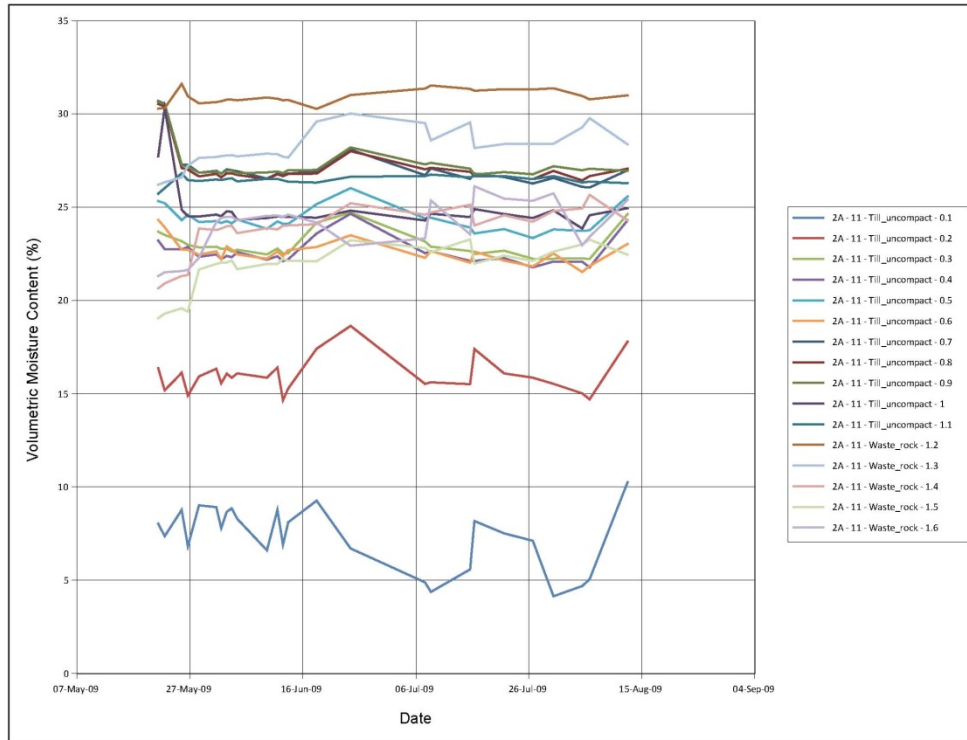


Figure 88: Daily volumetric moisture content in CT#2A (Station #11) measured manually by a Sentek Diviner 2000.

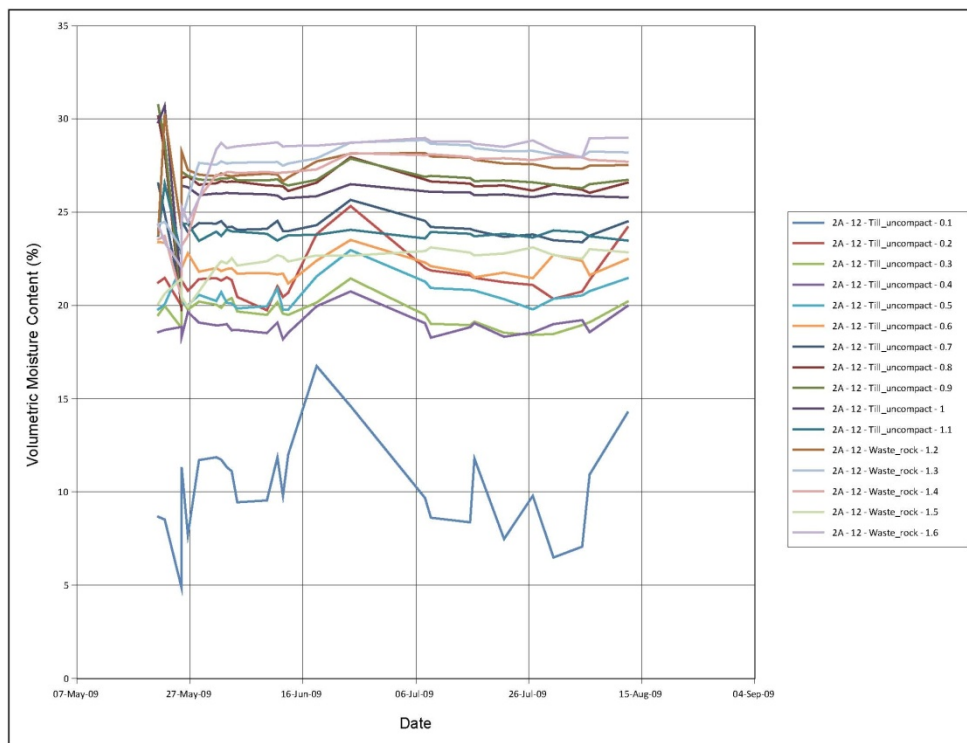


Figure 89: Daily volumetric moisture content in CT#2A (Station #12) measured manually by a Sentek Diviner 2000.

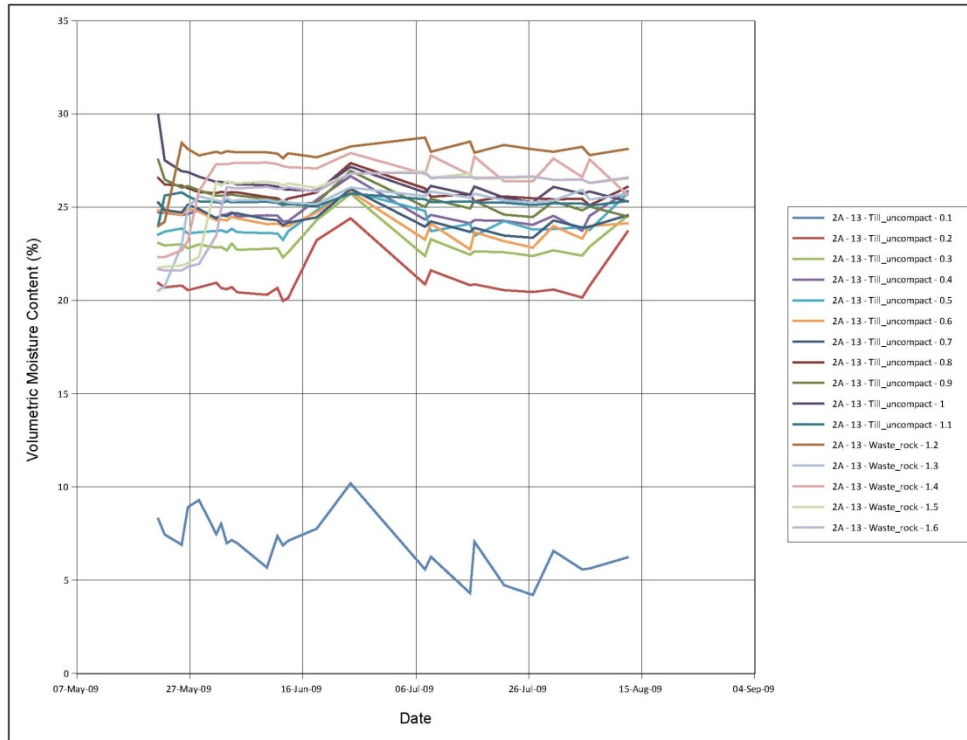


Figure 90: Daily volumetric moisture content in CT#2A (Station #13) measured manually by a Sentek Diviner 2000.

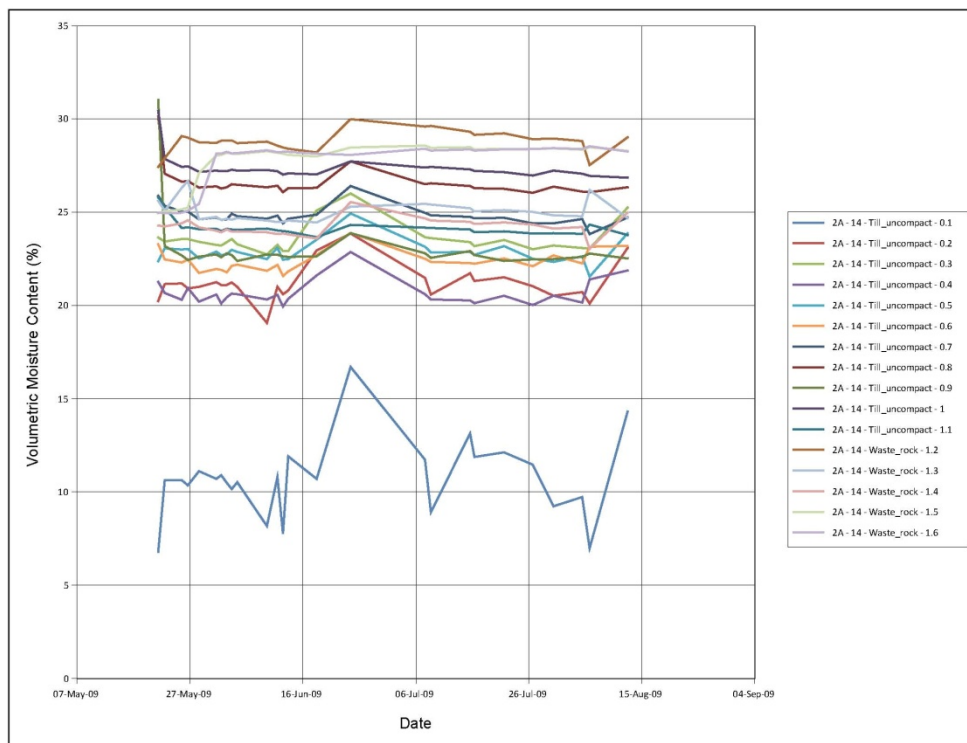


Figure 91: Daily volumetric moisture content in CT#2A (Station #14) measured manually by a Sentek Diviner 2000.

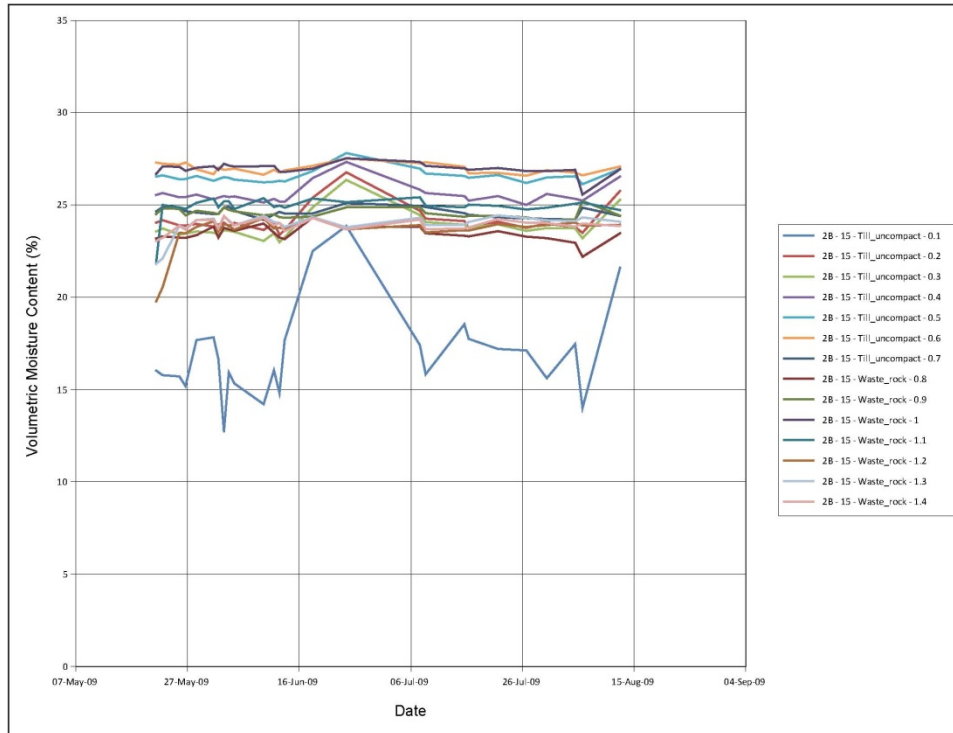


Figure 92: Daily volumetric moisture content in CT#2B (Station #15) measured manually by a Sentek Diviner 2000.

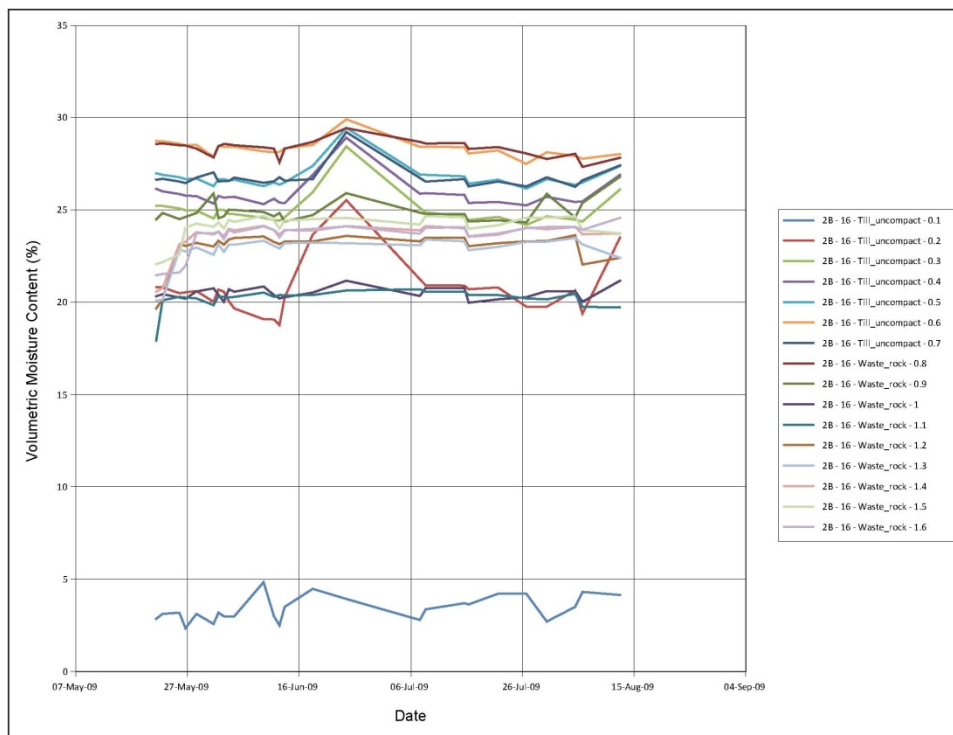


Figure 93: Daily volumetric moisture content in CT#2B (Station #16) measured manually by a Sentek Diviner 2000.

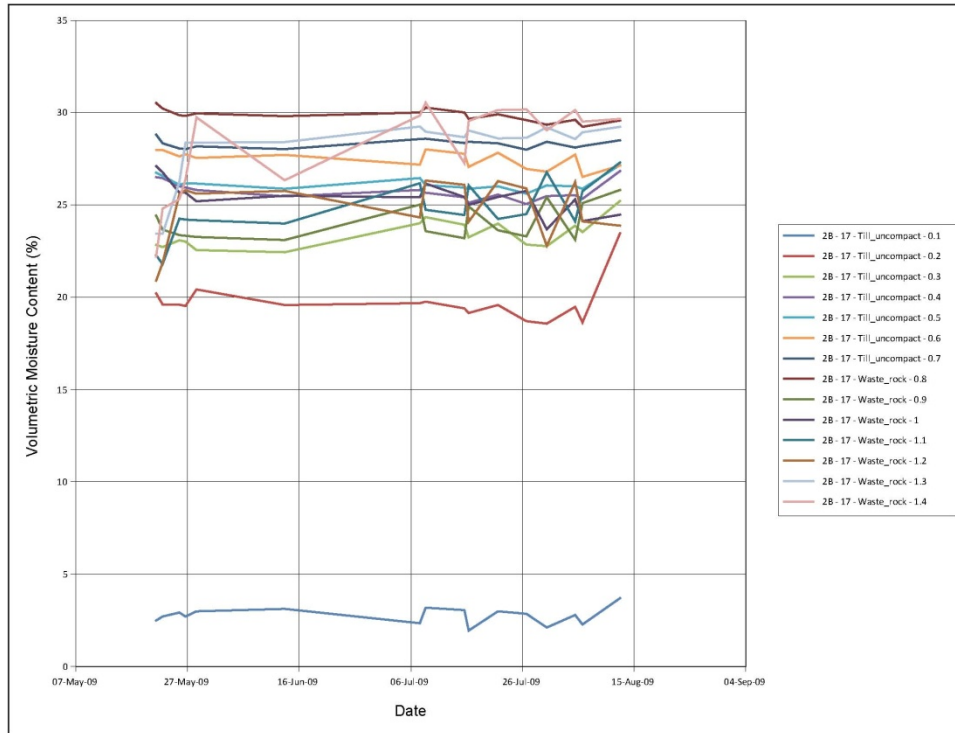


Figure 94: Daily volumetric moisture content in CT#2B (Station #17) measured manually by a Sentek Diviner 2000.

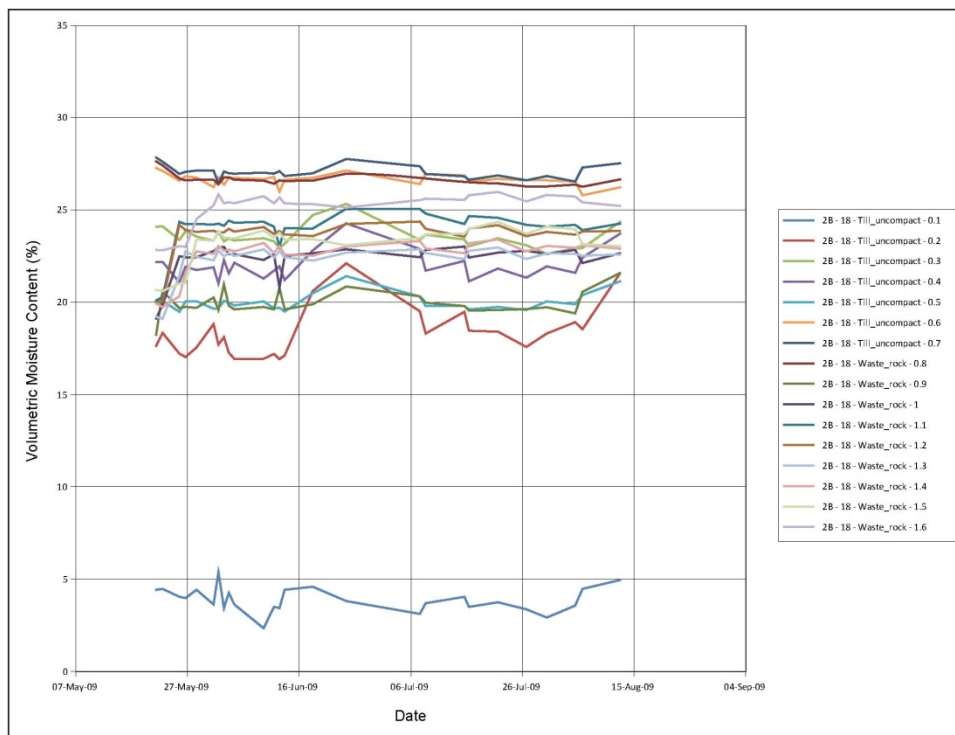


Figure 95: Daily volumetric moisture content in CT#2B (Station #18) measured manually by a Sentek Diviner 2000.

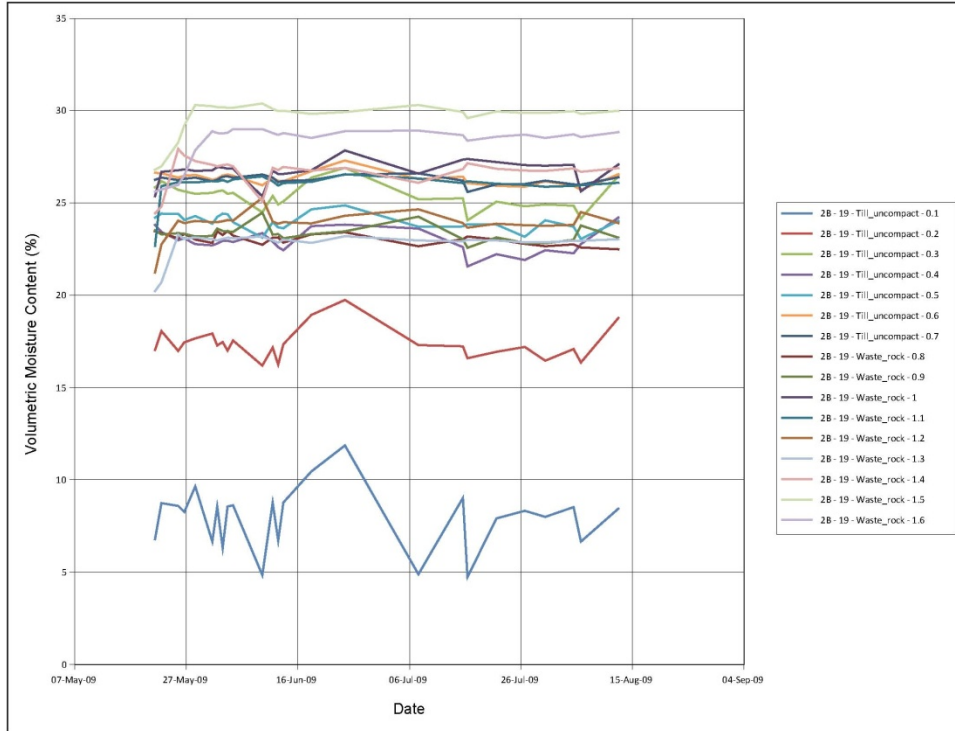


Figure 96: Daily volumetric moisture content in CT#2B (Station #19) measured manually by a Sentek Diviner 2000.

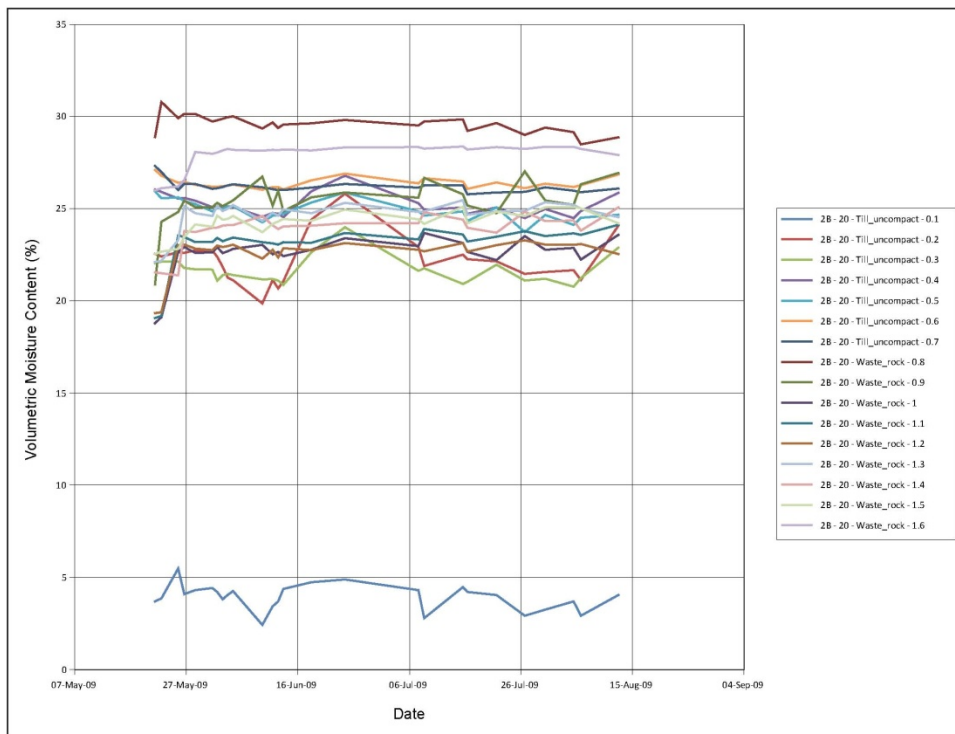


Figure 97: Daily volumetric moisture content in CT#2B (Station #20) measured manually by a Sentek Diviner 2000.

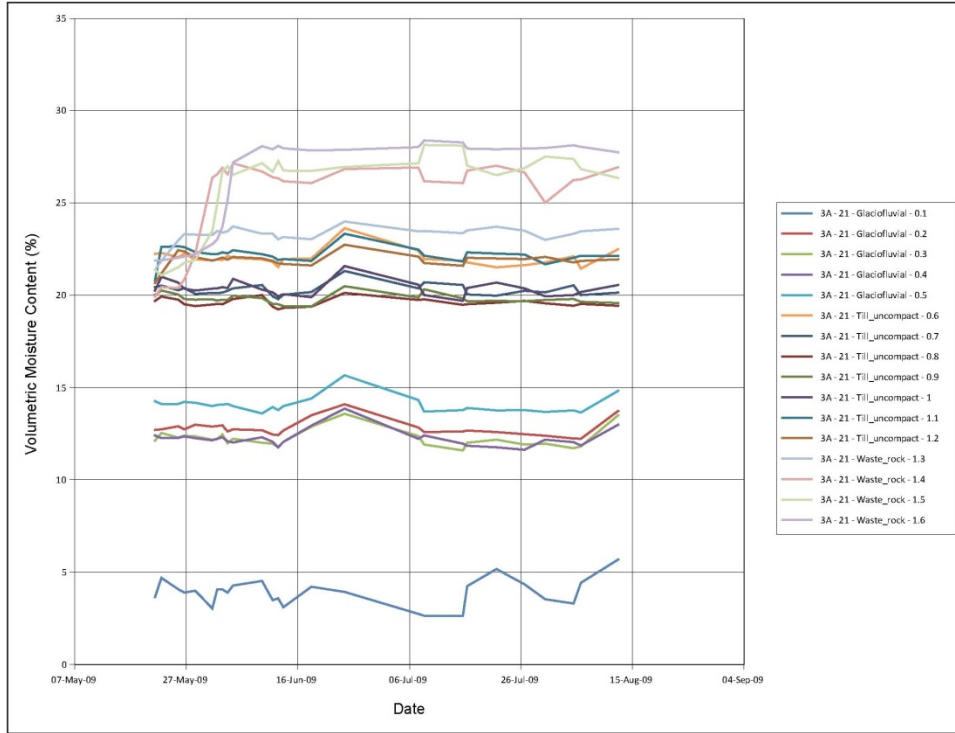


Figure 98: Daily volumetric moisture content in CT#3A (Station #21) measured manually by a Sentek Diviner 2000.

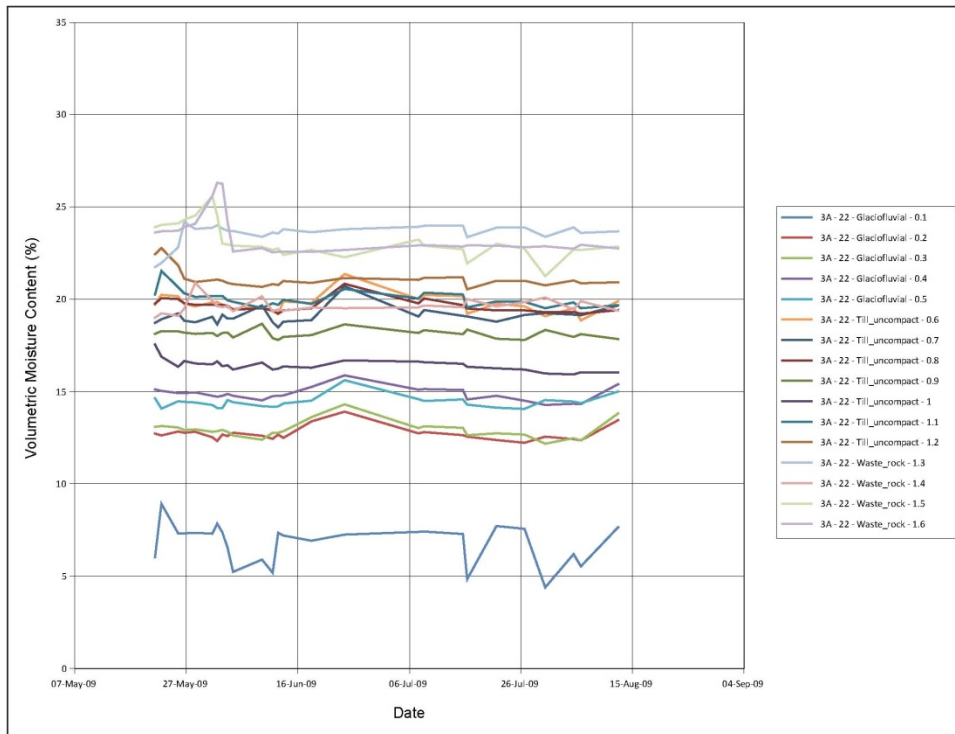


Figure 99: Daily volumetric moisture content in CT#3A (Station #22) measured manually by a Sentek Diviner 2000.

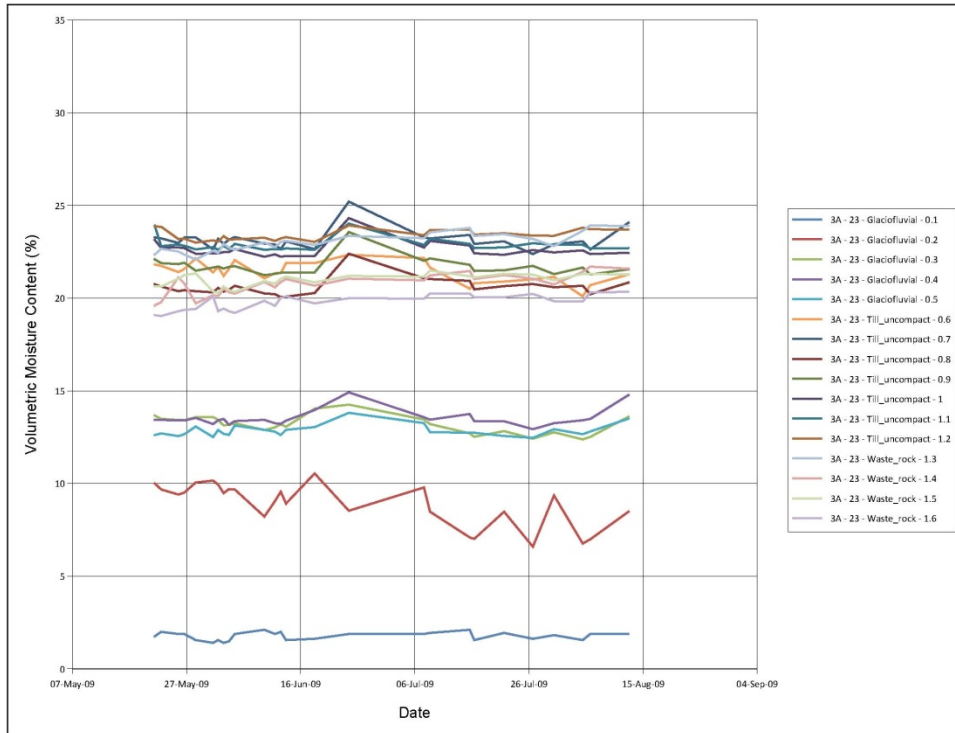


Figure 100: Daily volumetric moisture content in CT#3A (Station #23) measured manually by a Sentek Diviner 2000.

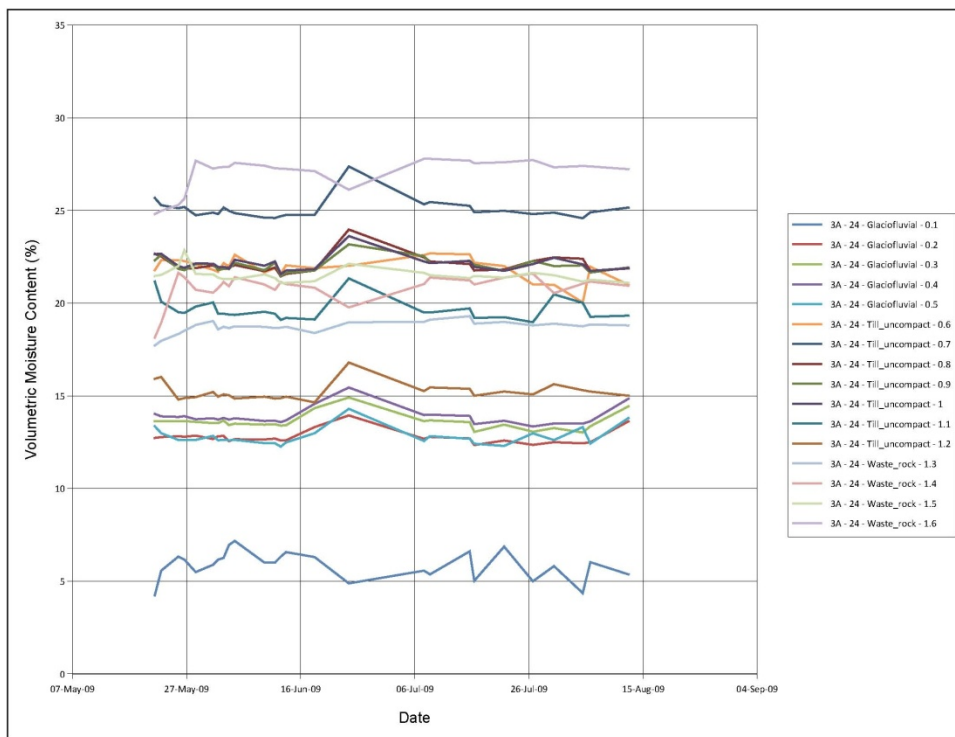


Figure 101: Daily volumetric moisture content in CT#3A (Station #24) measured manually by a Sentek Diviner 2000.

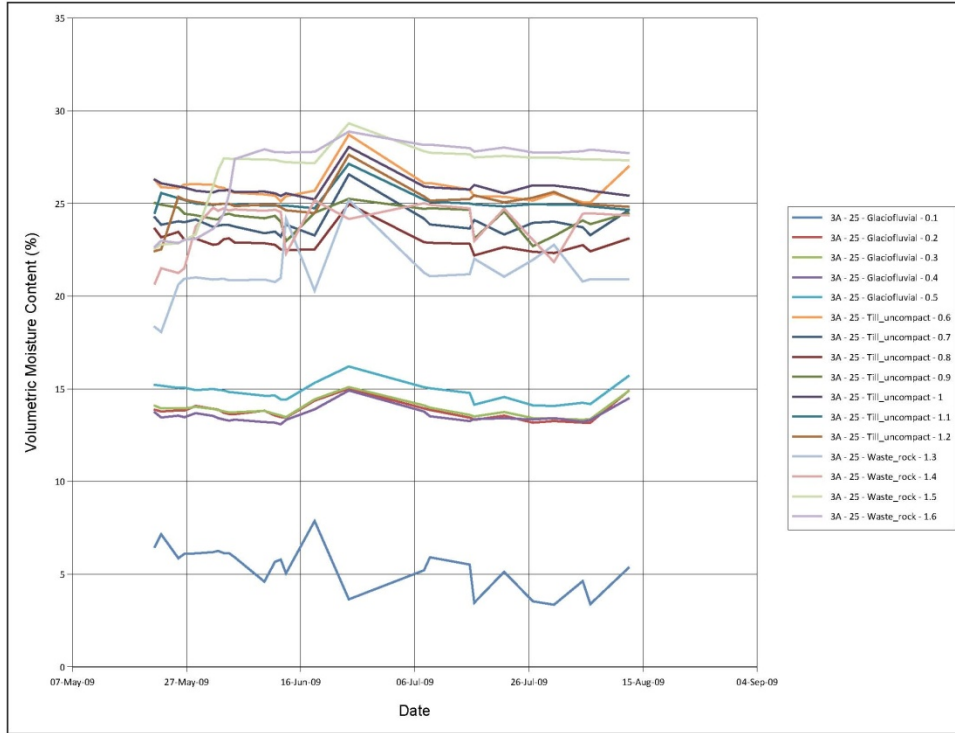


Figure 102: Daily volumetric moisture content in CT#3A (Station #25) measured manually by a Sentek Diviner 2000.

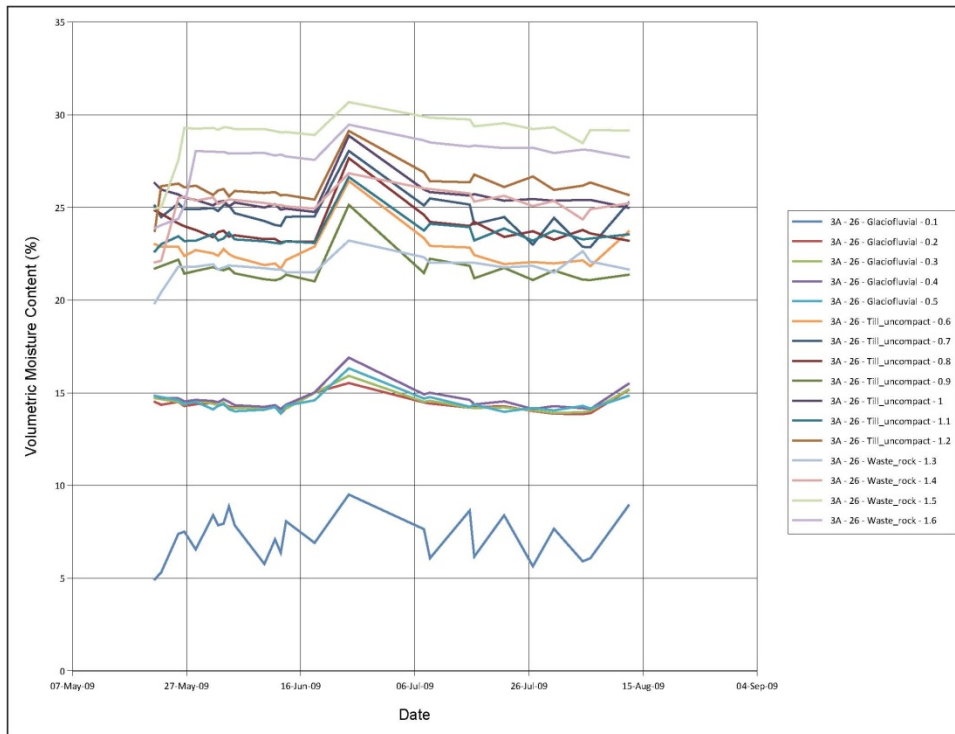


Figure 103: Daily volumetric moisture content in CT#3A (Station #26) measured manually by a Sentek Diviner 2000.

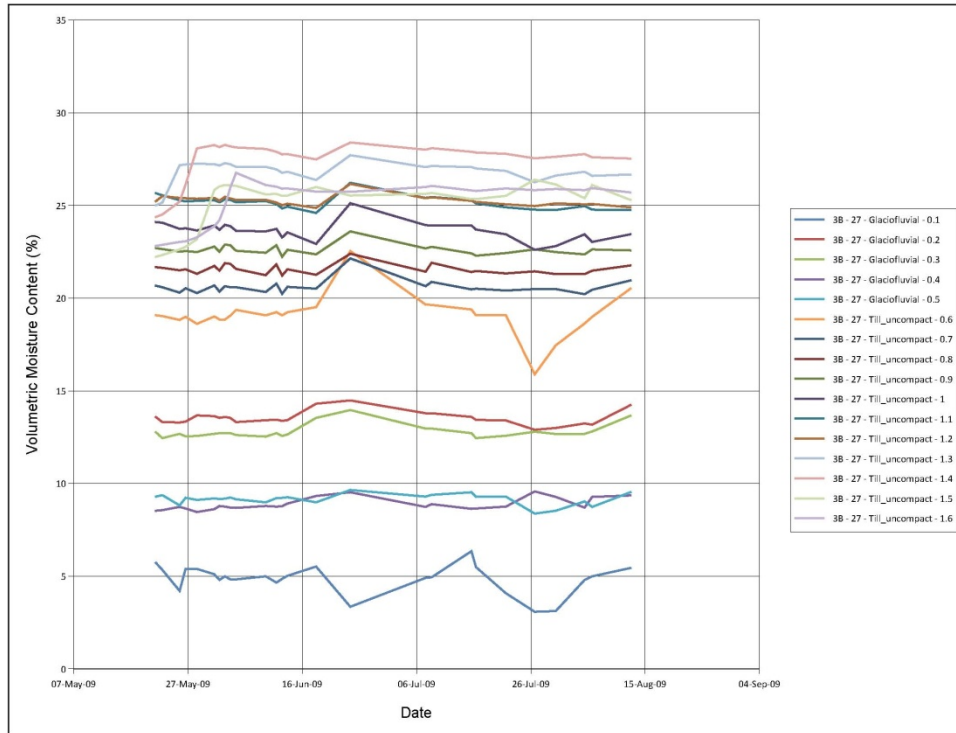


Figure 104: Daily volumetric moisture content in CT#3B (Station #27) measured manually by a Sentek Diviner 2000.

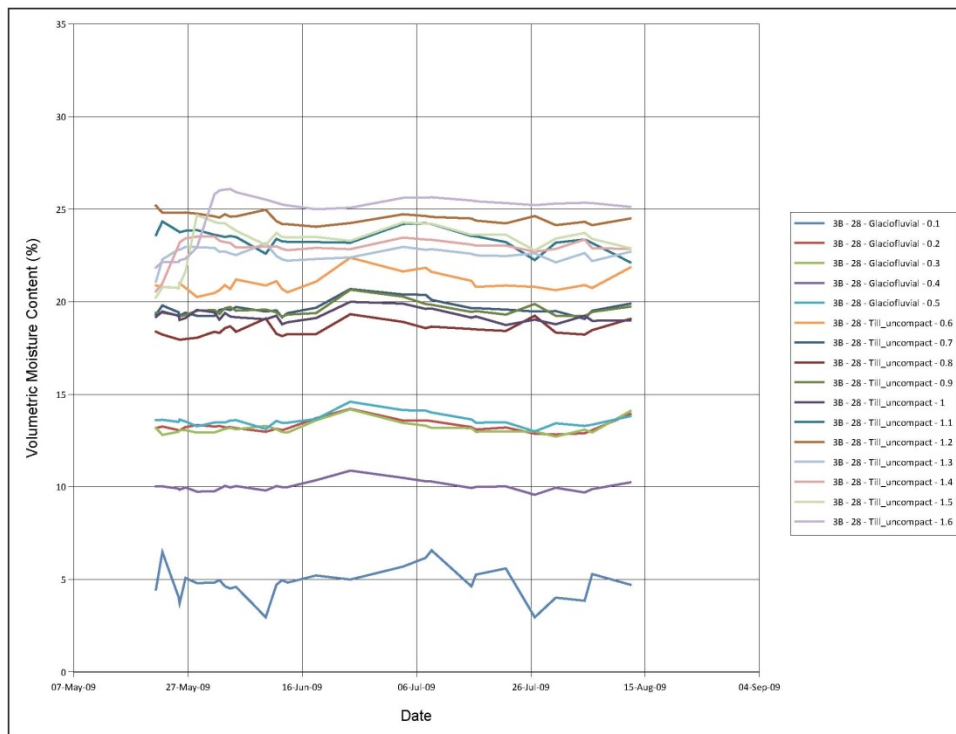


Figure 105: Daily volumetric moisture content in CT#3B (Station #28) measured manually by a Sentek Diviner 2000.

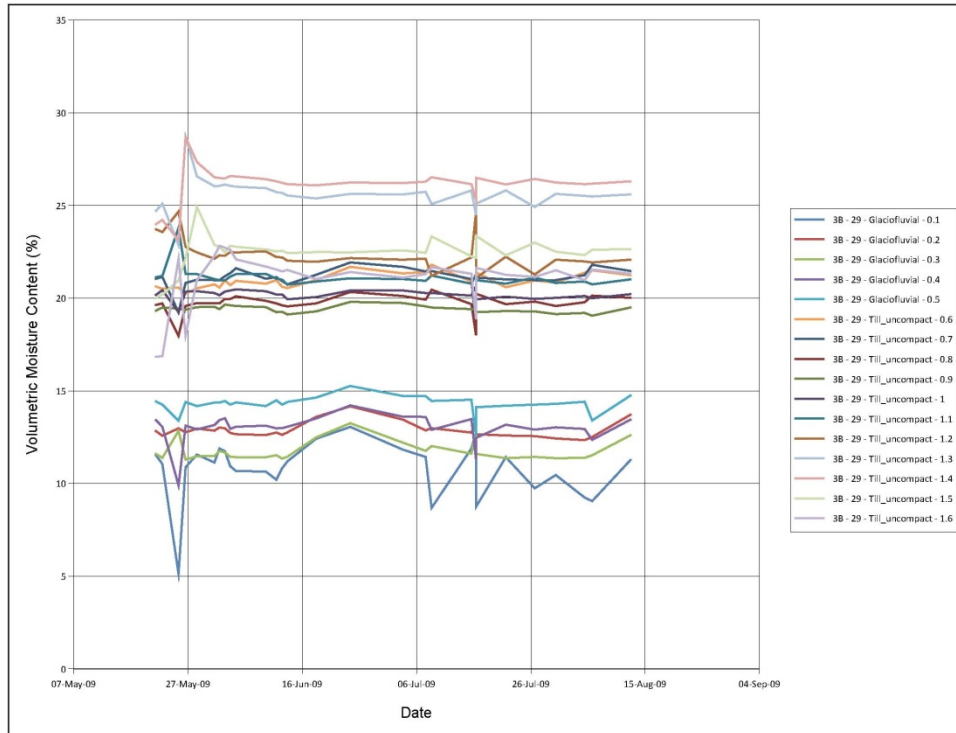


Figure 106: Daily volumetric moisture content in CT#3B (Station #29) measured manually by a Sentek Diviner 2000.

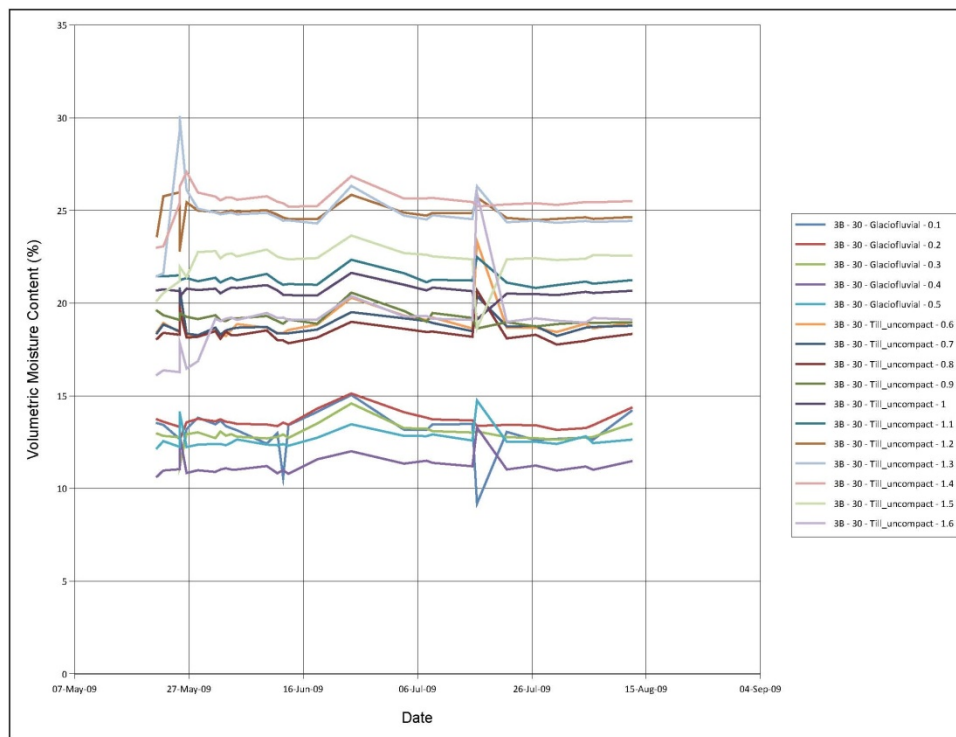


Figure 107: Daily volumetric moisture content in CT#3B (Station #30) measured manually by a Sentek Diviner 2000.

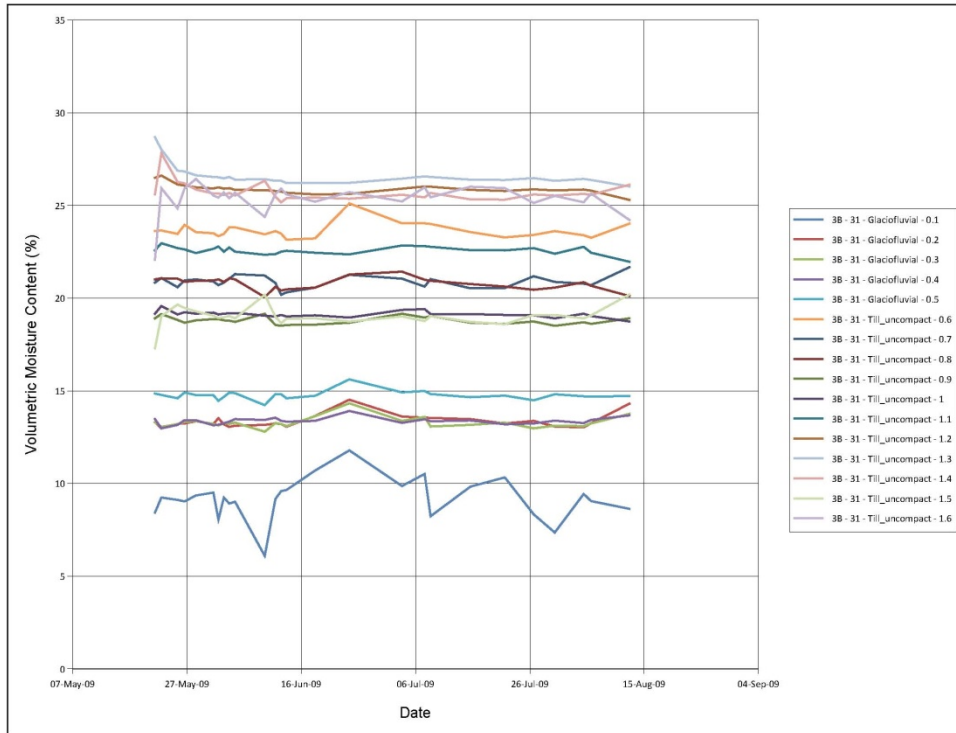


Figure 108: Daily volumetric moisture content in CT#3B (Station #31) measured manually by a Sentek Diviner 2000.

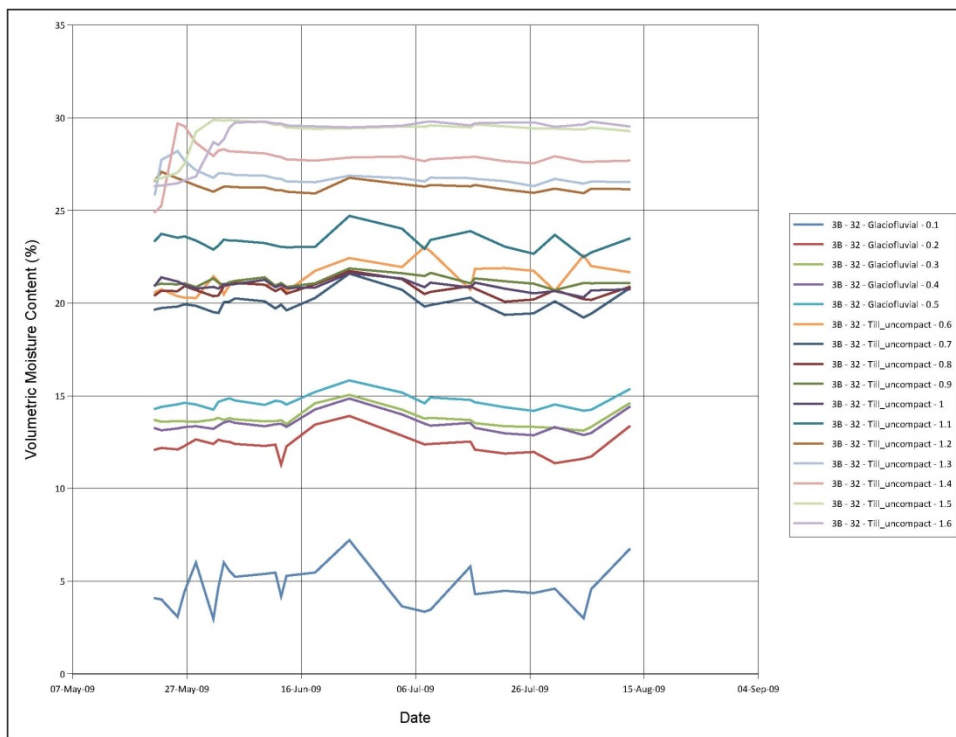


Figure 109: Daily volumetric moisture content in CT#3B (Station #32) measured manually by a Sentek Diviner 2000.

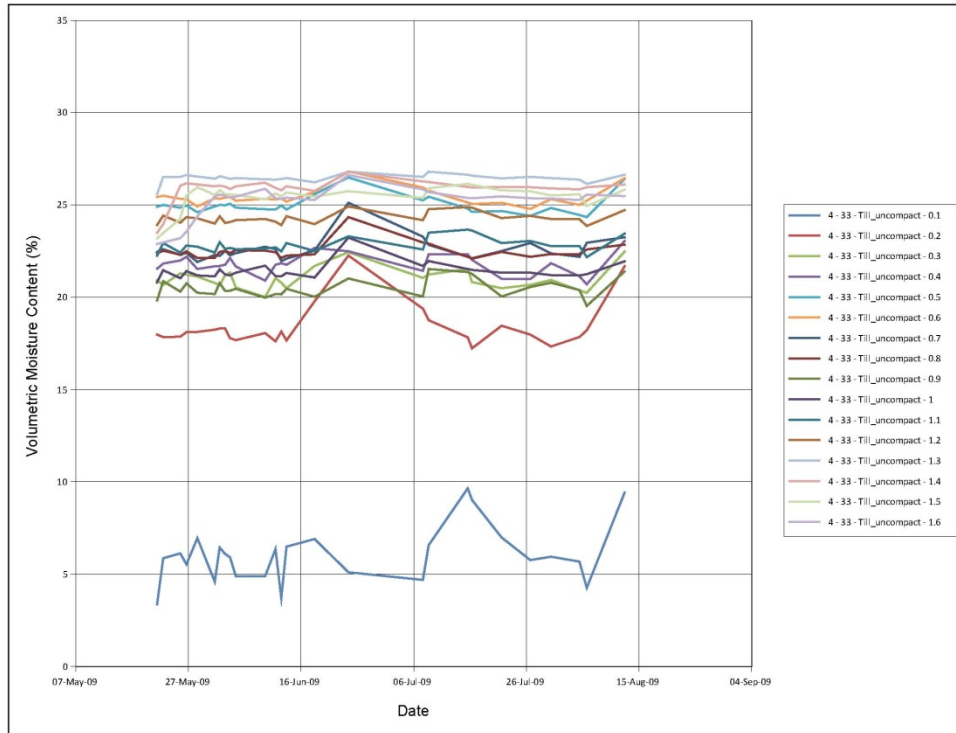


Figure 110: Daily volumetric moisture content in CT#4 (Station #33) measured manually by a Sentek Diviner 2000.

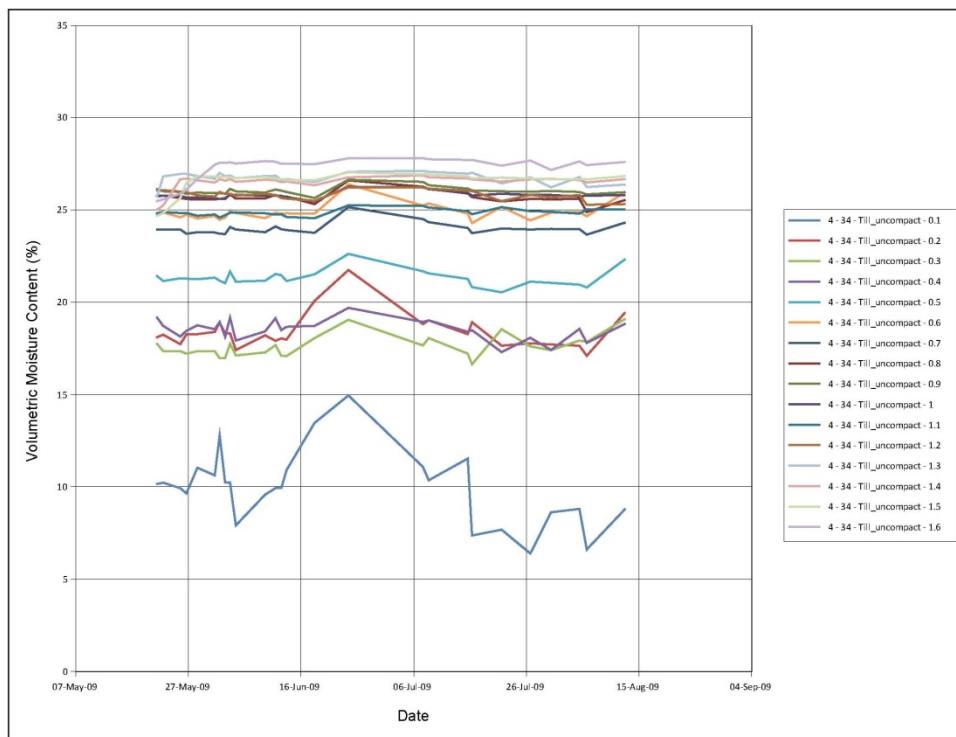


Figure 111: Daily volumetric moisture content in CT#4 (Station #34) measured manually by a Sentek Diviner 2000.

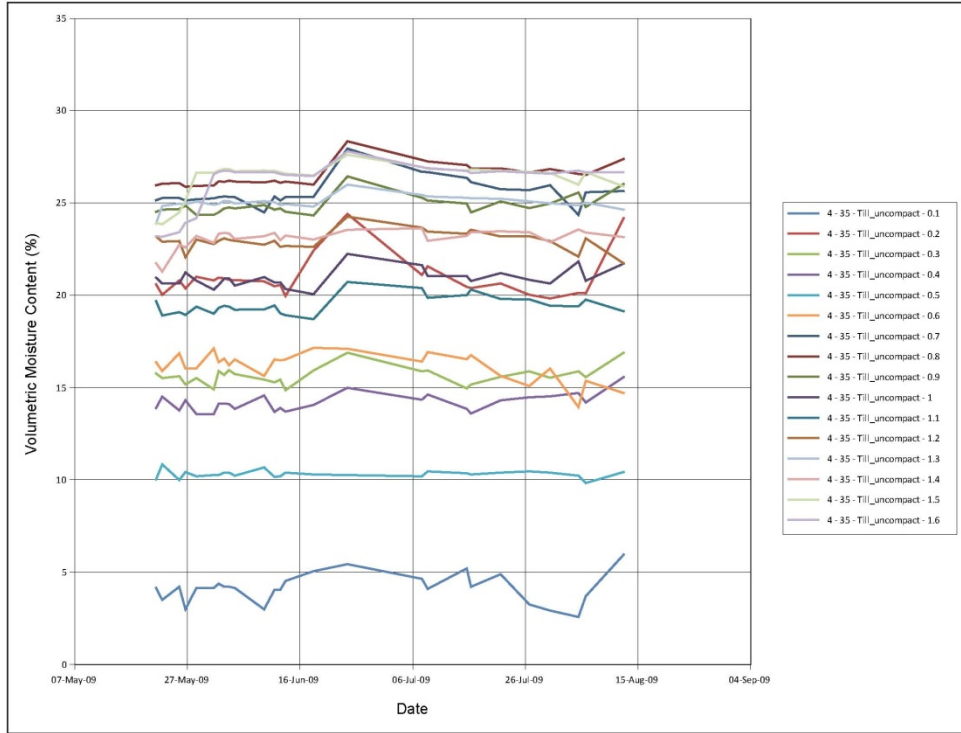


Figure 112: Daily volumetric moisture content in CT#4 (Station #35) measured manually by a Sentek Diviner 2000.

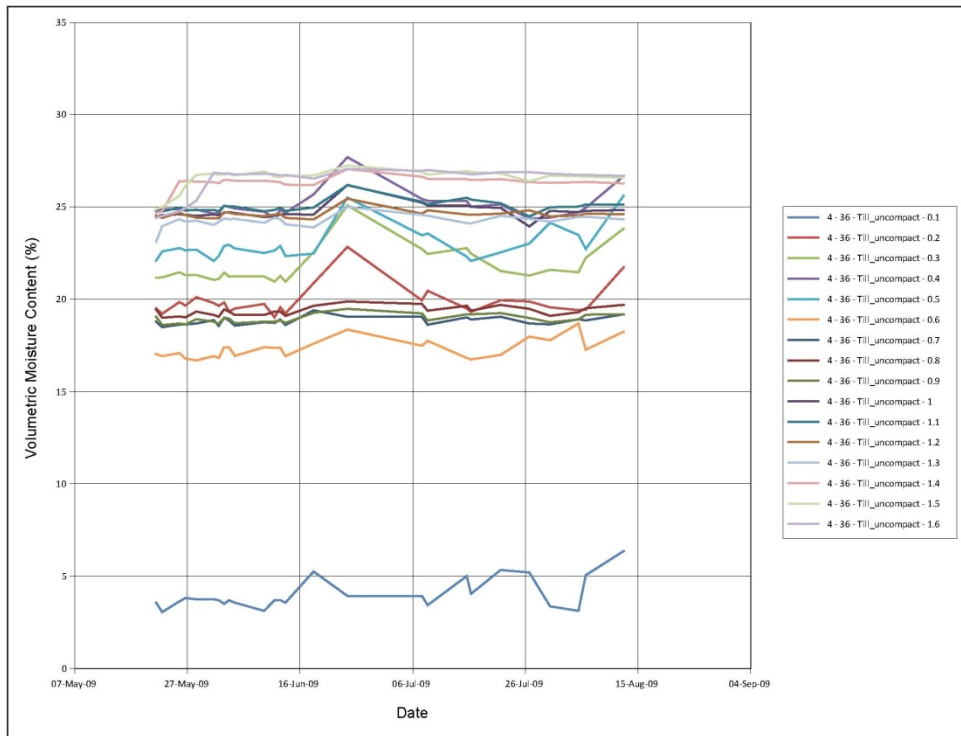


Figure 113: Daily volumetric moisture content in CT#4 (Station #36) measured manually by a Sentek Diviner 2000.

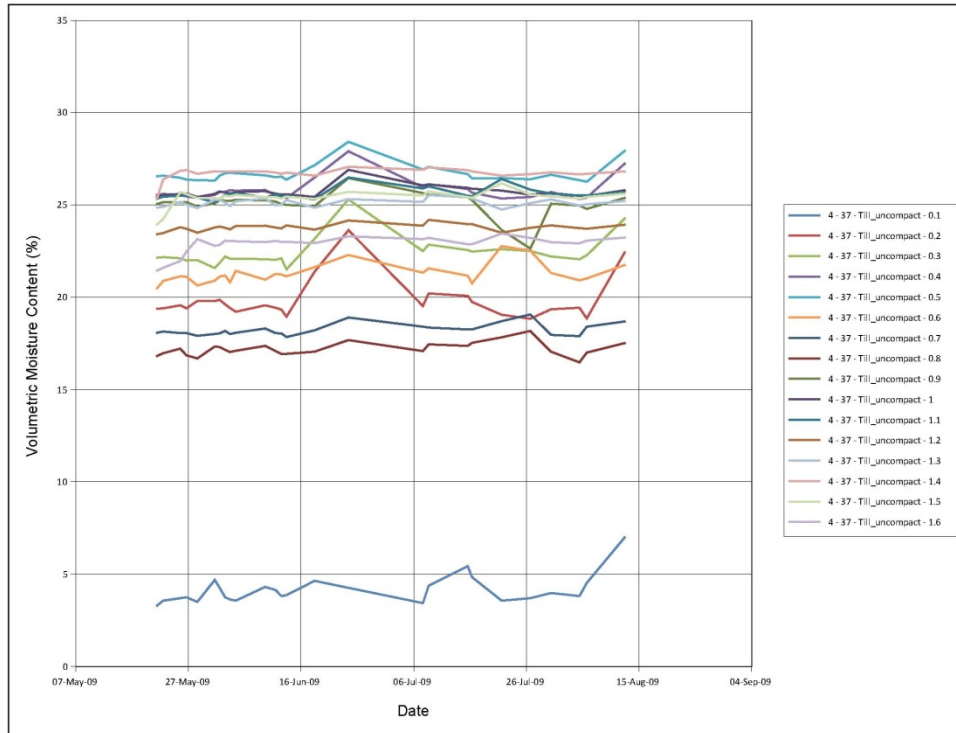


Figure 114: Daily volumetric moisture content in CT#4 (Station #37) measured manually by a Sentek Diviner 2000.

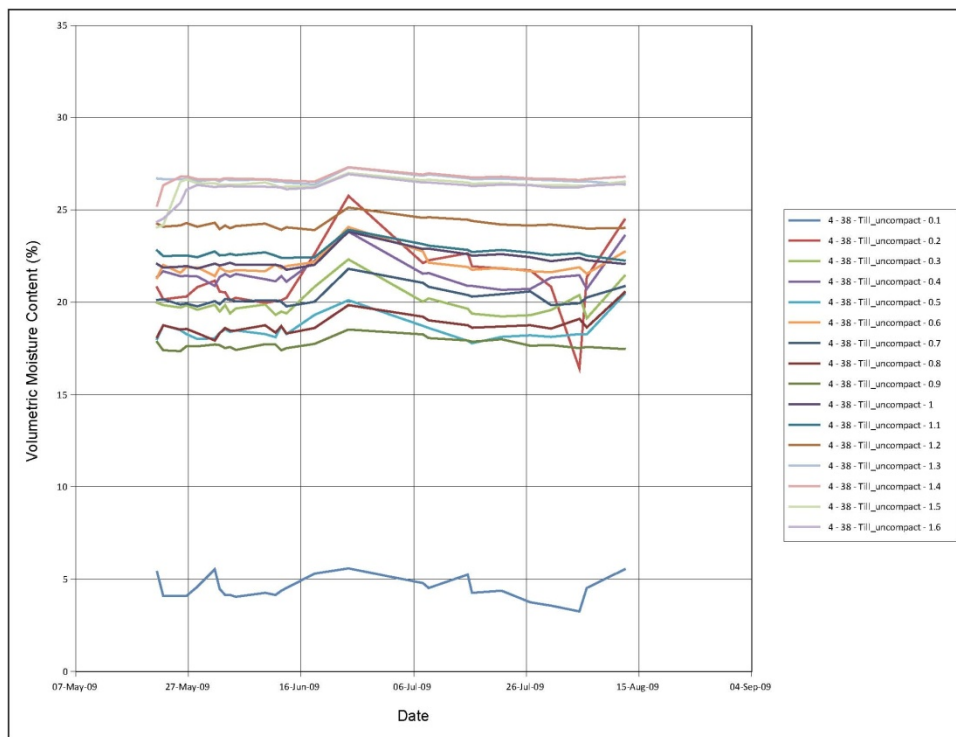


Figure 115: Daily volumetric moisture content in CT#4 (Station #38) measured manually by a Sentek Diviner 2000.

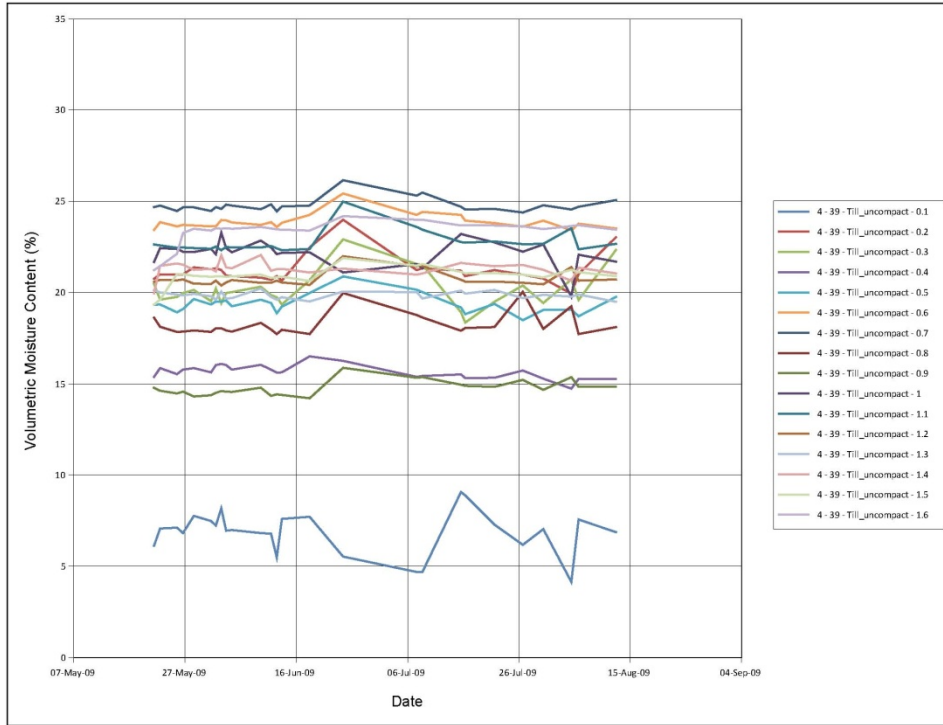


Figure 116: Daily volumetric moisture content in CT#4 (Station #39) measured manually by a Sentek Diviner 2000.

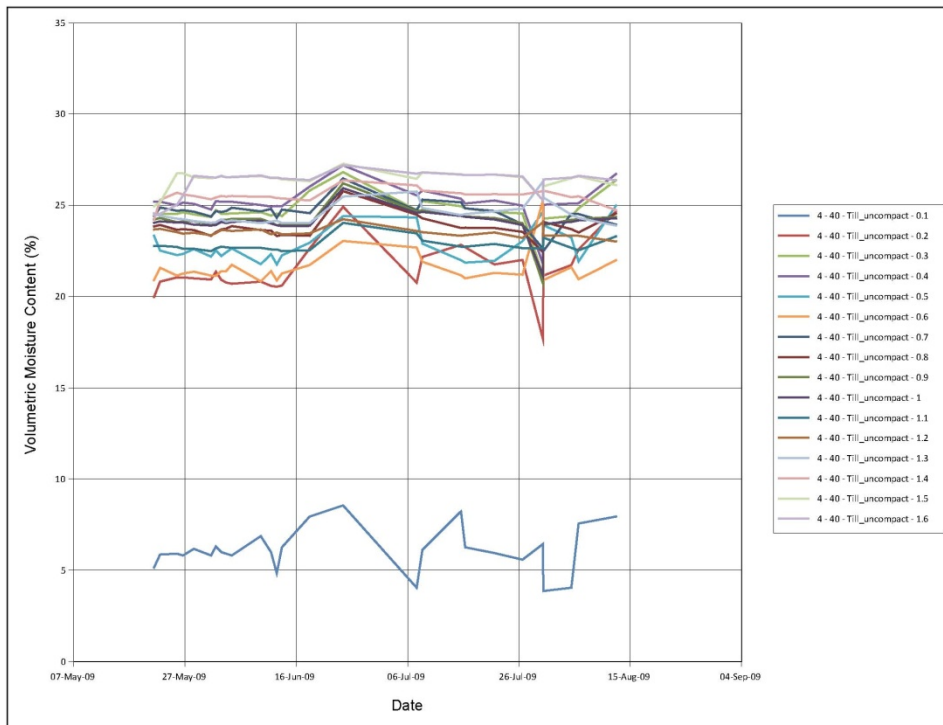


Figure 117: Daily volumetric moisture content in CT#4 (Station #40) measured manually by a Sentek Diviner 2000.

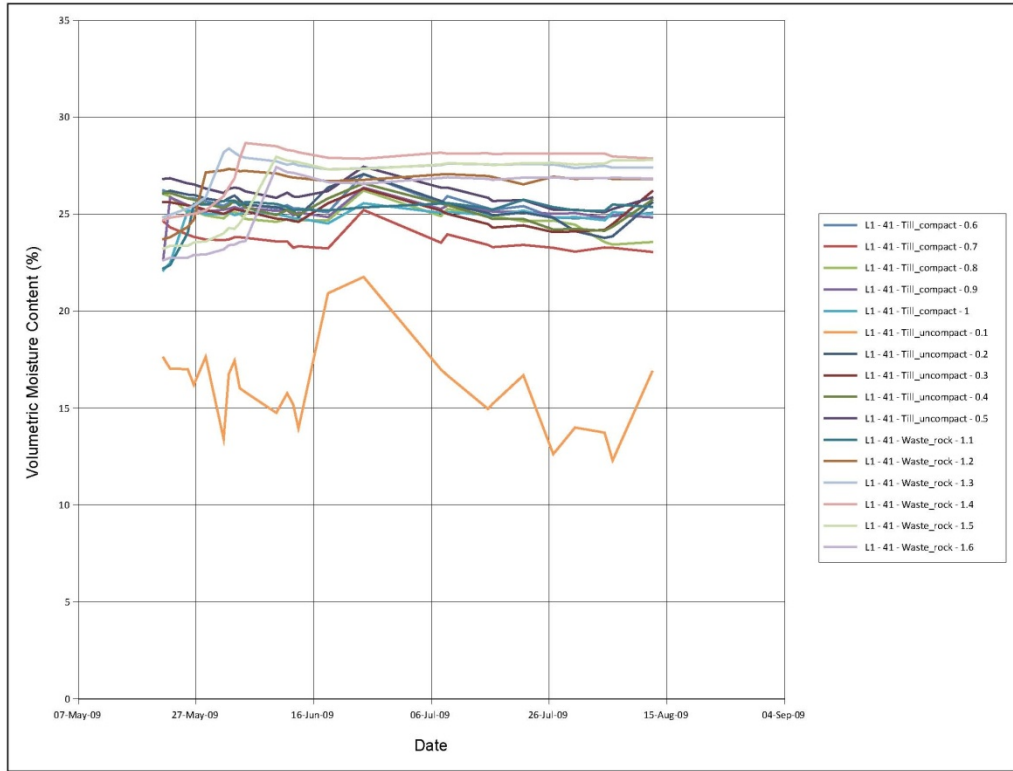


Figure 118: Daily volumetric moisture content in L#1 (Station #41) measured manually by a Sentek Diviner 2000.

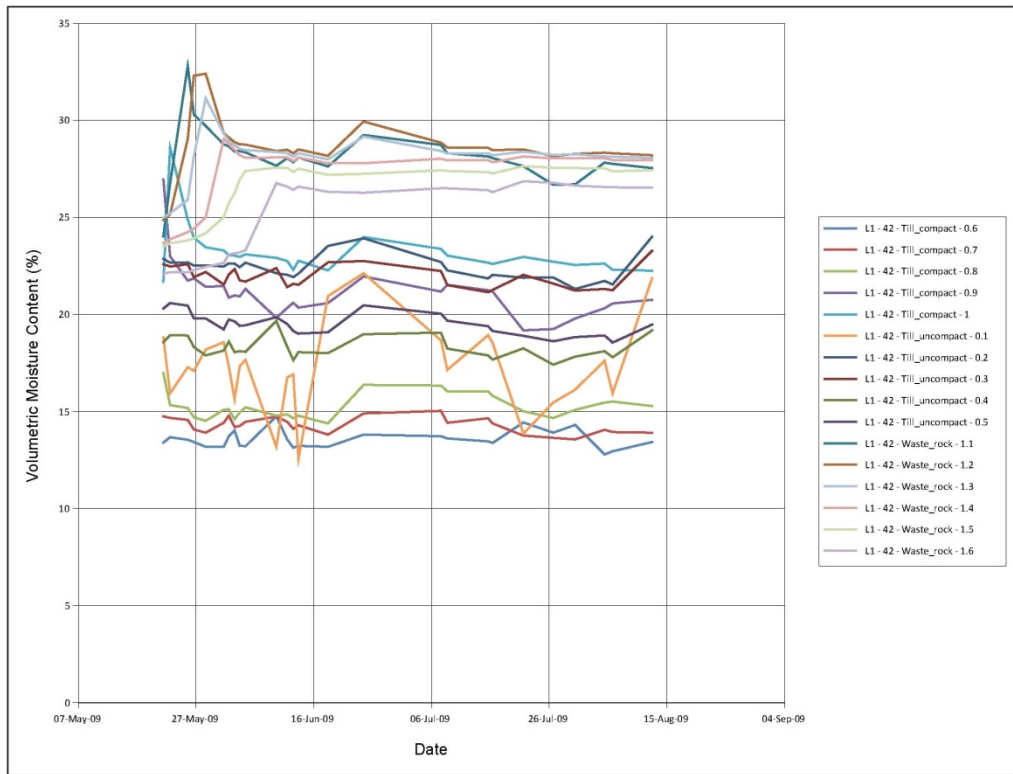


Figure 119: Daily volumetric moisture content in L#1 (Station #42) measured manually by a Sentek Diviner 2000.

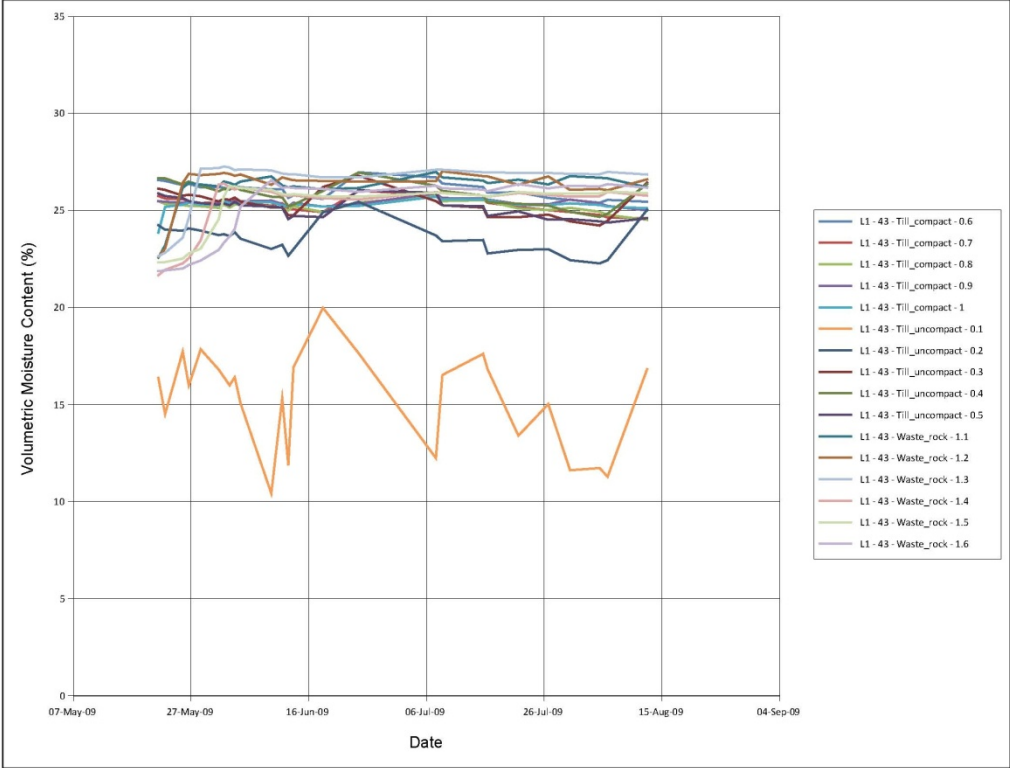


Figure 120: Daily volumetric moisture content in L#1 (Station #43) measured manually by a Sentek Diviner 2000.

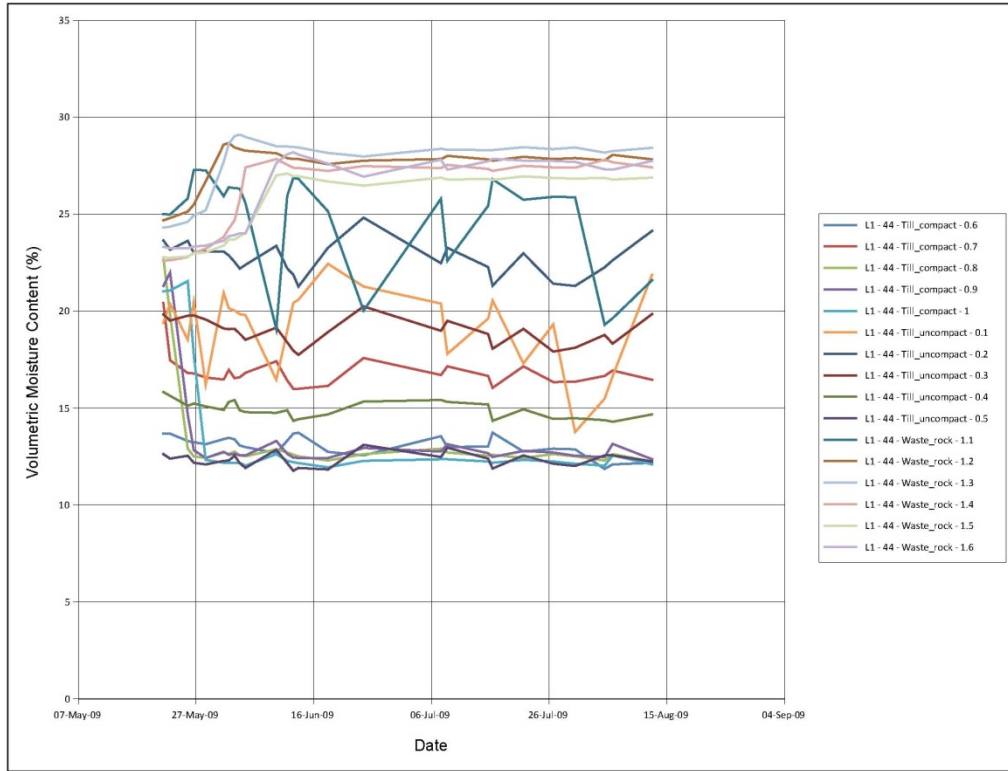


Figure 121: Daily volumetric moisture content in L#1 (Station #44) measured manually by a Sentek Diviner 2000.

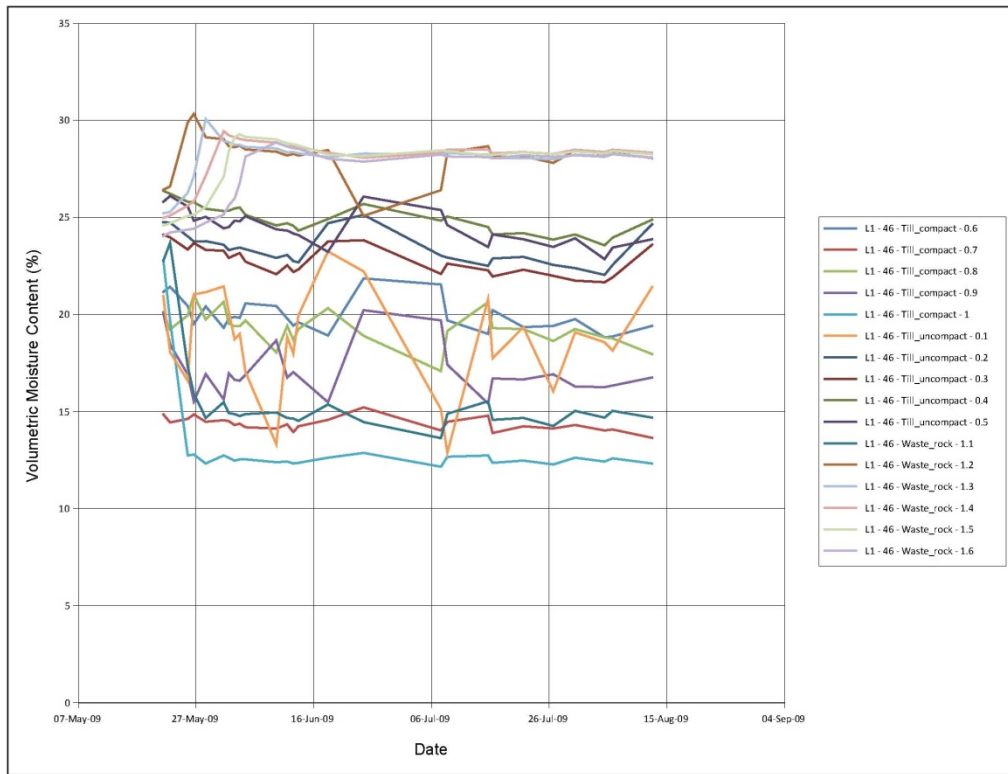


Figure 122: Daily volumetric moisture content in L#1 (Station #46) measured manually by a Sentek Diviner 2000.

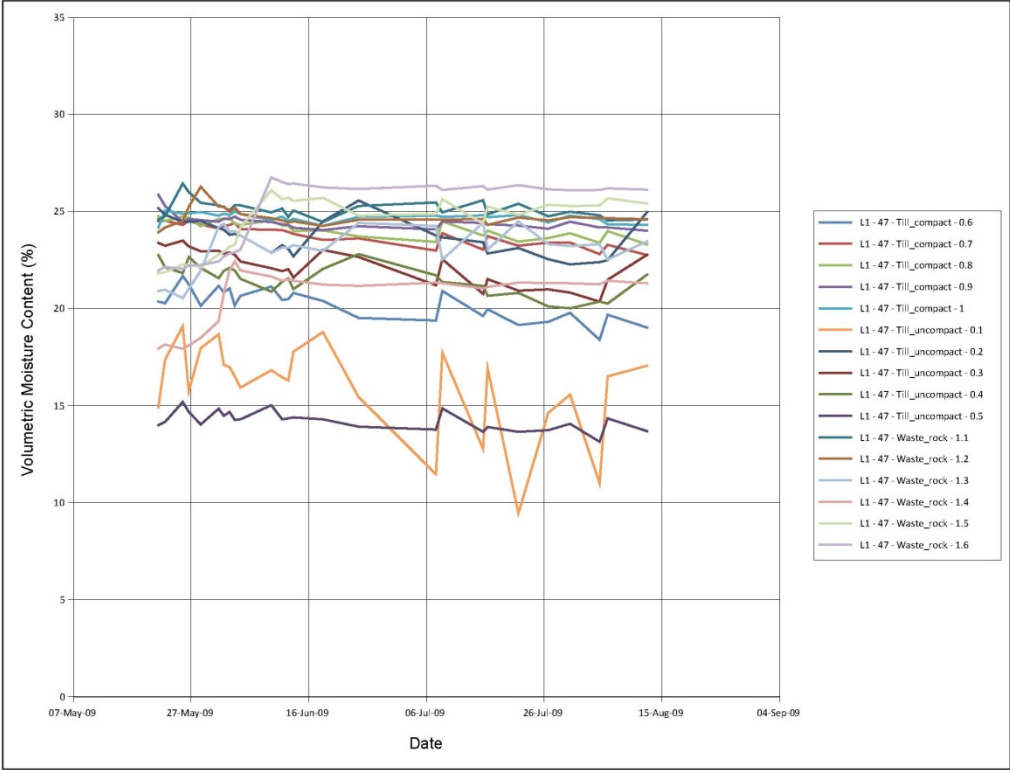


Figure 123: Daily volumetric moisture content in L#1 (Station #47) measured manually by a Sentek Diviner 2000.

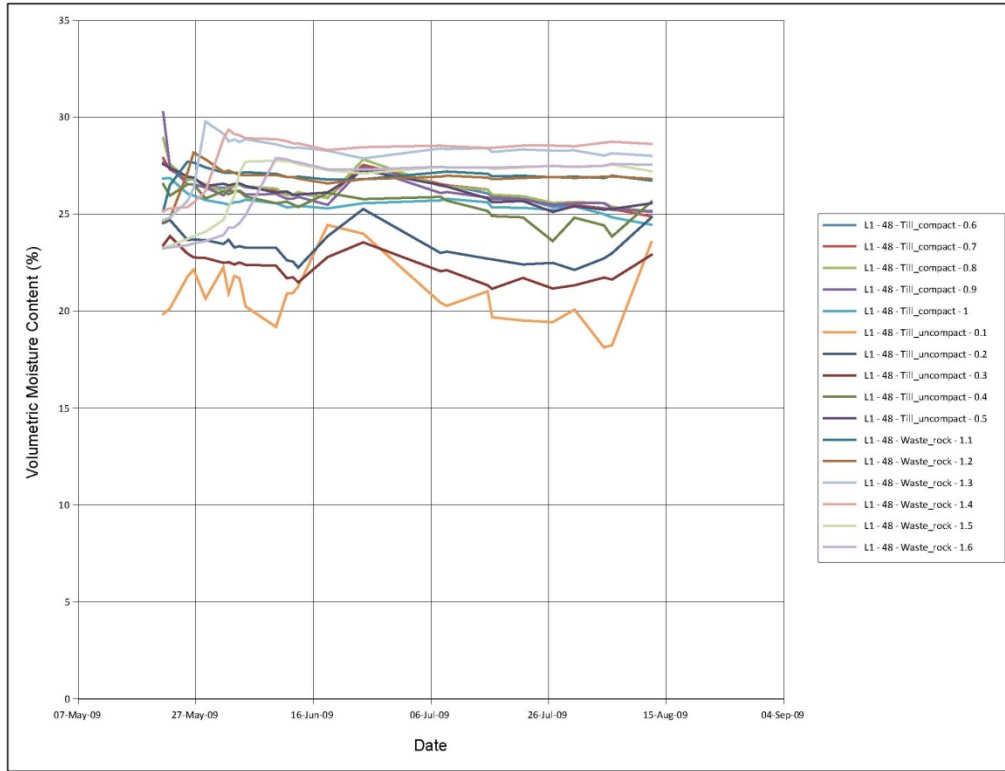


Figure 124: Daily volumetric moisture content in L#1 (Station #48) measured manually by a Sentek Diviner 2000.

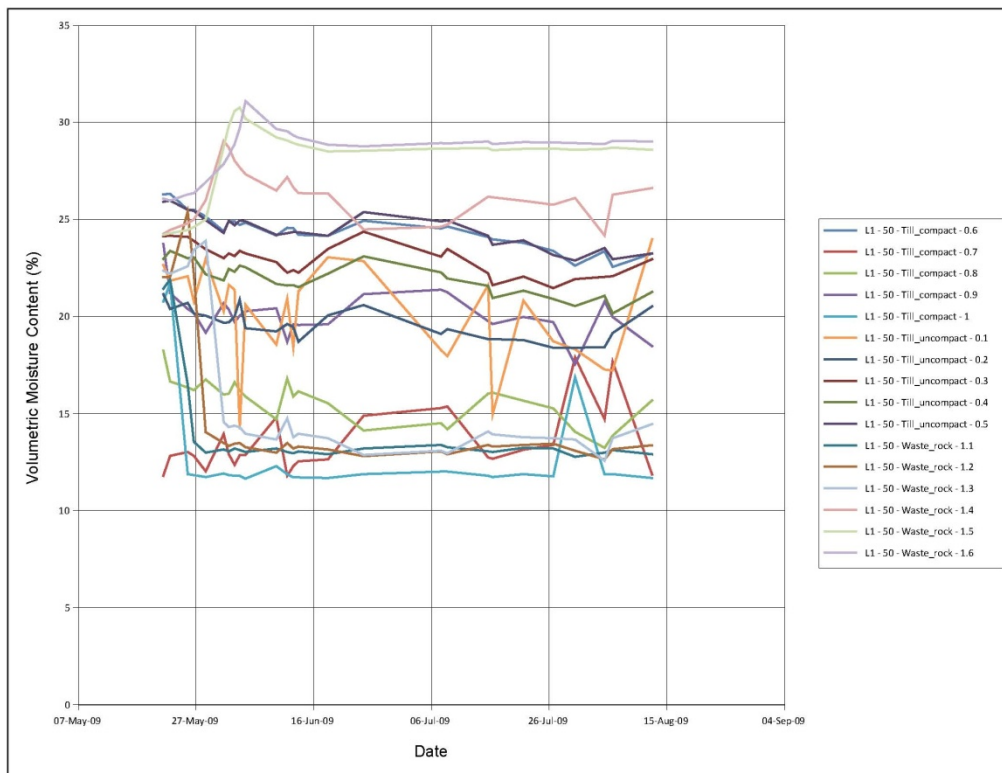


Figure 125: Daily volumetric moisture content in L#1 (Station #50) measured manually by a Sentek Diviner 2000.

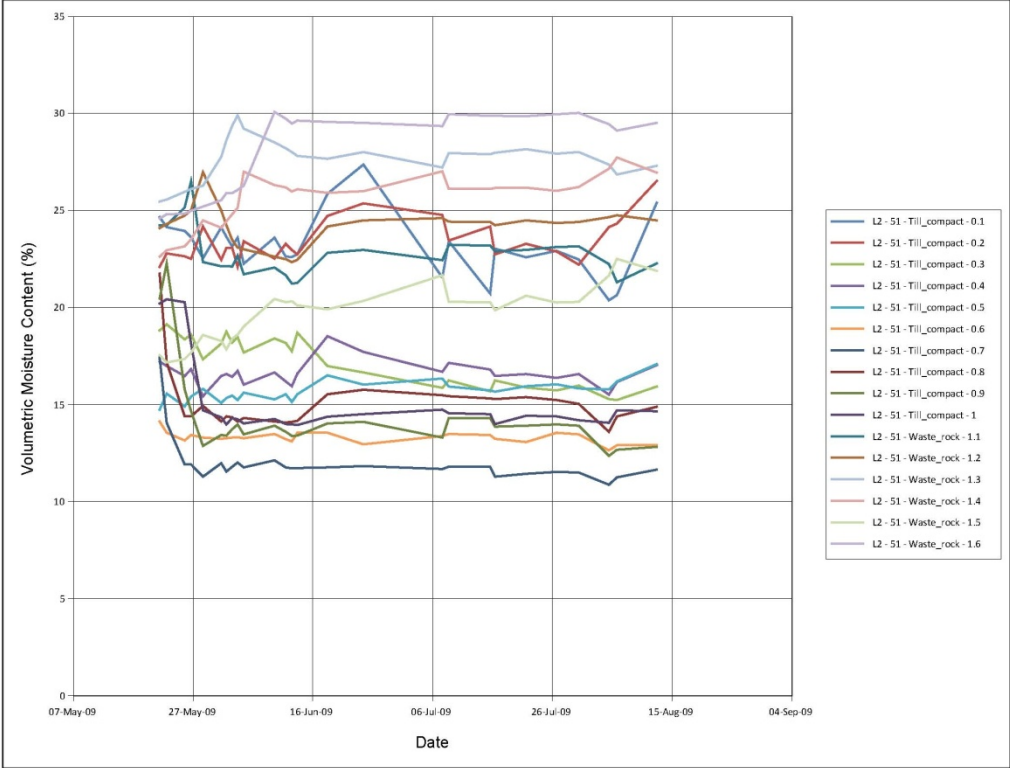


Figure 126: Daily volumetric moisture content in L#2 (Station #51) measured manually by a Sentek Diviner 2000.

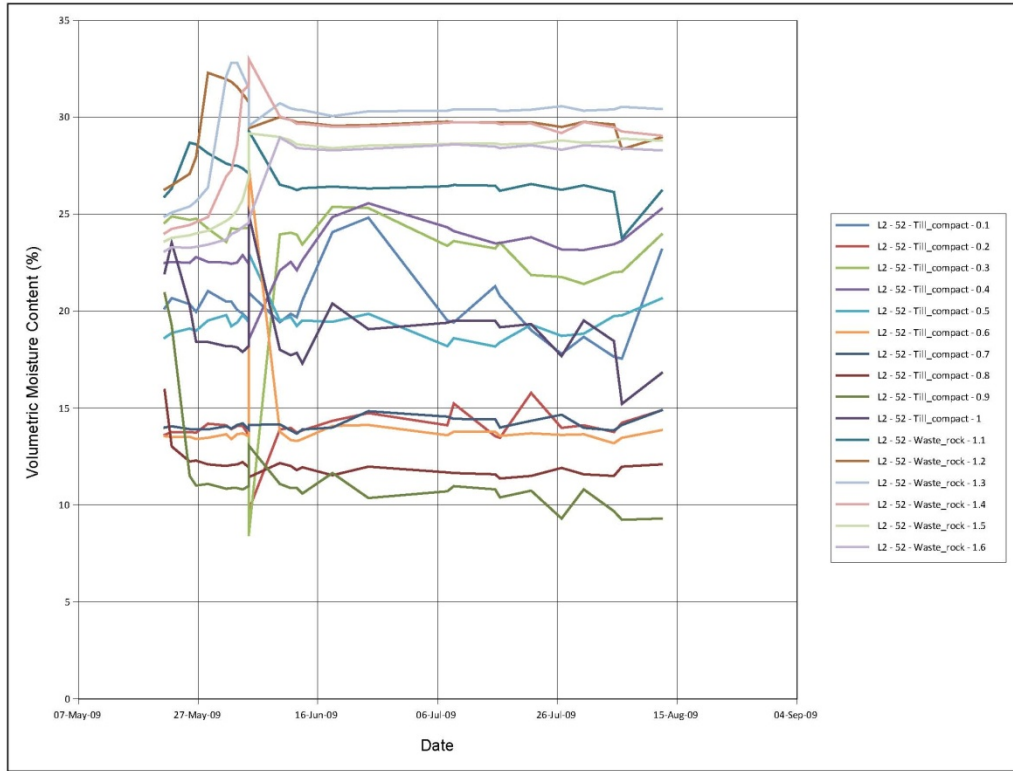


Figure 127: Daily volumetric moisture content in L#2 (Station #52) measured manually by a Sentek Diviner 2000.

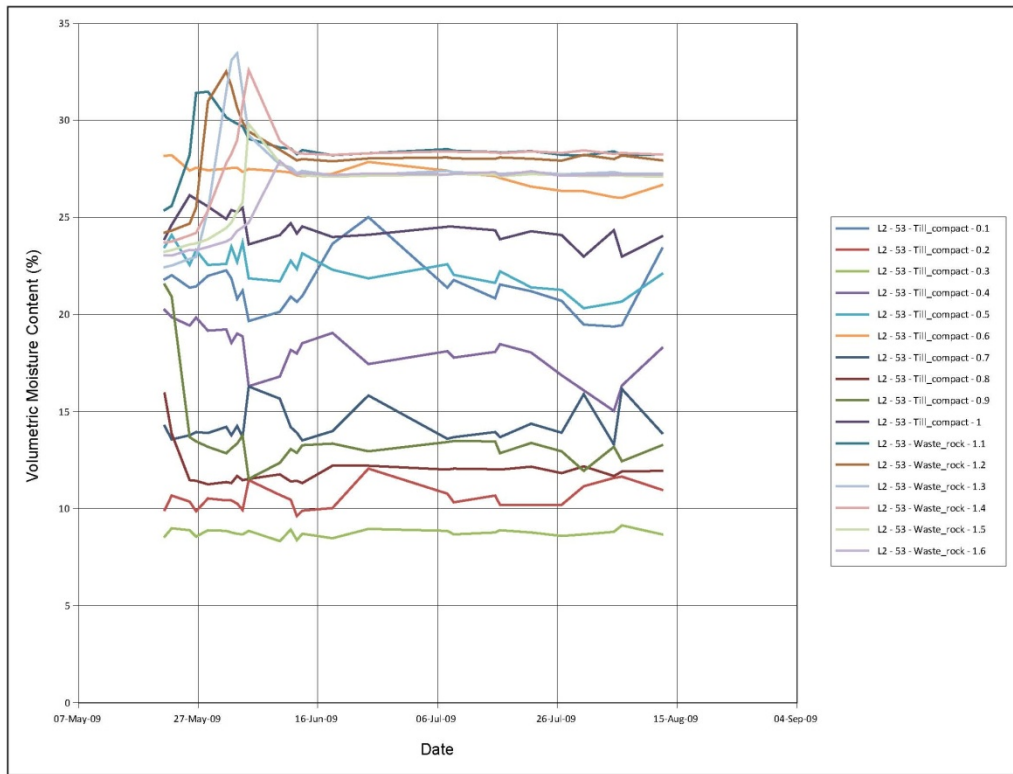


Figure 128: Daily volumetric moisture content in L#2 (Station #53) measured manually by a Sentek Diviner 2000.

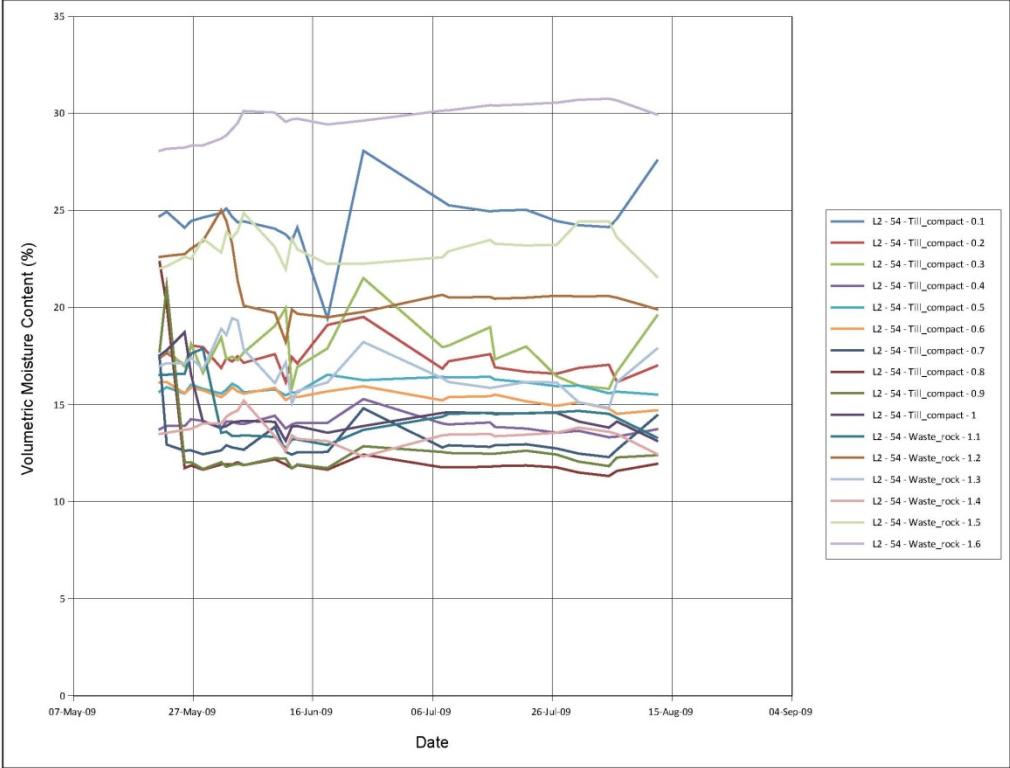


Figure 129: Daily volumetric moisture content in L#2 (Station #54) measured manually by a Sentek Diviner 2000.

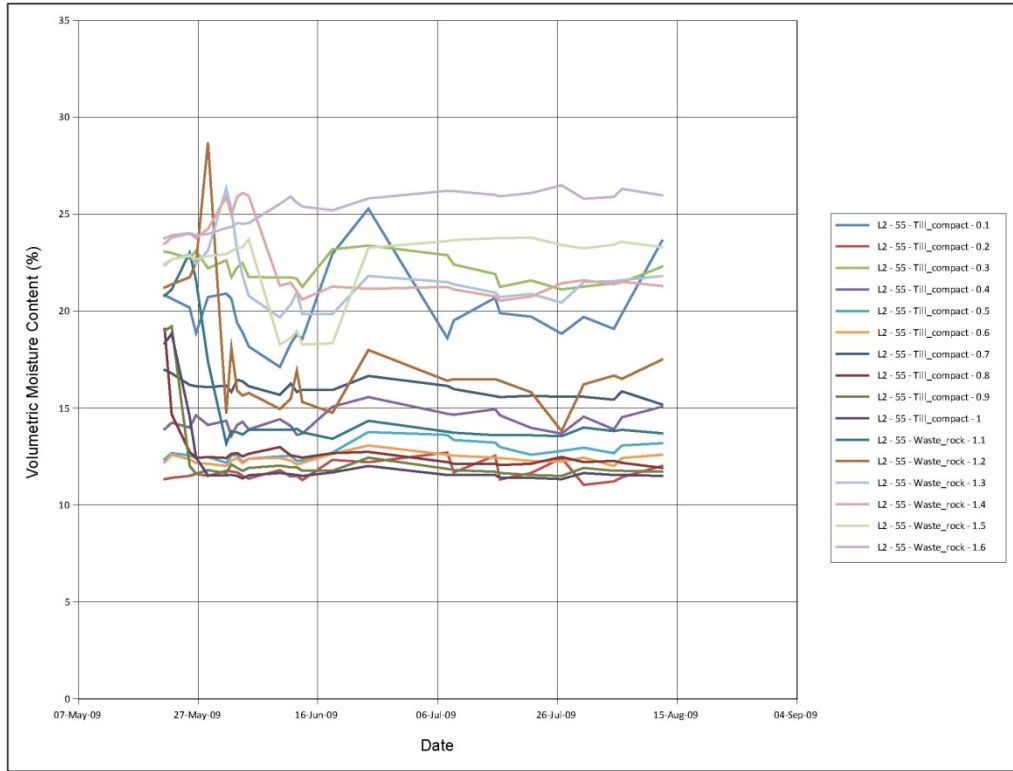


Figure 130: Daily volumetric moisture content in L#2 (Station #55) measured manually by a Sentek Diviner 2000.

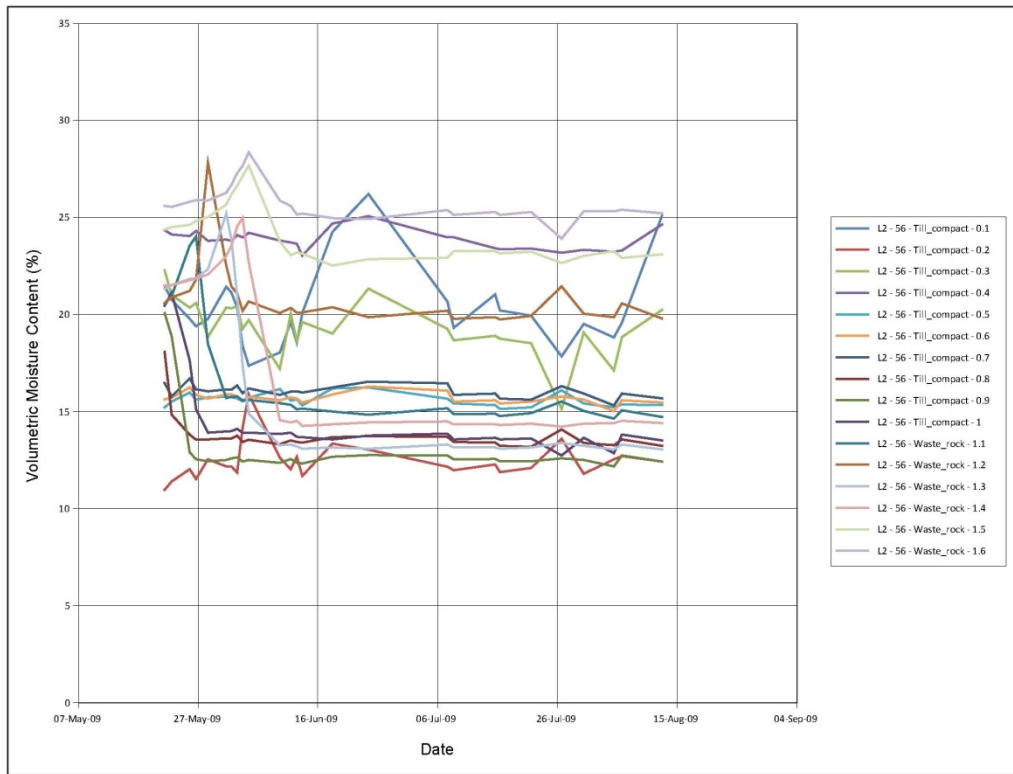


Figure 131: Daily volumetric moisture content in L#2 (Station #56) measured manually by a Sentek Diviner 2000.

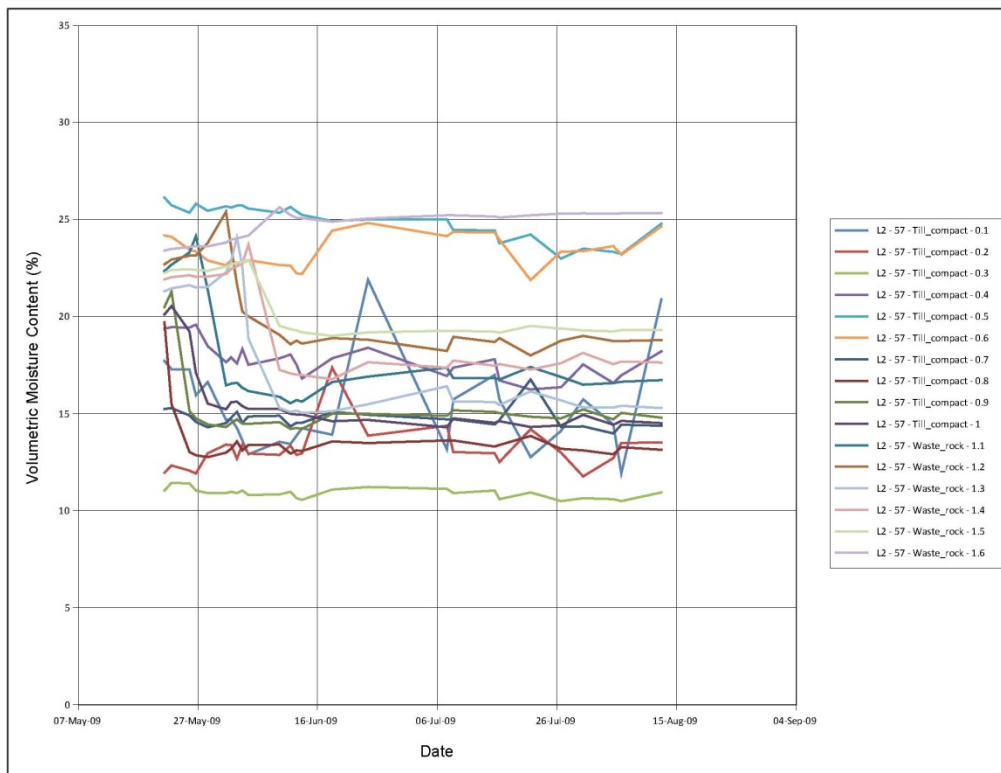


Figure 132: Daily volumetric moisture content in L#2 (Station #57) measured manually by a Sentek Diviner 2000.

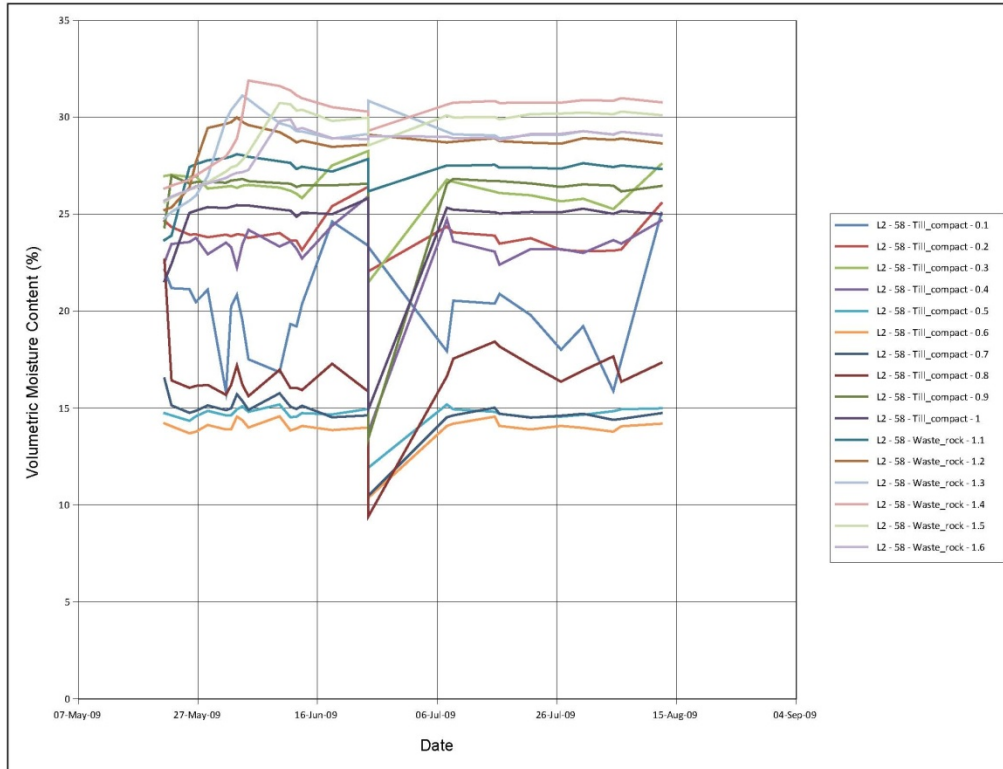


Figure 133: Daily volumetric moisture content in L#2 (Station #58) measured manually by a Sentek Diviner 2000.

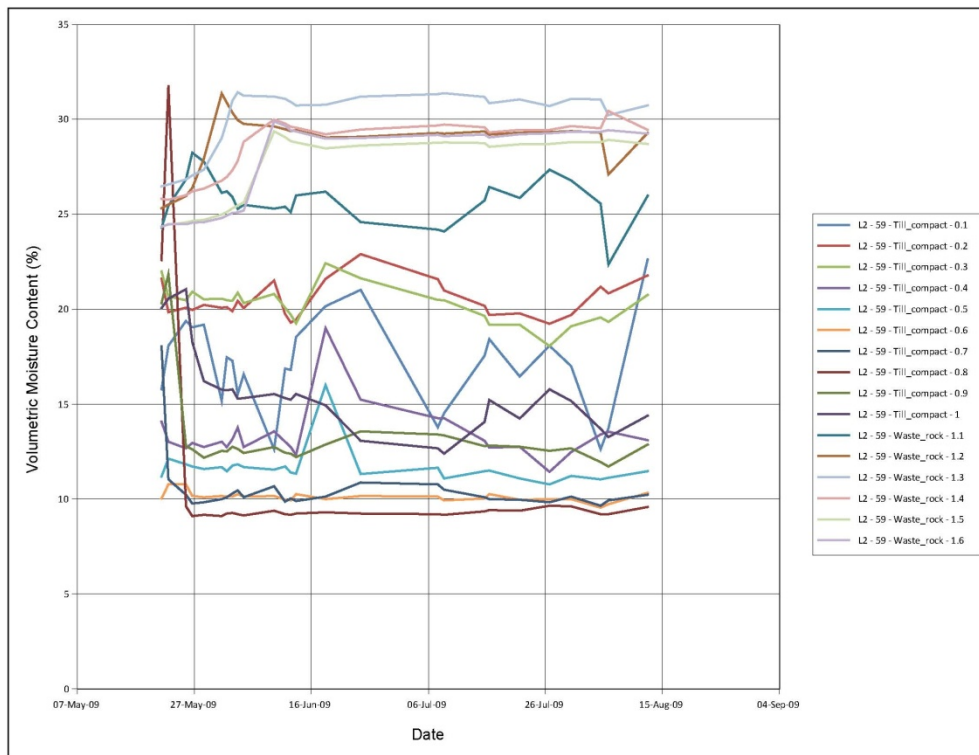


Figure 134: Daily volumetric moisture content in L#2 (Station #59) measured manually by a Sentek Diviner 2000.

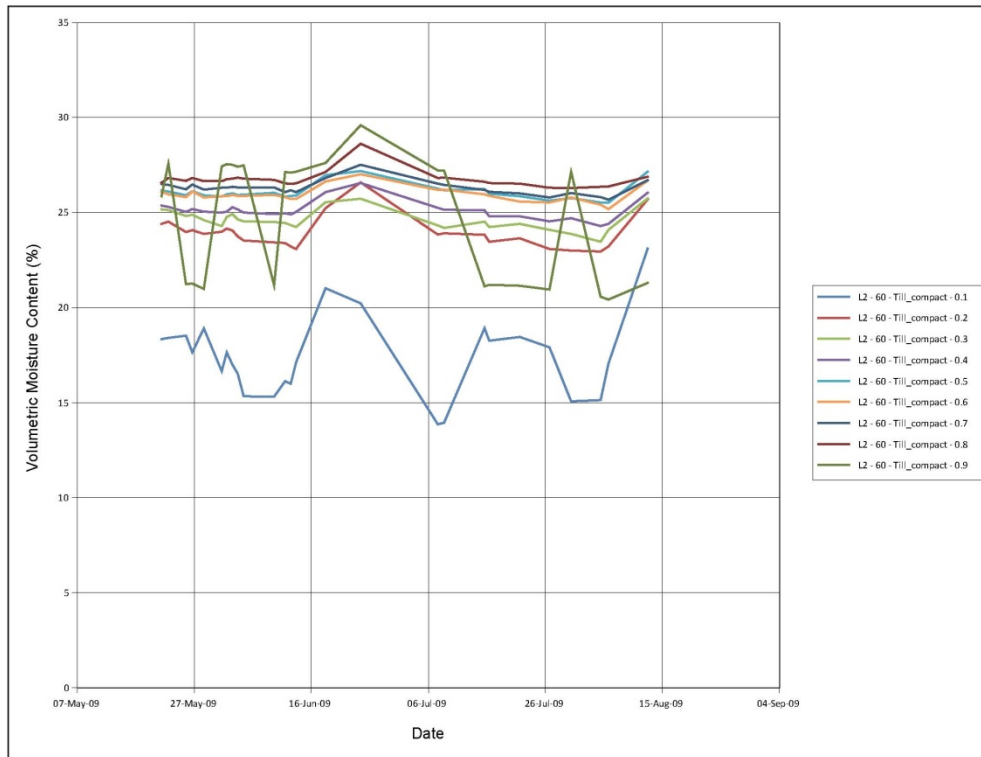


Figure 135: Daily volumetric moisture content in L2 (Station #60) measured manually by a Sentek Diviner 2000.

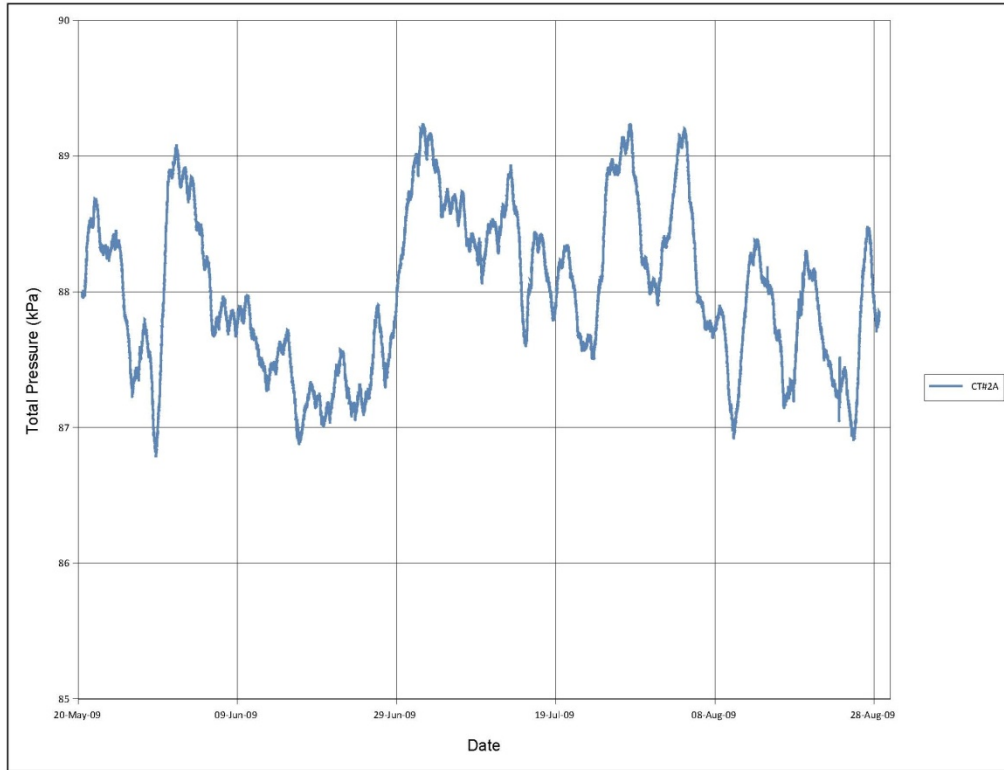


Figure 136: Hydrostatic pressure measured using the HOBO water level logger installed on CT#2A. Only significant values are displayed.

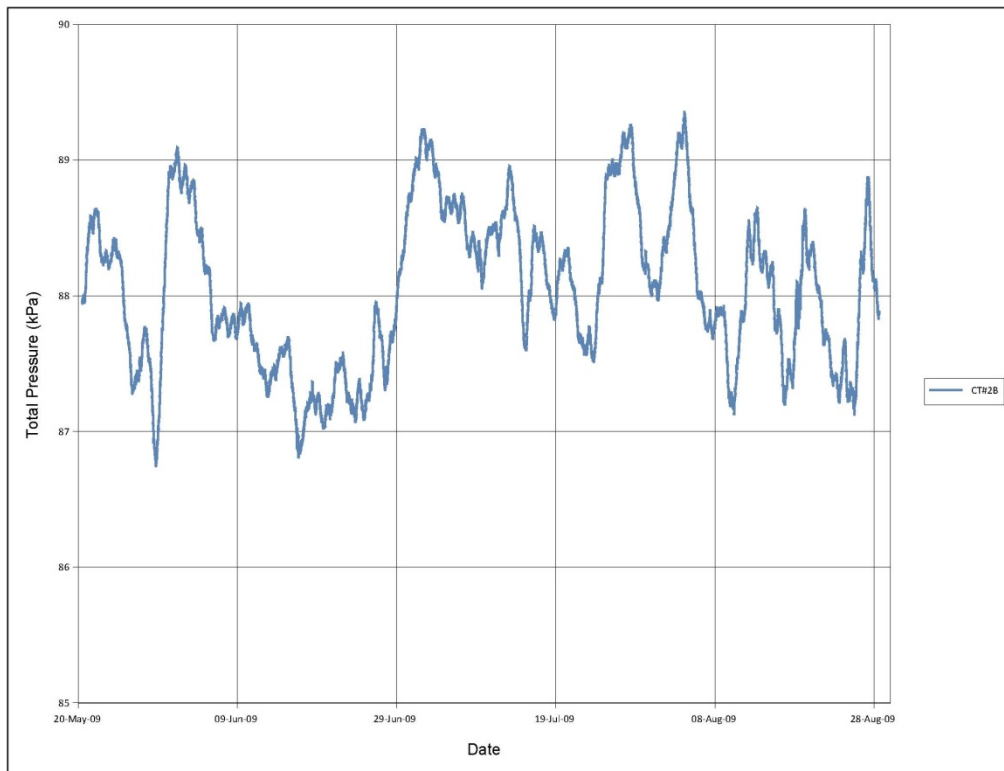


Figure 137: Hydrostatic pressure measured using the HOBO water level logger installed on CT#2B. Only significant values are displayed.

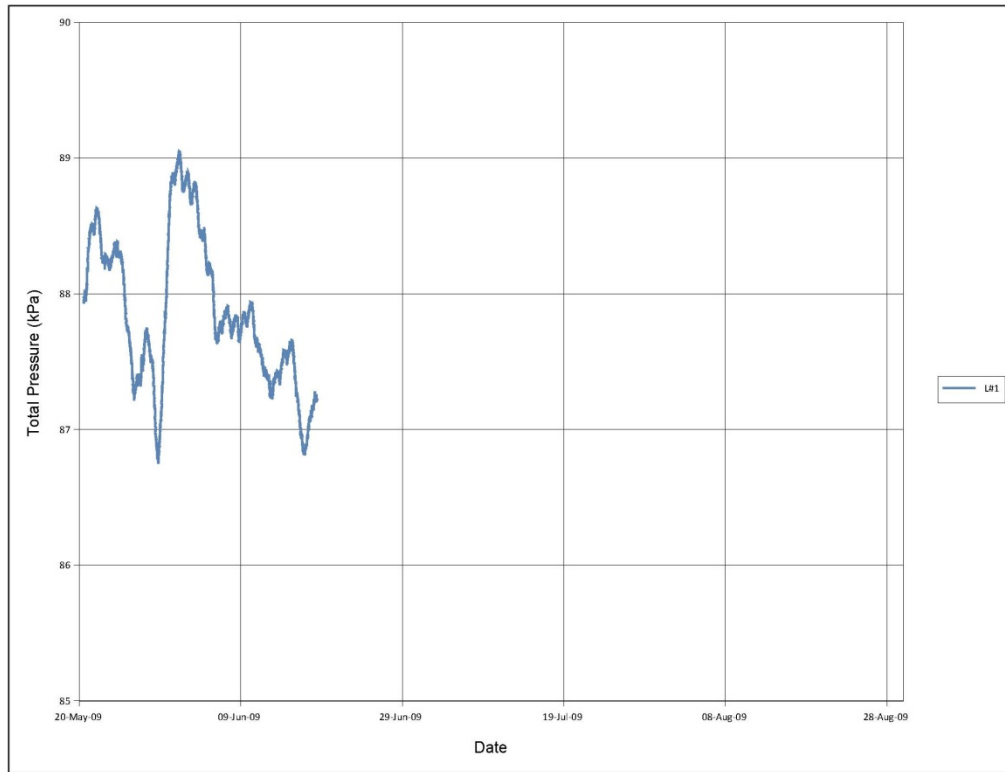


Figure 138: Hydrostatic pressure measured using the HOBO water level logger installed on L#1. Only significant values are displayed.

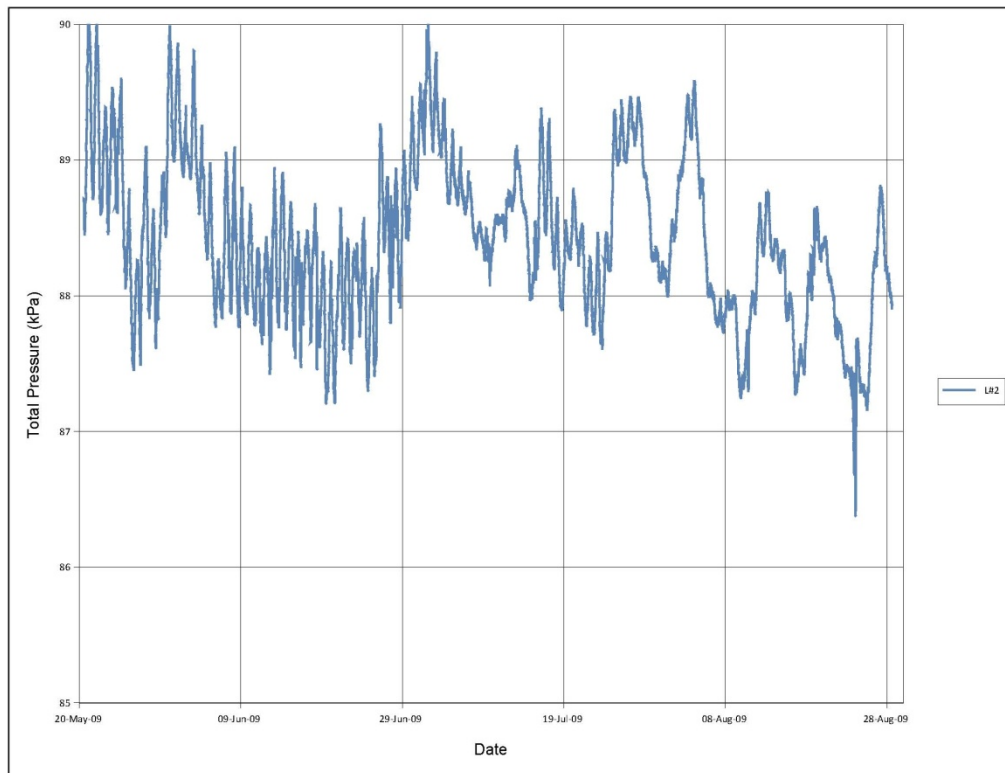


Figure 139: Hydrostatic pressure measured using the HOBO water level logger installed on L#2. Only significant values are displayed.

Appendices

Appendix A
Technical Instructions for Data Processing and Visualisation in
Microsoft Access – Technical Memorandum

Memo

To: File **Date:** January 22, 2010
cc: Maritz Rykaart, SRK **From:** Jozsef Miskolczi
Subject: Processing and visualizing field data from Faro – Vangorda Test Covers in Access databases **Project #:** 1CY001.030

The data downloaded by field personnel is transmitted to SRK by email. The data files are grouped in a compressed folder for ease of transmission. A full download suite should contain a total of 30 files and 2 additional subfolders (named CT1 and CT2a2b respectively). Most of the various types of data files are easily identifiable by the file extension, as presented in Table 1 below.

Table 1: Summary of Datalogger Types and File Formats

Datalogger Type	Monitored Parameter	File Extension	Dedicated Software	# of files in a complete download
SeaMetric DL75	Flow	*.dlf	Flow Inspector	15
Campbell Scientific CR10X	Suction, Soil Temperature, Soil Moisture Content, Flow (Tipping Buckets), Battery Voltage	*.dat	--	2
Campbell Scientific CR1000	Suction, Soil Temperature, Soil Moisture Content, Flow (Tipping Buckets), Battery Voltage	*.dat	--	4
Lakewood UL16	Soil Temperature	*.raw	Lakewood Prolog	1
Sentek Diviner 2000	Soil Moisture Content	*.dbk	Diviner 2000 Utilities	1
Davis Vantage Pro	Climate Parameters	*.wlk	Weatherlink	Two subfolders (CT1 and CT2a2b respectively) each containing same number of files, increasing by one each month
HOBO Water Level Logger	Presence/Absence of flow	*.hobo	HoboWare Pro	4

The sections below provide a brief description of the procedure to follow for uploading the field data into an Access database and subsequent data processing and visualisation.

1 Flow Inspector

1.1 Convert raw field data into text files

The raw data downloaded from each individual SeaMetric DL 75 datalogger is stored in files with extension *.dlf, with the numerals in the file name representing the dataloggers' serial number (used as unique identifier in this project). The dataloggers installed in the lower monitoring hut in 2005, 9 in total, have incremental serial numbers starting with 0506061 and ending 0506059 while the 6 dataloggers installed in 2008 in the upper monitoring hut have serial numbers from 72647 to 72652.

The following procedure will convert the raw data files into text files:

- Install the FlowInspector proprietary software on your computer
- Copy the downloaded data files to the C:\FIWORK directory
- Run the software and under File, Open and select a .dlf file
- The raw data for the recording period is exported by clicking File from the top drop down menu and selecting Export. From the popup dialogue box select .txt file type. When naming the exported file keep the original file name but add the year / month / day of the download to the file name as in the following example: 050605nyyyymmdd.txt, Where n = datalogger ID; and yyyymmdd = year / month / day of the download file
- Repeat steps 3 and 4 until all 15 files were exported as text files
- Copy the text files into the Flow Inspector folder under the Exported Data directory

1.2 Import text files into Access

- Open "transp_Flow_Thermistor_Diviner_dataAllKey03_Final1.accdb" database on the server
- Import text files one by one using the "External Data\Import\Text File" tool
 - In step 4 select "no primary key"

1.3 Data processing and calibration

- Run "sFlowInsp_rawToDataAll"
- Paste-append the data in the query to "FlowInspectorDataAll" table

1.4 Visualize data in Access

- Open "Data_Presentation" database
- Update link to "FlowInspectorDataAll" table
- Run "Fig_FlowMeters" to create the data graphs

2 Soil temperature measured by thermistors

2.1 Automated thermistors (Lakewood Prolog)

2.1.1 Convert raw files into text files

- Install the Lakewood Prolog proprietary software on your computer
- Open *.raw file in Lakewood Prolog software
- Switch to the “Sensor” tab on the left side of the window and select TP-10KC as measurement unit, in order to convert the raw data into temperature values (in °C)
- Export file as excel spreadsheet by clicking on the Excel logo
- Open file in Excel and delete first 9 rows, then save as Lakewood_yyyymmdd.txt file

2.1.2 Import text files into Access

- Open “transp_Flow_Thermistor_Diviner_dataAllKey03_Final1.accdb” database on the server
- Import text files one by one using the “External Data\Import\Text File” tool
 - In step 3 change data type for Field1 and Field2 to Text
 - In step 4 select “no primary key”

2.1.3 Data processing and calibration

- Transpose table using the “TransposeTable” form
 - fixed columns = 2
 - first column to transpose=3
 - target file: “Lakewood_dataTransp”
- Paste-Append data from “Lakewood_dataTransp” to “lakewood_rawTRANS”
- Run “sLakewoodCalc01”

2.1.4 Visualize data in Access

- At this point you cannot visualise the dataset, as data graphs are created for both the Manual and the Automated (Lakewood) data together. See section 2.2.3 and 2.2.4 for details.

2.2 Manual Thermistors

2.2.1 Convert raw files into text files

- Compile the manual readings into a single spreadsheet
- Save the spreadsheet as txt file with the following headings: “dataloggerID”, “SensorID”, “String_No”, “Port_No”, “Date”, “Resistance_kOhm”. Make sure the date is in SI format: yyyy/mm/dd. Leave the “dataloggerID”, “SensorID” columns blank.

2.2.2 Import text files into Access

- Open “transp_Flow_Thermistor_Diviner_dataAllKey03_Final1.accdb” database on the server
- Import text files one by one using the “External Data\Import\Text File” tool
 - In step 3 change data type for Field1 and Field2 to Text
 - In step 4 select “no primary key”

2.2.3 Data processing and calibration

- Run “Step2_ManualThermistor2009_CalcTemp”
- Run “Step4_sTemperatureData_combined”
- Run “Step5_ThermistorDataAll” to create table “SoilTempAllData_Thermistors” containing all thermistor data combined (manual and Lakewood)

2.2.4 Visualize data in Access

- Data graphs are created for both the Manual and the Automated (Lakewood) data together
- Open “Data_Presentation” database
- Update link to “SoilTempAllData_Thermistors” table

- Run “Fig_ThermistorsAll” to create the data graphs

3 Weatherlink

3.1 Convert raw files into text files

To convert the application specific format into text format, follow the procedure outlined in the “Data Post Processing Procedure” memo (SRK 2005).

The procedure is reproduced below:

- Install “Weatherlink” proprietary software on your computer.
- Place all **.wlk** files in the subdirectory directory and run WeatherLink program.
- Under **File** in the top pull down menu select **Open Station** and a popup dialogue box will open.
- Select the station that corresponds to the project location and Weatherlink will open all **.wlk** files in the directory.
- Click the **Browse** button (the yellow pad of paper and pencil) and all the data will be displayed.
- To export the data, click **Browse** from the top pull down menu and select **Export Records**.
- A pop up window will allow you can choose to export **Days / Months / Years**. Selecting **Years** will select all available data.
- Click **OK** and name the **.txt** file. The **.txt** file will contain the column headings and columns of data.
- When naming the exported **.txt** file use the following naming convention

ctnyyyymmdd.txt

Where ct = cover trial; n = 1 or 2, which identifies the datalogger; and yyyymmdd = year / month / day of the download data file

- Delete the data files from the Project directory and the VantageP directories before working on another data set or else the existing data will be incorporated into the new data.
 - Open each text file and perform make the following changes:
 - Delete first two rows from file
 - Change date format to YYYY-MM-DD
 - Save files as:
 - CT_1_raw
 - CT_2AB_raw

3.2 Import text files into Access

- Import the text file using the “external Data\Import\text file” tool
 - In step 4 select “no primary key”

3.3 Data processing and calibration

- Run “AddField43_CT1” and “AddField43_CT2AB” to add the Barometric Pressure in kPa field and create the tables “CT_1_calc” and “CT_2AB_calc”
- Transpose table “CT_1_calc” using the “Transpose Table” form; fixed columns = 2, first column to transpose=3; dataloggerID: Weatherlink; target file: CT_1_Transp
- Transpose table “CT_2AB_calc” using the “Transpose Table” form; fixed columns = 2, first column to transpose=3; dataloggerID: Weatherlink; target file: CT_2AB_Transp
- Run “ArrayNo_CT2A2B” for CT2A/B data to create “Weatherlink2009Data_CT2AB”
- Run “ArrayNo_CT1” for CT1 data to create “Weatherlink2009Data_CT1”
- Open “All_data.accdb” and link tables “Weatherlink2009Data_CT1” and “Weatherlink2009Data_CT2AB” to this database

- Run query “u_Weatherlink2009Data_All” to compile all data collected in 2009 by the 2 weather station
- Run MakeTable query “m_Weatherlink2009DataAll” to create table “Weatherlink2009DataAll” which contains all the data and the additional processed data fields

3.4 Visualize data in Access

- Open “Data_Presentation” database and refresh the link to “Weatherlink2009DataAll” table
- Run queries “q_WL_Wind_Direction” and “q_WL_AllParameters” to prepare the data for graphing
- Open form “Fig_WL_Wind_Direction” to create the graph for wind direction and form “q_WL_AllParameters” to create the graphs for all the other parameters. You will have to change the Y-axis scale and caption to the appropriate values for each parameter

4 Sentek Diviner

4.1 Convert raw files into text files

- Install Sentek Diviner Utilities proprietary software on your computer.
- From the Start / Programs / Sentek highlight Diviner 2000 Utilities. This runs the program.
- Click the **Settings** tab and under the **Current Backup Path** click **Browse** (this opens a second popup window) to set the path where the **.dbk** files are stored.
- Click the **Restore / Export** tab and highlight the **.dbk** files to be exported and click the **Export** button.
 - A second popup window will open with the title **Export to CSV**
 - Highlight the rows of data to be exported (all except 99) and select the radio button for **Calibrated Moisture Readings** under the **Format** heading at the bottom of the window
 - At the top of the **Export to CSV** window, under **Export As** click the **Browse** button to set the path where the exported files will be written to:
 - A third popup window, with the title **Save as** opens and under **Save in:** set the path and file to save the exported files
 - Under **File name:** enter the name of the exported **.csv** files
 - When naming the exported **.csv** files use the following naming convention

yyyymmdd

Where yyyymmdd is the year / month / day of the download data file

- Click **Save**. This will close the **Save as** window
- Click **OK** at the bottom of the **Export to CSV** window. This will open a new window titled **Newly Created Profile Files** displaying a list of the selected files to be exported
- Click **OK** at the bottom of this window
- A series of exported files will be created in the selected directory with the following naming convention

yyyymmdd (Pro##).csv

Where yyyymmdd is the year / month / day of the download data file; Pro = profile file; and ## = the file number corresponding to the station ID

- Export the data to csv format by selecting the “Restore/Export” tab and selecting the appropriate backup file; in the subsequent window select the “Scaled Frequency” option, then highlight all the profiles to be exported (all except profile No. 99)

4.2 Import text files into Access

- Open “Diviner_mn01.mdb”
- Run form “importText”; the path to the input files should be generic (i.e. not the mapped drive on your machine); the target file should be named “DivinerAllData”. This operation compiles all 60 profiles into one file located under the same path as the input files
- Import the “DivinerAllData” using the “External Data\Import\Text file” tool

4.3 Data processing and calibration

- Transpose “DivinerAllData” using the “transposeTable” form
 - fixed columns = 2
 - first column to transpose=3
 - target file: “DivinerAllData_Transp”
- Run “DivinerDataAll_Calc” (= make table query) to create “DivinerAllData_Calc” table which contains calibrated scaled frequency values

4.4 Visualize data in Access

- Open “Data_presentation.accdb” and update the link to “DivinerAllData_Calc”
- Run “DivinerAllData_2009” query to prepare data for graphing
- Open “DivinerAllData_2009” form to visualise the data in a graph

5 CR1000

5.1 Convert raw files into text files

The CR1000 datalogger outputs the data in separate tables for each of the instrument monitored. These individual tables do not require processing other than deleting the first rows which contain the description of the data and are not required in Access. No proprietary software is required for data pre-processing. The following is the procedure broken down for each data type.

5.1.1 Battery Voltage

- Open “CR1000_lysimeters_BattVolt.dat”
- Delete top 4 rows
- Save file with same name but .txt extension

5.1.2 Tipping Buckets

- Open “CR1000_lysimeters_TB.dat”
- Delete top 4 rows
- Save file with same name but .txt extension

5.1.3 Suction

- Open “CR1000_lysimeters_Suction.dat”
- Delete top 4 rows
- Save file with same name but .txt extension

5.1.4 Moisture Content

- Open “CR1000_lysimeters_Sentek_ES.dat”
- Delete top 4 rows
- Save file with same name but .txt extension

5.2 Import text files into Access

5.2.1 Battery Voltage

- Open “transp_CR1000_dataAllKey03_Final1.accdb”
- Import text files using the “External Data\Import\Text File” tool:
 - step 3 change field1 to Date/Time format
 - step 4 = no primary key
 - overwrite old file “CR1000_lysimeters_BattVolt”

5.2.2 Tipping Buckets

- Open “transp_CR1000_dataAllKey03_Final1.accdb”
- Import text file under same name:
 - step 3 change field1 to Date/Time format
 - step 4 = no primary key

5.2.3 Suction and soil temperature

- Open “transp_CR1000_dataAllKey03_Final1.accdb”
- Import text file under same name:
 - step 3 change field1 to Date/Time format
 - step 4 = no primary key

5.2.4 Moisture Content

- Open “transp_CR1000_dataAllKey03_Final1.accdb”
- Import text file under same name:
 - step 3 change field1 to Date/Time format
 - step 4 = no primary key

5.3 Data Processing and Calibration

5.3.1 Battery Voltage

- Transpose using the “Transpose” form:
 - No of fixed columns = 1
 - First column to transpose = 3
 - Target file: “CR1000_lysimeters_BattVolt_Transp”
- Run “Append_lysimBattVolt_ToCR1000_DataAll” to append data to the “CR1000_DataAll” table

5.3.2 Tipping Buckets

- Transpose using the “Transpose” form
 - No of fixed columns = 1
 - First column to transpose = 3
 - Target file: “CR1000_lysimeters_TB_Transp”
- Run “Append_lysimTB_ToCR1000_DataAll” to append data to the “CR1000_DataAll” table
- Run “q_TBtotals” to create “CR1000_lysimeters_TB”

5.3.3 Suction and soil temperature

- Transpose using the “Transpose” form
 - No of fixed columns = 1
 - First column to transpose = 3
 - Target file: “CR1000_lysimeters_Suction_Transp”
- Run “Append_lysimSuction_ToCR1000_DataAll” to append data to the “CR1000_DataAll” table
- Run “CR1000_RawSuctionData_cs229” to create “zData” table
- Run “CR1000_CalculatedSuction_cs229” to create “CR1000_SuctionOnly_cs229”

5.3.4 Moisture Content

- Transpose using the “Transpose” form
 - No of fixed columns = 1
 - First column to transpose = 3
 - Target file: “CR1000_lysimeters_Sentek_ES_Transp”
- Run “Append_lysimSentekES_ToCR1000_DataAll” to append data to the “CR1000_DataAll” table
- Run “createTable_CR1000_SentekES_Calc” to create “CR1000_SentekES_Only” table

5.4 Visualize data in Access

5.4.1 Battery Voltage

- Open “Data_presentation.accdb” and update the link to “CR1000_DataAllTranspKey”
- Run “u_CR1000_CR10X_BattVolt_all” to prepare data for visualisation
- Run “Fig_CR1000_CR10X_BattVolt_all” to visualise data as a graph

5.4.2 Tipping Buckets

- Open “Data_presentation.accdb” and update the link to “CR1000_DataAllTranspKey”
- Run “q_CR1000_Flow_TB” to prepare the data for graphing
- Run “Fig_CR1000_Flow_TB” form to visualise data as a graph

5.4.3 Suction

- Open “Data_presentation.accdb” and update the link to “CR1000_SuctionOnly_cs229” table
- Run “q_CR1000_Suction” to prepare data for graphing
- Run “Fig_CR1000_Suction” form to visualise data as a graph

5.4.4 Soil Temperature

- Open “Data_presentation.accdb” and update the link to “CR1000_DataAllTranspKey”
- Run “q_CR1000_SoilTemp_cs229” to prepare data for graphing
- Open “Fig_CR1000_SoilTemp_cs229” form to visualise data as a graph

5.4.5 Moisture Content

- Open “Data_presentation.accdb” and update the link to “CR1000_SentekES_Only” table
- Run “q_CR1000_SentekES” to prepare data for visualisation
- Open “Fig_CR1000_SentekES” form to visualise data as a graph

6 CR10X Data

The CR10X dataloggers output the data in one generic data table (one for each datalogger) with the extension “dat”. The data tables do not require any pre-processing.

6.1 Convert raw files into text files

- Change the name of the files from the current (received from field download) CR10X_#1_SA#1 to CR10X_1 and CR10X_#2_SA#1 to CR10X_2 respectively
- Change the extension of the data files from “*.dat” to “*.txt”

6.2 Import text files into Access

- Open “transp_CR10X_dataAllKey09_Final1.accdb”
- Import text files one-by-one using the “External Data\Import\Text File” tool
 - step 4 = no primary key
 - overwrite old file “CR10X_1” and “CR10X_2” respectively

6.3 Data processing and calibration

- Open “transp_CR10X_dataAllKey09_Final1.accdb”
- Run “m_createCR10x_1_TB” to create table “CR10x_1_TB” which contains only the TB data
- Run “update_CR10x_1” to eliminate the TB data from the table
- Transpose the data files using the “Transpose file” form
 - CR10X_1:
 - Fixed columns = 4
 - First column to transpose=5
 - Target file: “CR10x_1_dataTransp”
 - CR10X_2:
 - Fixed columns = 4
 - First column to transpose=5
 - Target file: “CR10x_2_dataTransp”
 - CR10X_1_TB:
 - Fixed columns = 3
 - First column to transpose=4
 - Target file: “CR10x_1_TB_dataTransp”
- Run “appendCR10x_1_Transp” to append the new CR10X_1 data to “cr10x_dataAllTranspKey” table
- Run “appendCR10x_1TB_Transp” to append the new CR10X_1TB data to “cr10x_dataAllTranspKey” table
- Run “appendCR10x_2_Transp” to append the new CR10X_2 data to “cr10x_dataAllTranspKey” table
- Run “updateCR10x_withDateTime” to calculate the date/time and update the new data in “cr10x_dataAllTranspKey”

6.3.1 Suction

- Open “transp_CR10X_dataAllKey09_calc_Final2.accdb”
- Update all links to tables from “transp_CR10X_dataAllKey09_Final1.accdb”
- Run “CR10x_CalculatedSuction_cs229” to create “CR10x_SuctionOnly_cs229” table

6.3.2 Moisture Content

- Open “transp_CR10X_dataAllKey09_calc_Final2.accdb”
- Update all links to tables from “transp_CR10X_dataAllKey09_Final1.accdb”
- Run “createTable_CR10x_SentekES_calc” to create “CR10x_ES_dataOnly” table

6.4 Visualize data in Access

6.4.1 Battery Voltage

- Open “Data_presentation.accdb” and update the link to “cr10x_dataAllTranspKey”
- Run “u_CR1000_CR10X_BattVolt_all” to prepare data for visualisation
- Run “Fig_CR1000_CR10X_BattVolt_all” form to visualise data as a graph

6.4.2 Tipping Buckets

- Open “Data_presentation.accdb” and update the link to “cr10x_dataAllTranspKey”
- Run “q_CR10X_Flow_TB” to prepare the data for graphing
- Run “Fig_CR10X_Flow_TB” form to visualise data as a graph

6.4.3 Suction

- Open “Data_presentation.accdb” and update the link to “CR10x_SuctionOnly_cs229” table
- Run “q_CR10X_Suction” to prepare data for graphing
- Run “Fig_CR10X_Suction” form to visualise data as a graph

6.4.4 Soil Temperature

- Open “Data_presentation.accdb” and update the link to “cr10x_dataAllTranspKey”
- Run “q_CR10X_SoilTemp_cs229” to prepare data for graphing
- Open “Fig_CR10X_SoilTemp_cs229” form to visualise data as a graph
-

6.4.5 Moisture Content

- Open “Data_presentation.accdb” and update the link to “CR10x_ES_dataOnly” table
- Run “q_CR10X_SentekES” to prepare data for visualisation
- Open “Fig_CR10X_SentekES” form to visualise data as a graph

7 References

SRK Consulting (Canada) Inc. (2007) Downloading, Pre&Post Processing of Datalogger Data through Proprietary Software. Technical Memorandum . Project No. 1CD003.051. January.

Appendix B
Additional Climatic Data Calculated and Stored by
Davis Instruments Vantage Pro Data Logger

Parameter	Description	Verification
Dew Point	Dew-point is the temperature to which air must be cooled for saturation (100% relative humidity) to occur, providing there is no change in water content. The dew-point is an important measurement used to predict the formation of dew, frost, and fog. Dew-point is also a good indicator of the air's actual water vapour content, unlike relative humidity, which takes the air's temperature into account. High dew-point indicates high vapour content; low dew-point indicates low vapour content. In addition a high dew-point indicates a better chance of rain and severe thunder storms.	Checked
Wind Run	Wind run is measurement of the "amount" of wind passing the station during a given period of time, expressed in either "miles of wind" or "kilometres of wind". WeatherLink calculates wind run by multiplying the average wind speed for each archive record by the archive interval.	Checked
Wind Chill	Wind chill takes into account how the speed of the wind affects our perception of air temperature. Your body warms the surrounding air molecules by transferring heat from your skin. If there's no air movement, this insulating layer of warm air molecules stays next to your body and offers some protection from cooler air molecules. Wind disperses this layer of warm air, causing the air temperature to "feel" colder. The faster the wind blows, the quicker the layer of warm air is dispersed, and the colder you feel. Above 76.7°F (24.8°C), wind movement has no effect on the apparent temperature. WeatherLink versions 5.1 and later use the Osczevski (1995) equation to calculate wind chill. This is the method adopted by the US National Weather Service in September of 2001.	Checked
Heat Index	The Heat Index uses the temperature and the relative humidity to determine how hot the air actually "feels." When humidity is low, the apparent temperature will be lower than the air temperature, since perspiration evaporates rapidly to cool the body. However, when humidity is high (i.e., the air is saturated with water vapour) the apparent temperature "feels" higher than the actual air temperature, because perspiration evaporates more slowly. WeatherLink uses the Steadman (1979 & 1998) formula to calculate Heat Index, which is more accurate than the method used by the Vantage Pro console and is calculated for all temperatures.	Checked
THW Index	The THW Index uses humidity, temperature and wind to calculate an apparent temperature that incorporates the cooling effects of wind on our perception of temperature.	Checked
THSW Index	The THSW Index uses humidity, temperature, the cooling effects of wind and the heating effects of direct solar radiation to calculate an apparent temperature.	Checked
Solar Energy	The amount of accumulated solar radiation energy over a period of time is measured in Langleys.	Checked
UV Dose	Measured in MED which stands for Minimum Erythmal Dose, defined as the amount of sunlight exposure necessary to induce a barely perceptible redness of the skin within 24 hours after sun exposure. In other words, exposure to 1 MED will result in a reddening of the skin. Because different skin types burn at different rates, 1 MED for persons with very dark skin is different from 1 MED for persons with very light skin.	Checked
Heating DD	One heating degree-day is the amount of heat required to keep a structure at 65°F when the outside temperature remains one degree below the 65°F threshold for 24 hours. One heating degree-day is also the amount of heat required to keep that structure at 65°F when the temperature remains 24°F below that 65° threshold for 1 hour.	Checked
Cooling DD	One cooling degree-day is the amount of cooling required to keep a structure at 65°F when the outside temperature remains one degree above the 65°F threshold for 24 hours. One cooling degree-day is also the amount of cooling required to keep that structure at 65°F when the temperature remains 24°F above that 65° threshold for 1 hour.	Checked
Inside Temp	The temperature measured inside the console	Checked
Inside Humidity	The relative humidity measured inside the console	Rising toward the end of the season.
ET	Evapotranspiration is the measure of the quantity of moisture transpiring from the leaves of a crop and evaporating from the ground. ET values are calculated from measured data on wind run, air temperature, relative humidity, and solar radiation. The ET value is calculated once each hour using the data averaged over the prior hour	Checked

Appendix C
Field Diagnostic Data Sheets

SRK Consulting
ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet

for Jozsef Miskolczi

Date and Time:
 Downloaded by:

Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)

CT#1		CT#2A/2B	
Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	Diagnostic test run:	<input type="text" value="y"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text"/>	Console battery voltage:	<input type="text"/>
Special Comments:	<input type="text" value="Battery voltages not recorded"/>		

Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)

	CR10X-1	CR10X-2	CR1000
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text"/>	<input type="text"/>	<input type="text"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text" value="Battery voltages not recorded"/>		

Seametrics Data Loggers (Flowmeters in Monitoring Hut)

	Download	Battery OK		Download	Battery O.K.
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL32):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="n"/>	<input type="text" value="n"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text" value="#4 needs new battery"/>				

Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

Diviner 2000 Data Logger (Manual Moisture Content Probe)

Data successfully downloaded:

Special Comments:

HOBO Water Level Loggers

	CT#2A	CT#2B	L#1	L#2
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Special Comments:	<input type="text"/>			

SRK Consulting
ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet

for Jozsef Miskolczi

Date and Time:
 Downloaded by:

Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)

CT#1		CT#2A/2B	
Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	Diagnostic test run:	<input type="text" value="y"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text" value="2.91 V"/>	Console battery voltage:	<input type="text" value="3.05 V"/>
Special Comments:	<input type="text" value="CT#1 - monitor says: 'low battery on station 5'"/>		

Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)

	CR10X-1	CR10X-2	CR1000
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.60 V"/>	<input type="text" value="13.76 V"/>	<input type="text"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text"/>		

Seametrics Data Loggers (Flowmeters in Monitoring Hut)

	<u>Download</u>	<u>Battery OK</u>		<u>Download</u>	<u>Battery O.K.</u>
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL#2):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="n"/>	<input type="text" value="n"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text" value="CT#3A DL#4 needs new battery"/>				

Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)

Data successfully downloaded:
 Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

Diviner 2000 Data Logger (Manual Moisture Content Probe)

Data successfully downloaded:
 Special Comments:

HOBO Water Level Loggers

	CT#2A	CT#2B	L#1	L#2
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="N"/>	<input type="text" value="y"/>
Special Comments:	<input type="text" value="comp. message for L#1: 'logger header is corrupt or blank. It needs to be initialized to default values'"/>			

SRK Consulting
ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet

for Jozsef Miskolczi

Date and Time:
 Downloaded by:

Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)

CT#1	CT#2A/2B
Data successfully downloaded: <input type="text" value="y"/>	Data successfully downloaded: <input type="text" value="y"/>
Diagnostic test run: <input type="text" value="y"/>	Diagnostic test run: <input type="text" value="y"/>
Diagnostic test results:	Diagnostic test results:
Console battery voltage: <input type="text" value="2.93 V"/>	Console battery voltage: <input type="text" value="3.06 V"/>
Special Comments: <input type="text"/>	

Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)

	CR10X-1	CR10X-2	CR1000
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.99 V"/>	<input type="text" value="14.50 V"/>	<input type="text" value="12.13 V"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments: <input type="text"/>			

Seametrics Data Loggers (Flowmeters in Monitoring Hut)

	Download	Battery OK		Download	Battery O.K.
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL#32):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="n"/>	<input type="text" value="n"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="n"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			

Special Comments:

Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

Diviner 2000 Data Logger (Manual Moisture Content Probe)

Data successfully downloaded:

Special Comments:

HOBO Water Level Loggers

	CT#2A	CT#2B	L#1	L#2
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>

Special Comments:

SRK Consulting

ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet

for Jozsef Miskolczi

Date and Time:
 Downloaded by:

Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)

CT#1		CT#2A/2B	
Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	Diagnostic test run:	<input type="text" value="y"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text" value="2.91 V"/>	Console battery voltage:	<input type="text" value="3.07 V"/>
Special Comments:	<input type="text"/>		

Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)

	CR10X-1	CR10X-2	CR1000
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.41 V"/>	<input type="text" value="13.47 V"/>	<input type="text" value="12.41 V"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text"/>		

Seametrics Data Loggers (Flowmeters in Monitoring Hut)

	Download Battery OK			Download Battery O.K.	
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL#32):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text"/>				

Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

Diviner 2000 Data Logger (Manual Moisture Content Probe)

Data successfully downloaded:

Special Comments:

HOBO Water Level Loggers

	CT#2A	CT#2B	L#1	L#2
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Special Comments:	<input type="text"/>			

SRK Consulting
ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet

for Jozsef Miskolczi

Date and Time:
 Downloaded by:

Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)

CT#1		CT#2A/2B	
Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	Diagnostic test run:	<input type="text" value="y"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text" value="2.89 V"/>	Console battery voltage:	<input type="text" value="3.08 V"/>
Special Comments:	<input type="text"/>		

Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)

	CR10X-1	CR10X-2	CR1000
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="14.02 V"/>	<input type="text" value="13.63 V"/>	<input type="text" value="12.24 V"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text"/>		

Seametrics Data Loggers (Flowmeters in Monitoring Hut)

	Download	Battery OK		Download	Battery O.K.
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL#2):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text"/>				

Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

Diviner 2000 Data Logger (Manual Moisture Content Probe)

Data successfully downloaded:

Special Comments:

HOBO Water Level Loggers

	CT#2A	CT#2B	L#1	L#2
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Special Comments:	<input type="text" value="L#1 not functional; see previous diagnostic sheets for error messages."/>			

SRK Consulting
ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet

for Jozsef Miskolczi

Date and Time:
 Downloaded by:

Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)

CT#1

CT#2A/2B

Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	Diagnostic test run:	<input type="text" value="y"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text" value="2.93 V"/>	Console battery voltage:	<input type="text" value="3.06 V"/>
Special Comments:	<input type="text" value="CT#1 Console says low battery on station 5"/>		

Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)

CR10X-1

CR10X-2

CR1000

Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.52 V"/>	<input type="text" value="13.62 V"/>	<input type="text" value="11.94 V"/>
Solar panel feed voltage if <11v	<input type="text"/>	<input type="text"/>	<input type="text"/>
Special Comments:	<input type="text" value="One of the plastic buckets in upper hut is plugged and full of water."/>		

Seametrics Data Loggers (Flowmeters in Monitoring Hut)

Download Battery OK

Download Battery O.K.

CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL32):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#1_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_1 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_2 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>	L#2_3 (DL#50)	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>			
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>			
Special Comments:	<input type="text"/>				

Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

Diviner 2000 Data Logger (Manual Moisture Content Probe)

Data successfully downloaded:

Special Comments:

HOBO Water Level Loggers

	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Special Comments:	<input type="text"/>			

SRK Consulting
ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet

for Jozsef Miskolczi

Date and Time:
 Downloaded by:

Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)

CT#1		CT#2A/2B	
Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	Diagnostic test run:	<input type="text" value="y"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text" value="2.93 V"/>	Console battery voltage:	<input type="text" value="3.03 V"/>
Special Comments:	<input type="text"/>		

Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)

	CR10X-1	CR10X-2	CR1000
Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="13.80 V"/>	<input type="text" value="13.62 V"/>	<input type="text" value="12.36 V"/>
Solar panel feed voltage if <11v	<input type="text" value="n/a"/>	<input type="text" value="n/a"/>	<input type="text" value="n/a"/>
Special Comments:	<input type="text"/>		

Seametrics Data Loggers (Flowmeters in Monitoring Hut)

Data successfully downloaded		Battery O.K.
CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL32):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>

Special Comments:

Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)

Data successfully downloaded:
 Manual readings taken on:

String #1:	<input type="text" value="y"/>	String #3:	<input type="text" value="y"/>
String #2:	<input type="text" value="y"/>	String #4:	<input type="text" value="y"/>

Special Comments:

Diviner 2000 Data Logger (Manual Moisture Content Probe)

Data successfully downloaded:
 Special Comments:

HOBO Water Level Loggers

	CT#2A	CT#2B	L#1	L#2
Data Successfully Downloaded	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Datalogger launched	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="n"/>	<input type="text" value="y"/>
Special Comments:	<input type="text"/>			

SRK Consulting
ARMC Waste Rock and Tailings Trial Covers- Information Data Sheet

for Jozsef Miskolczi

Date and Time:
 Downloaded by:

Davis Instruments Data Loggers (Weather Stations on CT#1 and CT#2A/2B)

CT#1

CT#2A/2B

Data successfully downloaded:	<input type="text" value="y"/>	Data successfully downloaded:	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="n"/>	Diagnostic test run:	<input type="text" value="n"/>
Diagnostic test results:		Diagnostic test results:	
Console battery voltage:	<input type="text" value="n/a"/>	Console battery voltage:	<input type="text" value="n/a"/>
Special Comments:	<input type="text"/>		

Campbell Scientific CR10X Data Loggers (Located in Monitoring Hut)

CR10X-1

CR10X-2

CR1000

Data successfully downloaded:	<input type="text" value="y"/>	<input type="text" value="y"/>	<input type="text" value="y"/>
Diagnostic test run:	<input type="text" value="n"/>	<input type="text" value="n"/>	<input type="text" value="n"/>
Diagnostic Test Results:			
Battery Voltage:	<input type="text" value="n/a"/>	<input type="text" value="n/a"/>	<input type="text" value="n/a"/>
Solar panel feed voltage if <11v	<input type="text" value="n/a"/>	<input type="text" value="n/a"/>	<input type="text" value="n/a"/>
Special Comments:	<input type="text"/>		

Seametrics Data Loggers (Flowmeters in Monitoring Hut)

Data successfully downloaded

Battery O.K.

CT#1 (DL#1):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2A (DL32):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#2B (DL#3):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A (DL#4):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3A-I (DL#5):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B (DL#6):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#3B-I (DL#7):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#4 (DL#8):	<input type="text" value="y"/>	<input type="text" value="y"/>
CT#4-I (DL#9):	<input type="text" value="y"/>	<input type="text" value="y"/>
Special Comments:	<input type="text" value="flowmeters in new hut also successfully downloaded"/>	

Lakewood Systems Data Logger (Thermistors on Grum O/B Dump)

Data successfully downloaded:

Manual readings taken on:

String #1:	<input type="text" value="n"/>	String #3:	<input type="text" value="n"/>
String #2:	<input type="text" value="n"/>	String #4:	<input type="text" value="n"/>

Special Comments:

Diviner 2000 Data Logger (Manual Moisture Content Probe)

Data successfully downloaded:

Special Comments:

HOBO Water Level Loggers

	CT#2A	CT#2B	L#1	L#2
Data Successfully Downloaded	n	n	n	n
Datalogger launched	n	n	n	n
Special Comments:	<input type="text"/>			

Appendix D
Summary and Calculation Sheets of In-Situ Hydraulic Conductivity
Testing Using the Guelph Permeameter and Single Ring Infiltrometer
Methods

Appendix D.1
Guelph Permeameter Data

Testing Method	Test Location	Hydraulic Conductivity (cm/s)	Tested by	Comments
Guelph Permeameter	L#1_1	8.09E-04	JM, MM	
Guelph Permeameter	L#1_2	8.57E-05	MM	
Guelph Permeameter	L#2_1	9.06E-05	JM, MM	
Guelph w/ tension infiltrometer	L#2_2	N/A	JM	Inconclusive
Guelph w/ tension infiltrometer	CT#1_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#1_2	#REF!	JM, MM	
Guelph Permeameter	CT#2A_1	-2.98E-04	JM, MM	
Guelph Permeameter	CT#2A_2	1.10E-04	MM	
Guelph Permeameter	CT#2B_1	-3.38E-06	JM, MM	
Guelph w/ tension infiltrometer	CT#3A_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#3A_2	#REF!	MM	
Guelph w/ tension infiltrometer	CT#3A_3	#REF!	MM	
Guelph w/ tension infiltrometer	CT#3B_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#3B_2	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#3B_3	#REF!	JM, MM	
Guelph Permeameter	CT#4_1	1.43E-04	MM	
Ring Infiltrometer	CT#1_1	#REF!	JM, MM	
Ring Infiltrometer	CT#1_2	#REF!	JM, MM	
Ring Infiltrometer	CT#1_3	#REF!	JM, MM	
Ring Infiltrometer	CT#3A_9	#REF!	MM	
Ring Infiltrometer	CT#3A_10	#REF!	MM	
Ring Infiltrometer	CT#3A_11	#REF!	MM	
Ring Infiltrometer	CT#3B_6	#REF!	MM	
Ring Infiltrometer	CT#3B_7	#REF!	MM	
Ring Infiltrometer	CT#3B_8	#REF!	MM	
Ring Infiltrometer	CT#4	N/A	JM	Inconclusive
Ring Infiltrometer	L#2	N/A	JM	Inconclusive

Location: L#1_1	Investigator: JM
Date: August 18, 2009	Depth of Well Hole: 0
Test No: 12	Hole Diameter: diameter: 7cm
Dominant Soil Type: Till	

Head = -178 mm							Head = -128 mm						
Reservoir(s) used: both							Reservoir(s) used: both						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	12:03:00	0:00:00	0.0	11.30	0.00	0.00	1	12:40					
2	12:04	0:01:00	0:01:00	12.00	-0.70	-0.70	2	12:41	0:01:00	0:01:00	39.50	0.50	0.50
3	12:05:00	0:02:00	0:01:00	12.60	-0.60	-0.60	3	12:42	0:02:00	0:01:00	40.70	1.20	1.20
4	12:06	0:03:00	0:01:00	13.20	-0.60	-0.60	4	12:43	0:03:00	0:01:00	41.90	1.20	1.20
5	12:07:00	0:04:00	0:01:00	13.80	-0.60	-0.60	5	12:44	0:04:00	0:01:00	43.00	1.10	1.10
6	12:08	0:05:00	0:01:00	14.40	-0.60	-0.60	6	12:45	0:05:00	0:01:00	44.10	1.10	1.10
7	12:09:00	0:06:00	0:01:00	15.10	0.70	0.70	7	12:46	0:06:00	0:01:00	45.20	1.10	1.10
8	12:10	0:07:00	0:01:00	15.70	0.60	0.60	8	12:47	0:07:00	0:01:00	46.30	1.10	1.10
9	12:11:00	0:08:00	0:01:00	16.10	0.40	0.40	9						
10	12:12	0:09:00	0:01:00	16.40	0.30	0.30	10						
11	12:13:00	0:10:00	0:01:00	17.40	1.00	1.00	11						
12	12:18	0:15:00	0:05:00	20.40	3.00	0.60	12						
13	12:23	0:20:00	0:05:00	23.20	2.80	0.56	13						
14	12:28	0:25:00	0:05:00	26.10	2.90	0.58	14						
15	12:33	0:30:00	0:05:00	29.00	2.90	0.58	15						
16	12:38	0:35:00	0:05:00	31.90	2.90	0.58	16						
17							17						
18							18						
19							19						
20							20						
21							21						
22							22						
23							23						
24							24						
25							25						
26							26						
27							27						
Steady rate for three consecutive readings (R1)					0.580	Steady rate for three consecutive readings (R2)					1.100		

Saturated Hydraulic Conductivity, $K_s = 8.09E-04$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm3/hr	cm3/hr	in3/hr	in3/hr	mm	mm		in	cm/s	cm/s
0.580	both	1.100	both	1225.656	2324.52	74.765016	141.79572	-178	-128	3.56	0.012800747		8.09E-04

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²

Guelph Infiltrometer Calculation Sheet

Location: L#1_2	Investigator: JM
Date: August 18, 2009	Depth of Well Hole: 0
Test No: 16	Hole Diameter: diameter: 7cm
Dominant Soil Type: Till	

Head = -50 mm							Head = -100 mm						
Reservoir(s) used: inner							Reservoir(s) used: both						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	15:15:00	0:00:00	0.0	17.20	0.00	0.00	1	16:49		35.80			
2	15:29	0:14:00	0:14:00	18.40	1.20	0.09	2	16:50	0:01:00	0:01:00	36.50	0.70	
3	15:39:00	0:24:00	0:10:00	19.90	1.50	0.15	3	16:51	0:02:00	0:01:00	37.40	0.90	
4	15:50	0:35:00	0:11:00	21.40	1.50	0.14	4	16:52	0:03:00	0:01:00	38.00	0.60	
5	16:03:00	0:48:00	0:13:00	23.30	1.90	0.15	5	16:53	0:04:00	0:01:00	38.80	0.80	
6	16:13	0:58:00	0:10:00	24.90	1.60	0.16	6	16:54	0:05:00	0:01:00	39.50	0.70	
7	16:23:00	1:08:00	0:10:00	26.40	1.50	0.15	7	16:55	0:06:00	0:01:00	40.30	0.80	
8	16:33	1:18:00	0:10:00	28.00	1.60	0.16	8	16:57	0:08:00	0:02:00	41.90	1.60	
9	16:47:00	1:32:00	0:14:00	30.30	2.30	0.16	9	16:58	0:09:00	0:01:00	42.70	0.80	
10							10						
11							11						
12							12						
13							13						
14							14						
15							15						
16							16						
17							17						
18							18						
19							19						
20							20						
21							21						
22							22						
23							23						
24							24						
25							25						
26							26						
27							27						
Steady rate for three consecutive readings (R1)					0.164		Steady rate for three consecutive readings (R2)					0.800	

Saturated Hydraulic Conductivity, $K_s = 8.57E-05$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm ³ /hr	cm ³ /hr	in ³ /hr	in ³ /hr	mm	mm		in	cm/s	cm/s
0.164	inner	0.800	both	21.19285714	1690.56	1.292764286	103.12416	-50	-100	-1.00	-0.087583018		8.57E-05

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²

Location: L#2_1	Investigator: JM
Date: August 19, 2009	Depth of Well Hole: 0
Test No: 1	Hole Diameter:
Dominant Soil Type: Compacted till	

Head = 168 mm							Head = -36 mm						
Reservoir(s) used: inner							Reservoir(s) used: inner						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	12:15	0:00:00	0.0	3.30	-	1	17:48	0:00:00	0.0	6.00	-		
2	14:02	1:47:00	1:47:00	5.20	1.90	0.02	2	17:49	0:01:00	0:01:00	7.60	1.60	
3	15:26	3:11:00	1:24:00	20.40	15.20	0.18	3	17:50	0:02:00	0:01:00	9.10	1.50	
4	15:36	3:21:00	0:10:00	23.10	2.70	0.27	4	17:51	0:03:00	0:01:00	10.60	1.50	
5	16:13	3:58:00	0:37:00	34.40	11.30	0.31	5	17:52	0:04:00	0:01:00	11.80	1.20	
6	16:18	4:03:00	0:05:00	35.70	1.30	0.26	6	17:53	0:05:00	0:01:00	13.00	1.20	
7	16:23	4:08:00	0:05:00	36.90	1.20	0.24	7	17:54	0:06:00	0:01:00	14.10	1.10	
8	16:28	4:13:00	0:05:00	38.10	1.20	0.24	8	17:55	0:07:00	0:01:00	15.20	1.10	
9	16:33	4:18:00	0:05:00	39.20	1.10	0.22	9	17:56	0:08:00	0:01:00	16.20	1.00	
10	16:38	4:23:00	0:05:00	40.30	1.10	0.22	10	17:57	0:09:00	0:01:00	17.10	0.90	
11	16:43	4:28:00	0:05:00	41.30	1.00	0.20	11	17:58	0:10:00	0:01:00	18.20	1.10	
12	16:48	4:33:00	0:05:00	42.40	1.10	0.22	12	17:59	0:11:00	0:01:00	19.10	0.90	
13	16:53	4:38:00	0:05:00	43.50	1.10	0.22	13	18:00	0:12:00	0:01:00	20.00	0.90	
14	16:58	4:43:00	0:05:00	44.60	1.10	0.22	14	18:01	0:13:00	0:01:00	20.90	0.90	
15							15	18:02	0:14:00	0:01:00	21.80	0.90	
16							16						
17							17						
18							18						
19							19						
20							20						
21							21						
22							22						
23							23						
24							24						
25							25						
26							26						
27							27						
Steady rate for three consecutive readings (R1)					0.215	Steady rate for three consecutive readings (R2)					0.900		

Saturated Hydraulic Conductivity, $K_s = 9.06E-05$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm ³ /hr	cm ³ /hr	in ³ /hr	in ³ /hr	mm	mm		in	cm/s	cm/s
0.215	inner	0.900	inner	27.735	116.1	1.691835	7.0821	168	-36	0.82	-0.007018415		9.06E-05

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²

Location: CT#2A_1	Investigator: JM
Date: August 11, 2008	Depth of Well Hole: 30
Test No: 12	Hole Diameter:
Dominant Soil Type: Glacial Till	

Head = -50 mm Reservoir(s) used: inner							Head = -122 mm Reservoir(s) used: inner						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	14:00		26.80			1	14:42		30.40				
2	14:03	0:03:00	35.30	8.50	2.83	2	14:44	0:02:00	32.70	2.30	1.15		
3	14:06	0:06:00	42.30	7.00	2.33	3	14:47	0:05:00	36.60	3.90	1.30		
4	14:08	0:08:00	46.90	4.60	2.30	4	14:50	0:08:00	40.70	4.10	1.37		
5	14:10	0:10:00	51.20	4.30	2.15	5	14:53	0:11:00	44.80	4.10	1.37		
6	14:12	0:12:00	55.40	4.20	2.10	6	14:57	0:15:00	49.90	5.10	1.28		
7	14:14	0:14:00	59.50	4.10	2.05	7	15:00	0:18:00	53.70	3.80	1.27		
8	14:16	0:16:00	63.10	3.60	1.80	8	15:03	0:21:00	57.60	3.90	1.30		
9	14:18	0:18:00	67.00	3.90	1.95	9	15:06	0:24:00	61.40	3.80	1.27		
10	14:20	0:20:00	70.90	3.90	1.95	10	15:10	0:28:00	66.30	4.90	1.23		
11	14:22	0:22:55	76.00	5.10	1.75	11							
12						12							
13	14:25	0:25:00	30.50			13							
14	14:26	0:26:00	33.00	2.50	2.50	14							
15	14:28	0:28:00	38.00	5.00	2.50	15							
16	14:30	0:30:00	43.10	5.10	2.55	16							
17	14:32	0:32:00	48.10	5.00	2.50	17							
18						18							
19						19							
20						20							
21						21							
22						22							
23						23							
24						24							
25						25							
26						26							
27						27							
Steady rate for three consecutive readings (R1)					2.513	Steady rate for three consecutive readings (R2)					1.278		

Saturated Hydraulic Conductivity, $K_s = -2.98E-04$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm ³ /hr	cm ³ /hr	in ³ /hr	in ³ /hr	mm	mm		in	cm/s	cm/s
2.513	inner	1.278	inner	324.1125	164.8333333	19.7708625	10.05483333	-50	-122	-0.69	0.009391053		-2.98E-04

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²

Location: CT#2A_2	Investigator: JM
Date: August 16, 2009	Depth of Well Hole: 0
Test No: 7	Hole Diameter:
Dominant Soil Type: Galcial till	

Head = -50 mm							Head = -11 mm						
Reservoir(s) used: inner							Reservoir(s) used: INNER						
Reading Number	Time	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Time	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)
1	13:58	-	-	5.20			1	19:13	-	-	10.00		
2	14:10	0:12:00	0:12	5.50	0.30	0.025	2	19:57	0:44:00	0:44:00	43.50	33.50	0.76
3	14:35	0:37:00	0:25	6.20	0.70	0.028	3	20:02	0:49:00	0:05:00	48.50	5.00	1.00
4	15:01	1:03:00	0:26	6.80	0.60	0.023	4	20:03	0:50:00	0:01:00	50.40	1.90	1.90
5	15:29	1:31:00	0:28	7.40	0.60	0.021	5	20:04	0:51:00	0:01:00	51.60	1.20	1.20
6	16:20	2:22:00	0:51	8.50	1.10	0.022	6	20:05	0:52:00	0:01:00	52.20	0.60	0.60
7	16:30	2:32:00	0:10	11.60	3.10	0.310	7	20:06	0:53:00	0:01:00	53.60	1.40	1.40
8	16:35	2:37:00	0:05	13.00	1.40	0.280	8	20:07	0:54:00	0:01:00	54.90	1.30	1.30
9	16:45	2:47:00	0:10	16.70	3.70	0.370	9	20:08	0:55:00	0:01:00	56.60	1.70	1.70
10	16:57	2:59:00	0:12	20.60	3.90	0.325	10	20:09	0:56:00	0:01:00	58.20	1.60	1.60
11	17:13	3:15:00	0:16	25.70	5.10	0.319	11	20:10	0:57:00	0:01:00	59.80	1.60	1.60
12	17:29	3:31:00	0:16	30.50	4.80	0.300	12	20:11	0:58:00	0:01:00	60.60	0.80	0.80
13	17:45	3:47:00	0:16	35.00	4.50	0.281	13	20:12	0:59:00	0:01:00	62.20	1.60	1.60
14	17:53	3:55:00	0:08	37.30	2.30	0.288	14	20:13	1:00:00	0:01:00	64.10	1.90	1.90
15	18:01	4:03:00	0:08	39.50	2.20	0.275	15	20:14	1:01:00	0:01:00	65.40	1.30	1.30
16	18:09	4:11:00	0:08	41.60	2.10	0.263	16	20:15	1:02:00	0:01:00	66.60	1.20	1.20
17	18:19	4:21:00	0:10	44.00	2.40	0.240	17	20:16	1:03:00	0:01:00	67.80	1.20	1.20
18	18:34	4:36:00	0:15	48.00	4.00	0.267	18	20:17	1:04:00	0:01:00	69.60	1.80	1.80
19	18:53	4:55:00	0:19	53.30	5.30	0.279	19	20:18	1:05:00	0:01:00	71.80	2.20	2.20
20							20	20:19	1:06:00	0:01:00	72.40	0.60	0.60
21							21	20:20	1:07:00	0:01:00	73.50	1.10	1.10
22							22	20:21	1:08:00	0:01:00	74.60	1.10	1.10
23							23	20:22	1:09:00	0:01:00	75.70	1.10	1.10
24							24						
25							25						
26							26						
27							27						
Steady rate for three consecutive readings (R1)						0.268	Steady rate for three consecutive readings (R2)						1.100

Saturated Hydraulic Conductivity, $K_s = 1.10E-04$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm ³ /hr	cm ³ /hr	in ³ /hr	in ³ /hr	mm	mm		in	cm/s	cm/s
0.268	inner	1.100	INNER	34.62820175	141.9	2.112320307	8.6559	-50	-11	1.28	0.036165491		1.10E-04

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²

Location: CT#2B_1	Investigator: JM
Date: August 17, 2009	Depth of Well Hole: 20
Test No: 10	Hole Diameter: 15
Dominant Soil Type: Glacial Till	

Head = -50 mm Reservoir(s) used: inner							Head = -100 mm Reservoir(s) used: both						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	10:53		3.70			1	15:17		12.60				
2	11:07	0:14:00	8.00	4.30	0.31	2	15:30	0:13:00	15.00	2.40	0.18		
3	11:17	0:24:00	10.90	2.90	0.29	3	15:35	0:18:00	16.00	1.00	0.20		
4	11:27	0:34:00	13.90	3.00	0.30	4	15:40	0:23:00	17.50	1.50	0.30		
5	11:37	0:44:00	16.80	2.90	0.29	5	15:50	0:33:00	19.90	2.40	0.24		
6	11:47	0:54:00	19.50	2.70	0.27	6	16:07	0:50:00	24.00	4.10	0.24		
7	11:57	1:04:00	22.90	3.40	0.34	7	16:17	1:00:00	26.40	2.40	0.24		
8	12:07	1:14:00	25.60	2.70	0.27	8							
9	12:17	1:24:00	28.70	3.10	0.31	9							
10	12:27	1:34:00	31.50	2.80	0.28	10							
11	12:28	1:35:30	31.50	0.00	0.00	11							
12	12:38	1:45:30	34.20	2.70	0.27	12							
13	12:48	1:55:30	37.00	2.80	0.28	13							
14	12:58	2:05:30	40.00	3.00	0.30	14							
15	13:08	2:15:30	42.30	2.30	0.23	15							
16	13:18	2:25:30	44.30	2.00	0.20	16							
17	13:28	2:35:30	45.70	1.40	0.14	17							
18	13:38	2:45:30	47.80	2.10	0.21	18							
19	13:49	2:56:30	50.40	2.60	0.24	19							
20	14:05	3:12:00	53.50	3.10	0.20	20							
21	14:08	3:15:30	54.20	0.70	0.20	21							
22	14:12	3:19:30	55.00	0.80	0.20	22							
23	14:16	3:23:00	55.60	0.60	0.17	23							
24						24							
25						25							
26						26							
27						27							
Steady rate for three consecutive readings (R1)					0.200	Steady rate for three consecutive readings (R2)					0.240		

Saturated Hydraulic Conductivity, $K_s = -3.38E-06$ cm/s

R1 cm/min	Tube used for R1	R2 cm/min	Tube used for R2	Q1 cm ³ /hr	Q2 cm ³ /hr	Q1 in ³ /hr	Q2 in ³ /hr	H1 mm	H2 mm	P	alpha in	Ks cm/s	Ks cm/s
0.200	inner	0.240	both	25.8	507.9967059	1.5738	30.98779906	-50	-100	-1.00	-0.059602009		-3.38E-06
Radius of porous disk =				4	in								
Area of inner tube =				2.15	cm ²								
Area of combined tubes =				35.22	cm ²								



Guelph Infiltrometer Calculation Sheet

Location: CT#4_1	Investigator: JM
Date: August 18, 2009	Depth of Well Hole: 0
Test No: 17	Hole Diameter: 0
Dominant Soil Type: Glacial Till	

Head = -110 mm							Head = -28 mm						
Reservoir(s) used: inner							Reservoir(s) used: INNER						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	17:01		5.80			1	18:18		6.70				
2	17:32	0:31:00	6.50	0.70	0.023	2	18:19	0:01:00	8.80	2.10	2.10		
3	17:50	0:49:00	8.30	1.80	0.10	3	18:20	0:02:00	10.40	1.60	1.60		
4	17:56	0:55:00	10.20	1.90	0.32	4	18:21	0:03:00	12.30	1.90	1.90		
5	18:01	1:00:00	12.30	2.10	0.42	5	18:22	0:04:00	13.80	1.50	1.50		
6	18:06	1:05:00	14.30	2.00	0.40	6	18:23	0:05:00	15.30	1.50	1.50		
7	18:11	1:10:00	16.40	2.10	0.42	7	18:24	0:06:00	16.90	1.60	1.60		
8	18:16	1:15:00	18.50	2.10	0.42	8	18:25	0:07:00	18.40	1.50	1.50		
9						9	18:26	0:08:00	19.90	1.50	1.50		
10						10							
11						11							
12						12							
13						13							
14						14							
15						15							
16						16							
17						17							
18						18							
19						19							
20						20							
21						21							
22						22							
23						23							
24						24							
25						25							
26						26							
27						27							
Steady rate for three consecutive readings (R1)					0.415	Steady rate for three consecutive readings (R2)					1.520		

Saturated Hydraulic Conductivity, $K_s = 1.43E-04$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm ³ /hr	cm ³ /hr	in ³ /hr	in ³ /hr	mm	mm		in	cm/s	cm/s
0.415	inner	1.520	INNER	53.535	196.08	3.265635	11.96088	-110	-28	1.34	0.01583155		1.43E-04

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²

Appendix D.2
Tension Infiltrometer Data

Testing Method	Test Location	Hydraulic Conductivity (cm/s)	Tested by	Comments
Guelph Permeameter	L#1_1	#REF!	JM, MM	
Guelph Permeameter	L#1_2	#REF!	MM	
Guelph Permeameter	L#2_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	L#2_2	N/A	JM	Inconclusive
Guelph w/ tension infiltrometer	CT#1_1	3.47E-04	JM, MM	
Guelph w/ tension infiltrometer	CT#1_2	-3.50E-06	JM, MM	
Guelph Permeameter	CT#2A_1	#REF!	JM, MM	
Guelph Permeameter	CT#2A_2	#REF!	MM	
Guelph Permeameter	CT#2B_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#3A_1	6.59E-05	JM, MM	
Guelph w/ tension infiltrometer	CT#3A_2	8.83E-04	MM	
Guelph w/ tension infiltrometer	CT#3A_3	1.11E-04	MM	
Guelph w/ tension infiltrometer	CT#3B_1	8.30E-04	JM, MM	
Guelph w/ tension infiltrometer	CT#3B_2	1.07E-03	JM, MM	
Guelph w/ tension infiltrometer	CT#3B_3	4.39E-04	JM, MM	
Guelph Permeameter	CT#4_1	#REF!	MM	
Ring Infiltrrometer	CT#1_1	#REF!	JM, MM	
Ring Infiltrrometer	CT#1_2	#REF!	JM, MM	
Ring Infiltrrometer	CT#1_3	#REF!	JM, MM	
Ring Infiltrrometer	CT#3A_9	#REF!	MM	
Ring Infiltrrometer	CT#3A_10	#REF!	MM	
Ring Infiltrrometer	CT#3A_11	#REF!	MM	
Ring Infiltrrometer	CT#3B_6	#REF!	MM	
Ring Infiltrrometer	CT#3B_7	#REF!	MM	
Ring Infiltrrometer	CT#3B_8	#REF!	MM	
Ring Infiltrrometer	CT#4	N/A	JM	Inconclusive
Ring Infiltrrometer	L#2	N/A	JM	Inconclusive



Guelph Infiltrometer Calculation Sheet
Tension Infiltrometer

Location: L#2_2	Investigator: JM
Date: August 19, 2009	Depth of Well Hole: N/A
Test No: 5	Hole Diameter:
Dominant Soil Type: Till	

Head = -105 mm							Head = mm						
Reservoir(s) used: inner							Reservoir(s) used: inner						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	10:31:00	0:00:00	5.55	0.00	0.00	1							
2	13:49	3:18:00	6.20	-0.65	0.00	2							
3	14:13:00	3:42:00	6.50	-0.30	-0.01	3							
4						4							
5						5							
6						6							
7						7							
8						8							
9						9							
10						10							
11						11							
12						12							
13						13							
14						14							
15						15							
16						16							
17						17							
18						18							
19						19							
20						20							
21						21							
22						22							
23						23							
24						24							
25						25							
26						26							
27						27							
Steady rate for three consecutive readings (R1)					0.000	Steady rate for three consecutive readings (R2)					0.000		

Saturated Hydraulic Conductivity, $K_s = \#DIV/0!$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm ³ /hr	cm ³ /hr	in ³ /hr	in ³ /hr	mm	mm		in	cm/s	cm/s
0.000	inner	0.000	inner	0	0	0	0	-105	0	1.00	#DIV/0!	#DIV/0!	

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²



Guelph Infiltrometer Calculation Sheet
Tension Infiltrometer

Location: CT#1_1	Investigator: JM
Date: August 17, 2009	Depth of Well Hole: N/A
Test No: 11	Hole Diameter:
Dominant Soil Type: Till	

Head = -197 mm							Head = -41 mm						
Reservoir(s) used: inner							Reservoir(s) used: inner						
Reading Number	Time	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Time	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)
1	13:44:00	0:00:00	0.0	10.50	0.00	0.00	1	16:59			12.60		
2	14:13	0:29:00	0:29:00	14.70	-4.20	-0.14	2	17:00	0:00:30	0:00:30	14.30	1.70	3.40
3	14:23	0:39:00	0:10:00	17.30	-2.60	-0.26	3	17:00	0:01:00	0:00:30	16.50	2.20	4.40
4	14:33	0:49:00	0:10:00	20.20	-2.90	-0.29	4	17:01	0:01:30	0:00:30	18.50	2.00	4.00
5	14:57	1:13:00	0:24:00	26.70	-6.50	-0.27	5	17:01	0:02:00	0:00:30	20.50	2.00	4.00
6	15:23	1:39:00	0:26:00	36.00	-9.30	-0.36	6	17:02	0:02:30	0:00:30	22.50	2.00	4.00
7	15:44	2:00:00	0:21:00	41.10	5.10	0.24	7	17:02	0:03:00	0:00:30	24.50	2.00	4.00
8	15:54	2:10:00	0:10:00	43.50	2.40	0.24	8						
9	16:04	2:20:00	0:10:00	45.80	2.30	0.23	9						
10	16:14	2:30:00	0:10:00	47.90	2.10	0.21	10						
11	16:24	2:40:00	0:10:00	50.10	2.20	0.22	11						
12	16:36	2:52:00	0:12:00	52.70	2.60	0.22	12						
13	16:46	3:02:00	0:10:00	54.70	2.00	0.20	13						
14	16:56	3:12:00	0:10:00	56.70	2.00	0.20	14						
15							15						
16							16						
17							17						
18							18						
19							19						
20							20						
21							21						
22							22						
23							23						
24							24						
25							25						
26							26						
27							27						
Steady rate for three consecutive readings (R1)						0.209	Steady rate for three consecutive readings (R2)						4.000

Saturated Hydraulic Conductivity, $K_s = 3.47E-04$ cm/s

R1	Tube used for R1	R2	Tube used for R2	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min		cm/min		cm ³ /hr	cm ³ /hr	in ³ /hr	in ³ /hr	mm	mm		in	cm/s	cm/s
0.209	inner	4.000	inner	27.004	516	1.647244	31.476	-197	-41	1.26	0.018911037	3.47E-04	

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²



Guelph Infiltrometer Calculation Sheet
Tension Infiltrometer

Location: CT#1_2	Investigator: JM
Date: August 18, 2009	Depth of Well Hole: N/A
Test No: 2	Hole Diameter:
Dominant Soil Type: Till	

Head = -97 mm							Head = -38 mm						
Reservoir(s) used: inner							Reservoir(s) used: inner						
Reading Number	Time	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Time	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)
1	15:15:00	-	-	4.40	-	0.00	1	16:00	-	-	5.60	-	-
2	15:46	0:31:30	0:31:30	6.10	1.70	0.05	2	16:01	0:01:00	0:01:00	5.80	0.20	0.20
3	15:47	0:32:00	0:00:30	6.50	0.40	0.80	3	16:03	0:03:00	0:02:00	6.20	0.40	0.20
4	15:48	0:33:00	0:01:00	7.20	0.70	0.70	4	16:05	0:05:00	0:02:00	6.60	0.40	0.20
5	15:49	0:34:00	0:01:00	7.80	0.60	0.60	5	16:07	0:07:00	0:02:00	6.90	0.30	0.15
6	15:50	0:35:00	0:01:00	8.30	0.50	0.50	6	16:09	0:09:00	0:02:00	7.30	0.40	0.20
7	15:51	0:36:00	0:01:00	8.60	0.30	0.30	7	16:11	0:11:00	0:02:00	7.70	0.40	0.20
8	15:52	0:37:00	0:01:00	9.00	0.40	0.40	8	16:13	0:13:00	0:02:00	8.00	0.30	0.15
9	15:53	0:38:00	0:01:00	9.40	0.40	0.40	9	16:14	0:14:00	0:01:00	8.20	0.20	0.20
10	15:54	0:39:00	0:01:00	9.80	0.40	0.40	10	16:16	0:16:00	0:02:00	8.50	0.30	0.15
11	15:55	0:40:00	0:01:00	10.20	0.40	0.40	11	16:39	0:39:00	0:23:00	13.00	4.50	0.20
12	15:56	0:41:00	0:01:00	10.60	0.40	0.40	12	16:41	0:41:00	0:02:00	13.30	0.30	0.15
13							13	16:43	0:43:00	0:02:00	13.70	0.40	0.20
14							14	16:45	0:45:00	0:02:00	14.10	0.40	0.20
15							15	16:47	0:47:00	0:02:00	14.50	0.40	0.20
16							16						
17							17						
18							18						
19							19						
20							20						
21							21						
22							22						
23							23						
24							24						
25							25						
26							26						
27							27						
Steady rate for three consecutive readings (R1)						0.400	Steady rate for three consecutive readings (R2)						0.200

Saturated Hydraulic Conductivity, $K_s = -3.50E-06$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm ³ /hr	cm ³ /hr	in ³ /hr	in ³ /hr	mm	mm		in	cm/s	cm/s
0.400	inner	0.200	inner	51.6	25.8	3.1476	1.5738	-97	-38	1.64	-0.011748257	-3.50E-06	

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²



Guelph Infiltrometer Calculation Sheet

Tension Infiltrometer

Location: CT#3A_1	Investigator: JM
Date: August 14, 2009	Depth of Well Hole: 0
Test No: 2	Hole Diameter:
Dominant Soil Type: Glacial Fluvial	

Head = -198 mm							Head = -52 mm						
Reservoir(s) used: inner							Reservoir(s) used: inner						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	10:52:00	0:00:00	70.50	0.00	0.00	1	13:40		69.90				
2	11:11	0:19:00	66.60	3.90	0.21	2	13:41	0:01:00	68.40	1.50	1.50		
3	11:18	0:26:00	65.00	1.60	0.23	3	13:42	0:02:00	66.80	1.60	1.60		
4	11:30	0:38:00	62.10	2.90	0.24	4	13:43	0:03:00	65.30	1.50	1.50		
5	11:43	0:51:00	58.90	3.20	0.25	5	13:44	0:04:00	64.00	1.30	1.30		
6	11:53	1:01:00	56.30	2.60	0.26	6	13:45	0:05:00	62.60	1.40	1.40		
7	12:04	1:12:00	53.60	2.70	0.25	7	13:46	0:06:00	61.20	1.40	1.40		
8	12:14	1:22:00	51.00	2.60	0.26	8	13:47	0:07:00	59.80	1.40	1.40		
9	12:24	1:32:00	48.00	3.00	0.30	9	13:48	0:08:00	58.40	1.40	1.40		
10	12:27	0:00:00	74.50	-26.50		10							
11	12:37	1:45:00	73.00	1.50	0.15	11							
12	12:47	1:55:00	70.55	2.45	0.25	12							
13	12:57	2:05:00	68.00	2.55	0.26	13							
14	13:07	2:15:00	65.50	2.50	0.25	14							
15	13:17	2:25:00	63.00	2.50	0.25	15							
16	13:27	2:35:00	60.50	2.50	0.25	16							
17						17							
18						18							
19						19							
20						20							
21						21							
22						22							
23						23							
24						24							
25						25							
26						26							
27						27							
Steady rate for three consecutive readings (R1)					0.250	Steady rate for three consecutive readings (R2)					1.400		

Saturated Hydraulic Conductivity, $K_s = 6.59E-05$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm3/hr	cm3/hr	in3/hr	in3/hr	mm	mm		in	cm/s	cm/s
0.250	inner	1.400	inner	32.25	180.6	1.96725	11.0166	-198	-52	1.36	0.011799771	6.59E-05	

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²



Guelph Infiltrometer Calculation Sheet
Tension Infiltrometer

Location: CT#3A_2	Investigator: JM
Date: August 14, 2009	Depth of Well Hole: 0
Test No: 3	Hole Diameter:
Dominant Soil Type: Glacial Fluvial	

Head = -193 mm							Head = -50 mm						
Reservoir(s) used: inner							Reservoir(s) used: inner						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	14:30:00	0:00:00	0.0	2.30	0.00	1	17:39		12.00				
2	14:59	0:29:00	0:29:00	6.00	3.70	0.13	2	17:39	0:00:15	0:00:15	13.50	1.50	6.00
3	15:10	0:40:00	0:11:00	7.30	1.30	0.12	3	17:39	0:00:30	0:00:15	14.70	1.20	4.80
4	15:28	0:58:00	0:18:00	9.20	1.90	0.11	4	17:39	0:00:45	0:00:15	16.20	1.50	6.00
5	15:52	1:22:00	0:24:00	16.8	7.60	0.32	5	17:40	0:01:00	0:00:15	17.40	1.20	4.80
6	16:10	1:40:00	0:18:00	13.60	-3.20	-0.18	6	17:40	0:01:15	0:00:15	18.80	1.40	5.60
7	16:36	2:06:00	0:26:00	16.00	2.40	0.09	7	17:40	0:01:45	0:00:30	21.20	2.40	4.80
8	17:10	2:40:00	0:34:00	19.00	3.00	0.09	8	17:41	0:02:00	0:00:15	22.30	1.10	4.40
9	17:28	2:58:00	0:18:00	20.50	1.50	0.08	9	17:41	0:02:15	0:00:15	23.40	1.10	4.40
10							10	17:42	0:03:00	0:00:45	26.80	3.40	4.53
11							11	17:44	0:05:00	0:02:00	39.00	12.20	6.10
12							12	17:44	0:05:15	0:00:15	40.20	1.20	4.80
13							13	17:44	0:05:30	0:00:15	41.20	1.00	4.00
14							14	17:44	0:05:45	0:00:15	42.50	1.30	5.20
15							15	17:45	0:06:00	0:00:15	43.50	1.00	4.00
16							16	17:45	0:06:15	0:00:15	44.60	1.10	4.40
17							17	17:45	0:06:30	0:00:15	45.60	1.00	4.00
18							18						
19							19						
20							20						
21							21						
22							22						
23							23						
24							24						
25							25						
26							26						
27							27						
Steady rate for three consecutive readings (R1)					0.088	Steady rate for three consecutive readings (R2)					4.133		

Saturated Hydraulic Conductivity, $K_s = 8.83E-04$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm3/hr	cm3/hr	in3/hr	in3/hr	mm	mm		in	cm/s	cm/s
0.088	inner	4.133	inner	11.34668175	533.2	0.692147587	32.5252	-193	-50	1.35	0.026922876	8.83E-04	

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²



Guelph Infiltrometer Calculation Sheet

Tension Infiltrometer

Location: CT#3A_3	Investigator: JM
Date: August 15, 2009	Depth of Well Hole: 0
Test No: 4	Hole Diameter:
Dominant Soil Type: Glacial Fluvial	

Head = -203 mm Reservoir(s) used: inner							Head = -52 mm Reservoir(s) used: inner						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	13:58:00	0:00:00	0.0	14.70	0.00	1	17:00		5.00				
2	14:44	0:46:00	0:46:00	24.00	9.30	0.20	2	17:00	0:00:19	0:00:19	6.00	1.00	3.16
3	15:37	1:39:00	0:53:00	28.80	4.80	0.09	3	17:01	0:00:49	0:00:30	7.00	1.00	2.00
4	16:01	2:03:00	0:24:00	31.30	2.50	0.10	4	17:01	0:01:19	0:00:30	8.00	1.00	2.00
5	16:11	2:13:00	0:10:00	32.20	0.90	0.09	5	17:02	0:01:51	0:00:32	9.00	1.00	1.87
6	16:21	2:23:00	0:10:00	33.00	0.80	0.08	6	17:02	0:02:32	0:00:41	10.00	1.00	1.46
7	16:31	2:33:00	0:10:00	34.00	1.00	0.10	7	17:03	0:03:06	0:00:34	11.00	1.00	1.76
8	16:41	2:43:00	0:10:00	34.80	0.80	0.08	8	17:04	0:04:06	0:01:00	12.40	1.40	1.40
9	16:51	2:53:00	0:10:00	35.60	0.80	0.08	9	17:05	0:05:06	0:01:00	13.80	1.40	1.40
10							10	17:06	0:06:06	0:01:00	15.10	1.30	1.30
11							11	17:07	0:07:06	0:01:00	16.50	1.40	1.40
12							12	17:08	0:08:06	0:01:00	17.70	1.20	1.20
13							13	17:09	0:09:06	0:01:00	18.90	1.20	1.20
14							14	17:10	0:10:06	0:01:00	19.90	1.00	1.00
15							15	17:11	0:11:06	0:01:00	21.10	1.20	1.20
16							16	17:12	0:12:06	0:01:00	22.30	1.20	1.20
17							17	17:13	0:13:06	0:01:00	23.50	1.20	1.20
18							18						
19							19						
20							20						
21							21						
22							22						
23							23						
24							24						
25							25						
26							26						
27							27						
Steady rate for three consecutive readings (R1)					0.085	Steady rate for three consecutive readings (R2)					1.200		

Saturated Hydraulic Conductivity, $K_s = 1.11E-04$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm ³ /hr	cm ³ /hr	in ³ /hr	in ³ /hr	mm	mm		in	cm/s	cm/s
0.085	inner	1.200	inner	10.965	154.8	0.668865	9.4428	-203	-52	1.34	0.01753262	1.11E-04	

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²



Guelph Infiltrometer Calculation Sheet

Tension Infiltrometer

Location: CT#3B_1	Investigator: JM
Date: August 16, 2009	Depth of Well Hole: 0
Test No: 5	Hole Diameter:
Dominant Soil Type: Glacial Fluvial	

Head = -190 mm Reservoir(s) used: inner							Head = -20 mm Reservoir(s) used: inner						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	12:08:00	0:00:00	0.0	4.10	0.00	1	15:30		8.30				
2	12:38	0:30:00	0:30:00	4.90	0.80	0.03	2	15:30	0:00:15	0:00:15	10.50	2.20	8.80
3	13:41	1:33:00	1:03:00	8.00	3.10	0.05	3	15:30	0:00:30	0:00:15	12.70	2.20	8.80
4	13:53	1:45:00	0:12:00	8.60	0.60	0.05	4	15:30	0:00:45	0:00:15	15.00	2.30	9.20
5	14:01	1:53:00	0:08:00	9.10	0.50	0.06	5	15:31	0:01:00	0:00:15	17.50	2.50	10.00
6	14:39	2:31:00	0:38:00	11.50	2.40	0.06	6	15:31	0:01:15	0:00:15	19.40	1.90	7.60
7	14:50	2:42:00	0:11:00	12.30	0.80	0.07	7	15:31	0:01:30	0:00:15	21.80	2.40	9.60
8	14:55	2:47:00	0:05:00	12.60	0.30	0.06	8	15:31	0:01:45	0:00:15	24.50	2.70	10.80
9	15:00	2:52:00	0:05:00	13.00	0.40	0.08	9	15:32	0:02:00	0:00:15	27.70	3.20	12.80
10	15:05	2:57:00	0:05:00	13.30	0.30	0.06	10	15:32	0:02:15	0:00:15	31.50	3.80	15.20
11	15:10	3:02:00	0:05:00	13.60	0.30	0.06	11	15:32	0:02:30	0:00:15	33.00	1.50	6.00
12	15:15	3:07:00	0:05:00	13.90	0.30	0.06	12	15:32	0:02:45	0:00:15	35.00	2.00	8.00
13							13	15:33	0:03:00	0:00:15	37.20	2.20	8.80
14							14	15:33	0:03:15	0:00:15	39.40	2.20	8.80
15							15	15:33	0:03:30	0:00:15	41.30	1.90	7.60
16							16	15:33	0:03:45	0:00:15	43.30	2.00	8.00
17							17	15:34	0:04:00	0:00:15	45.30	2.00	8.00
18							18	15:34	0:04:15	0:00:15	47.30	2.00	8.00
19							19	15:34	0:04:30	0:00:15	49.40	2.10	8.40
20							20	15:34	0:04:45	0:00:15	51.00	1.60	6.40
21							21	15:35	0:05:00	0:00:15	53.30	2.30	9.20
22							22	15:35	0:05:15	0:00:15	55.00	1.70	6.80
23							23	15:35	0:05:30	0:00:15	57.20	2.20	8.80
24							24	15:35	0:05:45	0:00:15	59.00	1.80	7.20
25							25	15:36	0:06:00	0:00:15	61.00	2.00	8.00
26							26	15:36	0:06:15	0:00:15	63.00	2.00	8.00
27							27	15:36	0:06:30	0:00:15	64.90	1.90	7.60
Steady rate for three consecutive readings (R1)					0.060	Steady rate for three consecutive readings (R2)					7.920		

Saturated Hydraulic Conductivity, $K_s = 8.30E-04$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm3/hr	cm3/hr	in3/hr	in3/hr	mm	mm		in	cm/s	cm/s
0.060	inner	7.920	inner	7.74	1021.68	0.47214	62.32248	-190	-20	1.12	0.028722364	8.30E-04	

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²



Guelph Infiltrometer Calculation Sheet

Tension Infiltrometer

Location: CT#3B_2	Investigator: JM
Date: August 16, 2009	Depth of Well Hole: 0
Test No: 6	Hole Diameter:
Dominant Soil Type: Glacial Fluvial	

Head = -145 mm Reservoir(s) used: inner							Head = -39 mm Reservoir(s) used: inner						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	15:45:00	0:00:00	0.0	6.30	0.00	1	17:07		18.80				
2	15:58	0:13:00	0:13:00	10.80	4.50	0.35	2	17:07	0:00:15	21.30	2.50	10.00	
3	16:12	0:27:00	0:14:00	25.50	14.70	1.05	3	17:08	0:00:30	23.50	2.20	8.80	
4	16:17	0:32:00	0:05:00	31.90	6.40	1.28	4	17:08	0:00:45	26.10	2.60	10.40	
5	16:22	0:37:00	0:05:00	38.50	6.60	1.32	5	17:08	0:01:00	29.50	3.40	13.60	
6	16:27	0:42:00	0:05:00	43.60	5.10	1.02	6	17:08	0:01:15	33.00	3.50	14.00	
7	16:32	0:47:00	0:05:00	48.60	5.00	1.00	7	17:09	0:01:30	36.70	3.70	14.80	
8	16:37	0:52:00	0:05:00	53.70	5.10	1.02	8	17:09	0:01:45	39.60	2.90	11.60	
9	16:42	0:57:00	0:05:00	58.60	4.90	0.98	9	17:09	0:02:00	42.10	2.50	10.00	
10	16:47	1:02:00	0:05:00	63.60	5.00	1.00	10	17:09	0:02:15	44.50	2.40	9.60	
11	16:52	1:07:00	0:05:00	68.50	4.90	0.98	11	17:10	0:02:30	46.90	2.40	9.60	
12							12	17:10	0:02:45	49.60	2.70	10.80	
13							13	17:10	0:03:00	52.10	2.50	10.00	
14							14	17:10	0:03:15	54.60	2.50	10.00	
15							15	17:11	0:03:30	57.40	2.80	11.20	
16							16	17:11	0:03:45	60.00	2.60	10.40	
17							17	17:11	0:04:00	62.50	2.50	10.00	
18							18	17:11	0:04:15	65.00	2.50	10.00	
19							19	17:12	0:04:30	67.50	2.50	10.00	
20							20	17:12	0:04:45	70.00	2.50	10.00	
21							21						
22							22						
23							23						
24							24						
25							25						
26							26						
27							27						
Steady rate for three consecutive readings (R1)					0.987	Steady rate for three consecutive readings (R2)					10.000		

Saturated Hydraulic Conductivity, $K_s = 1.07E-03$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm3/hr	cm3/hr	in3/hr	in3/hr	mm	mm		in	cm/s	cm/s
0.987	inner	10.000	inner	127.28	1290	7.76408	78.69	-145	-39	1.37	0.021849133	1.07E-03	

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²



Guelph Infiltrometer Calculation Sheet
Tension Infiltrometer

Location: CT#3B_3	Investigator: JM
Date: August 17, 2009	Depth of Well Hole: 0
Test No: 9	Hole Diameter:
Dominant Soil Type: Glacial Fluvial	

Head = -175 mm							Head = mm						
Reservoir(s) used: inner							Reservoir(s) used: inner						
Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R1 (cm/min)	Reading Number	Elapsed Time	Time Interval (min)	Water Level in Reservoir (cm)	Water Level Change (cm)	Rate of Water Level Change, R2 (cm/min)		
1	9:27:00	0:00:00	0.0	4.50	0.00	1	12:41		13.60				
2	10:05	0:38:00	0:38:00	5.10	0.60	2	12:41	0:00:15	15.50	1.90	7.60		
3	10:59	1:32:00	0:54:00	9.10	4.00	3	12:42	0:00:30	17.00	1.50	6.00		
4	11:10	1:43:00	0:11:00	9.90	0.80	4	12:42	0:00:45	19.00	2.00	8.00		
5	11:22	1:55:00	0:12:00	10.90	1.00	5	12:42	0:01:00	21.00	2.00	8.00		
6	11:32	2:05:00	0:10:00	11.70	0.80	6	12:42	0:01:15	23.00	2.00	8.00		
7	11:42	2:15:00	0:10:00	12.50	0.80	7							
8	11:52	2:25:00	0:10:00	13.20	0.70	8							
9	12:02	2:35:00	0:10:00	14.00	0.80	9							
10	12:12	2:45:00	0:10:00	14.80	0.80	10							
11	12:22	2:55:00	0:10:00	15.50	0.70	11							
12	12:32	3:05:00	0:10:00	16.30	0.80	12							
13						13							
14						14							
15						15							
16						16							
17						17							
18						18							
19						19							
20						20							
21						21							
22						22							
23						23							
24						24							
25						25							
26						26							
27						27							
Steady rate for three consecutive readings (R1)					0.077	Steady rate for three consecutive readings (R2)					8.000		

Saturated Hydraulic Conductivity, $K_s = 4.39E-04$ cm/s

R1	Tube used	R2	Tube used	Q1	Q2	Q1	Q2	H1	H2	P	alpha	Ks	Ks
cm/min	for R1	cm/min	for R2	cm3/hr	cm3/hr	in3/hr	in3/hr	mm	mm		in	cm/s	cm/s
0.077	inner	8.000	inner	9.89	1032	0.60329	62.952	-175	0	1.00	0.026558456	4.39E-04	

Radius of porous disk = 4 in
 Area of inner tube = 2.15 cm²
 Area of combined tubes = 35.22 cm²

Appendix D.3
Ring Infiltrometer Data

Testing Method	Test Location	Hydraulic Conductivity (cm/s)	Tested by	Comments
Guelph Permeameter	L#1_1	#REF!	JM, MM	
Guelph Permeameter	L#1_2	#REF!	MM	
Guelph Permeameter	L#2_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	L#2_2	N/A	JM	Inconclusive
Guelph w/ tension infiltrometer	CT#1_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#1_2	#REF!	JM, MM	
Guelph Permeameter	CT#2A_1	#REF!	JM, MM	
Guelph Permeameter	CT#2A_2	#REF!	MM	
Guelph Permeameter	CT#2B_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#3A_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#3A_2	#REF!	MM	
Guelph w/ tension infiltrometer	CT#3A_3	#REF!	MM	
Guelph w/ tension infiltrometer	CT#3B_1	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#3B_2	#REF!	JM, MM	
Guelph w/ tension infiltrometer	CT#3B_3	#REF!	JM, MM	
Guelph Permeameter	CT#4_1	#REF!	MM	
Ring Infiltrrometer	CT#1_1	7.77E-06	JM, MM	
Ring Infiltrrometer	CT#1_2	5.49E-05	JM, MM	
Ring Infiltrrometer	CT#1_3	5.84E-05	JM, MM	
Ring Infiltrrometer	CT#3A_9	7.17E-04	MM	
Ring Infiltrrometer	CT#3A_10	5.12E-04	MM	
Ring Infiltrrometer	CT#3A_11	1.38E-03	MM	
Ring Infiltrrometer	CT#3B_6	6.15E-04	MM	
Ring Infiltrrometer	CT#3B_7	2.41E-03	MM	
Ring Infiltrrometer	CT#3B_8	9.50E-04	MM	
Ring Infiltrrometer	CT#4	N/A	JM	Inconclusive
Ring Infiltrrometer	L#2	N/A	JM	Inconclusive



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump
 Date: 15-Aug-09
 Test-Pit-No: CT#1_1b Test 1
 Operator: JM

Reference Head: 27.4 cm
 Inner Diameter of Ring: 59 cm
 Inner Area of Ring: 2734.0 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 17.2 cm

NOTES:

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/14/2009 17:07	66	66	6.6	20.8	0.9	0.82
	8/14/2009 18:13			7.5	19.9		
2	8/14/2009 18:13	995	1061	11.2	16.2	3.7	0.22
	8/15/2009 10:48			7.3	20.1		
3	8/15/2009 11:14	68	68	7.5	19.9	0.2	0.18
	8/15/2009 12:22			8.0	19.4		
4	8/15/2009 12:22	92	160	8.3	19.1	0.3	0.33
	8/15/2009 13:54			8.4	19.0		
5	8/15/2009 13:54	54	214	8.6	18.8	0.2	0.11
	8/15/2009 14:48			10.6	16.8		
6	8/15/2009 14:48	52	266	11.2	16.2	0.6	0.23
	8/15/2009 15:40			11.4	16.0		
7	8/15/2009 15:40	107	373	11.5	15.9	0.1	0.03
	8/15/2009 17:27			13.0	14.4		
8	8/15/2009 17:27	970	1343	13.1	14.3	0.1	0.04
	8/16/2009 9:37			13.5	13.9		
9	8/16/2009 9:37	154	1497				
	8/16/2009 12:11						
10	8/16/2009 12:11	107	1604				
	8/16/2009 13:58						
11	8/16/2009 13:58	214	1818				
	8/16/2009 17:32						
12	8/16/2009 17:32	903	2721				
	8/17/2009 8:35						
13	8/17/2009 8:35	150	2871				
	8/17/2009 11:05						
14	8/17/2009 11:05	262	3133				
	8/17/2009 15:27						
15							
16							
17							
18							
19							
20							

Average Infiltration Rate: 0.07 cm/hr
 Infiltration Rate (account for lateral divergence): 0.04 cm/hr
 Effective Saturated Hydraulic Conductivity K_s : 7.77E-06 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump
 Date: 15-Aug-09
 Test-Pit-No: CT#1_2c Test 2
 Operator: JM

Reference Head: 22.3 cm
 Inner Diameter of Ring: 59 cm
 Inner Area of Ring: 2734.0 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 10.3 cm

NOTES:

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/14/2009 17:04	69	69	5.3	17.0	2.7	2.35
	8/14/2009 18:13			8.0	14.3		
2	8/14/2009 18:13	995	1064	19.6	2.7	11.6	0.70
	8/15/2009 10:48			7.8	14.5		
3	8/15/2009 11:13	68	68	8.4	13.9	0.6	0.53
	8/15/2009 12:21			9.5	12.8		
4	8/15/2009 12:21	92	160	9.6	12.7	0.1	0.11
	8/15/2009 13:53			10.1	12.2		
5	8/15/2009 13:53	53	213	11.5	10.8	1.4	0.80
	8/15/2009 14:46			19.0	3.3		
6	8/15/2009 14:46	53	266	5.9	16.4	1.4	0.57
	8/15/2009 15:39			7.3	15.0		
7	8/15/2009 15:39	105	371	8.1	14.2	0.8	0.49
	8/15/2009 17:24			9.2	13.1		
8	8/15/2009 17:24	162	406	10.0	12.3	0.8	0.79
	8/16/2009 9:36			17.5	4.8		
9	8/16/2009 9:43	903	1370	18.0	4.3	0.5	0.20
	8/16/2009 12:10			19.7	2.6		
10	8/16/2009 12:10	147	147				
	8/16/2009 13:47						
11	8/16/2009 13:47	162	406				
	8/16/2009 16:29						
12	8/16/2009 16:29	61	467				
	8/16/2009 17:30						
13	8/16/2009 17:30	903	1370				
	8/17/2009 8:33						
14	8/17/2009 8:33	150	1520				
	8/17/2009 11:03						
15	8/17/2009 11:03	263	1783				
	8/17/2009 15:26						
16							
17							
18							
19							
20							

Average Infiltration Rate: 0.36 cm/hr
 Infiltration Rate (account for lateral divergence): 0.20 cm/hr
 Effective Saturated Hydraulic Conductivity K_{fs} : 5.49E-05 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump

Date: 19-Aug-09

Test-Pit-No: CT#1_3 Test 3

Operator: JM

Reference Head: 18.5 cm
 Inner Diameter of Ring: 60 cm
 Inner Area of Ring: 2827.4 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 9.7 cm

NOTES: saturated after rain

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/18/2009 18:15			9.0	9.5		
	8/19/2009 9:18	903	903	14.5	4.0	5.5	0.37
2	8/20/2009 9:34	0		3.0	15.5		
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Average Infiltration Rate: 0.37 cm/hr
 Infiltration Rate (account for lateral divergence): 0.21 cm/hr
 Effective Saturated Hydraulic Conductivity K_s : 5.84E-05 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump

Date: 19-Aug-09

Test-Pit-No: CT#3B_6 Test 6

Operator: JM

Reference Head: 23 cm
 Inner Diameter of Ring: 59 cm
 Inner Area of Ring: 2734.0 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 5.0 cm

NOTES: Reference head assumed as 23 cm

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/19/2009 11:53 8/19/2009 12:39	46	46	13.0 17.2	10.0 5.8	4.2	5.48
2	8/19/2009 12:39 8/19/2009 12:58	19	65	19.7	3.3	2.5	7.89
3	8/19/2009 12:58 8/19/2009 13:50	52	117	22.0	1.0	2.3	2.65
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Average Infiltration Rate: 2.65 cm/hr
 Infiltration Rate (account for lateral divergence): 1.48 cm/hr
 Effective Saturated Hydraulic Conductivity K_s : 6.15E-04 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump
 Date: 19-Aug-09
 Test-Pit-No: CT#3B_7b Test 7
 Operator: JM

Reference Head: 23 cm
 Inner Diameter of Ring: 59 cm
 Inner Area of Ring: 2734.0 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 3.7 cm

NOTES: Reference head assumed as 23 cm

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/19/2009 11:59 8/19/2009 12:39	40	40	13.5 23.0	9.5 0.0	9.5	14.25
2	8/19/2009 14:08 8/19/2009 14:11	3	3	18.4 18.9	4.6 4.1	0.5	10.00
3	8/19/2009 14:11 8/19/2009 14:14	3	6	19.3	3.7	0.4	8.00
4	8/19/2009 14:14 8/19/2009 14:17	3	9	19.8	3.2	0.5	10.00
5	8/19/2009 14:17 8/19/2009 14:20	3	12	20.2	2.8	0.4	8.00
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Average Infiltration Rate: 9.00 cm/hr
 Infiltration Rate (account for lateral divergence): 5.02 cm/hr
 Effective Saturated Hydraulic Conductivity K_s : 2.41E-03 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump

Date: 19-Aug-09

Test-Pit-No: CT#3B_8b

Test 8

Operator: JM

Reference Head: 23 cm
 Inner Diameter of Ring: 59 cm
 Inner Area of Ring: 2734.0 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 8.4 cm

NOTES: Reference head assumed as 23 cm

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/19/2009 12:07 8/19/2009 12:42	35	35	7.6 11.8	-7.6 -11.8	4.2	7.20
2	8/19/2009 12:42 8/19/2009 13:00	18	53	13.3	-13.3	1.5	5.00
3	8/19/2009 13:00 8/19/2009 13:48	48	101	17.8	-17.8	4.5	5.63
4	8/19/2009 14:27 8/19/2009 14:33	6	6	12.8 13.5	10.2 9.5	0.7	7.00
5	8/19/2009 14:33 8/19/2009 14:41	8	14	14.0	9.0	0.5	3.75
6	8/19/2009 14:41 8/19/2009 14:46	5	19	14.3	8.7	0.3	3.60
7	8/19/2009 14:46 8/19/2009 14:51	5	24	14.8	8.2	0.5	6.00
	8/19/2009 14:51 8/19/2009 14:56	5	29	15.3	7.7	0.5	6.00
9	8/19/2009 14:56 8/19/2009 15:01	5	34	15.8	7.2	0.5	6.00
10	8/19/2009 15:01 8/19/2009 15:06	5	39	16.3	6.7	0.5	6.00
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Average Infiltration Rate: 5.48 cm/hr
 Infiltration Rate (account for lateral divergence): 3.06 cm/hr
 Effective Saturated Hydraulic Conductivity K_s : 9.50E-04 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump

Date: 19-Aug-09

Test-Pit-No: CT#3A_9 Test 9

Operator: JM

Reference Head: 23 cm
 Inner Diameter of Ring: 59 cm
 Inner Area of Ring: 2734.0 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 9.2 cm

NOTES: Reference head assumed as 23 cm

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/19/2009 12:37 8/19/2009 13:02	25	25	8.5 11.0	14.5 12.0	2.5	6.00
2	8/19/2009 13:02 8/19/2009 13:47	45	70	14.1	8.9	3.1	4.13
3	8/19/2009 13:47 8/19/2009 14:29	42	112	16.5	6.5	2.4	3.43
4	8/19/2009 14:29 8/19/2009 15:02	33	145	18.7	4.3	2.2	4.00
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Average Infiltration Rate: 4.39 cm/hr
 Infiltration Rate (account for lateral divergence): 2.45 cm/hr
 Effective Saturated Hydraulic Conductivity K_s : 7.17E-04 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump

Date: 19-Aug-09

Test-Pit-No: CT#3A_10

Test 10

Operator: JM

Reference Head: 23 cm
 Inner Diameter of Ring: 59 cm
 Inner Area of Ring: 2734.0 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 8.8 cm

NOTES: Reference head assumed as 23 cm

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/19/2009 12:48 8/19/2009 13:03	15	15	8.5 9.9	14.5 13.1	1.4	5.60
2	8/19/2009 13:03 8/19/2009 13:46	43	58	13.0	10.0	3.1	4.33
3	8/19/2009 13:46 8/19/2009 14:30	44	102	16.0	7.0	3.0	4.09
4	8/19/2009 14:30 8/19/2009 15:03	33	135	17.8	5.2	1.8	3.27
5	8/19/2009 15:03 8/19/2009 15:50	47	182	20.0	3.0	2.2	2.81
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Average Infiltration Rate: 3.04 cm/hr
 Infiltration Rate (account for lateral divergence): 1.70 cm/hr
 Effective Saturated Hydraulic Conductivity K_s : 5.12E-04 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump

Date: 19-Aug-09

Test-Pit-No: CT#3A_11b

Test 11

Operator: JM

Reference Head: 23 cm
 Inner Diameter of Ring: 59 cm
 Inner Area of Ring: 2734.0 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 6.1 cm

NOTES:
 *- possibly leaking, pooling and running water around base of ring
 *- Reference Head assumed as 23 cm

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/19/2009 12:56			8.5	14.5		
	8/19/2009 13:44	48	48	9.9	13.1	1.4	1.75
2	8/19/2009 13:44						
	8/19/2009 14:31	47	95	13.0	10.0	3.1	3.96
3	8/19/2009 14:40			15.0	8.0		
	8/19/2009 14:45	5	5	15.7	7.3	0.7	8.40
4	8/19/2009 14:45						
	8/19/2009 14:50	5	10	16.1	6.9	0.4	4.80
5	8/19/2009 14:50						
	8/19/2009 14:55	5	15	17.0	6.0	0.9	10.80
6	8/19/2009 14:55						
	8/19/2009 15:00	5	20	17.7	5.3	0.7	8.40
7	8/19/2009 15:00						
	8/19/2009 15:05	5	25	18.2	4.8	0.5	6.00
	8/19/2009 15:05						
	8/19/2009 15:10	5	30	18.3	4.7	0.1	1.20
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Average Infiltration Rate:
 Infiltration Rate (account for lateral divergence):
 Effective Saturated Hydraulic Conductivity K_s :

6.60 cm/hr
 3.68 cm/hr
 1.38E-03 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump
 Date: 19-Aug-09
 Test-Pit-No: CT#4 Test 4
 Operator: JM

Reference Head: 23.2 cm
 Inner Diameter of Ring: 60 cm
 Inner Area of Ring: 2827.4 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 9.7 cm

NOTES:

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/18/2009 18:49 8/19/2009 9:20	871	871	10.6 17.0	12.6 6.2	6.4	0.44
2	8/19/2009 9:20 8/20/2009 9:38	0 1458	0 1458	12.8	10.4	-4.2	-0.17
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Average Infiltration Rate: 0.44 cm/hr
 Infiltration Rate (account for lateral divergence): 0.25 cm/hr
 Effective Saturated Hydraulic Conductivity K_s : 7.01E-05 cm/sec



Ring Infiltrometer Calculation Sheet

Location: Vangorda Waste Rock Dump
 Date: 19-Aug-09
 Test-Pit-No: L#2 Test 5
 Operator: JM

Reference Head: 22.4 cm
 Inner Diameter of Ring: 60 cm
 Inner Area of Ring: 2827.4 cm²
 Lateral Divergence: 10 cm
 Depth of Wetting Front: 15 cm
 Water Entry Value: -1.5 cm
 Average Depth of Water in Ring: 11.9 cm

NOTES: saturated by rain; ring empty over night of 18to19

No.	Time t dd/mm/yy hh:mm	Δt min	Time Elapsed min	Level reading cm	Water level cm	Change in Water Level cm	Infiltration Rate cm/hr
1	8/18/2009 18:34 8/19/2009 9:00	866	866	3.4 22.4	19.0 0.0	19.0	1.32
2	8/19/2009 9:00						
3	8/19/2009 9:31	31	897	5.8	16.6		
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Average Infiltration Rate: 1.32 cm/hr
 Infiltration Rate (account for lateral divergence): 0.74 cm/hr
 Effective Saturated Hydraulic Conductivity K_s : 1.83E-04 cm/sec

Appendix E
Field Records of In-Situ Density Measurements

COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

Soil Description: Till, waste rock cover pads

Date Backfill Placed: 2005

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-1 250	CT #4 Row 1 Column 1	GR	2176	8.2	2130	10	102.2
	2009-2 250	CT #4 Row 2 Column 1	GR	2118	9.9	2130	10	99.4
	2009-3 250	CT #4 Row 3 Column 1	GR	2105	9.4	2130	10	98.8
	2009-4 250	CT #4 Row 4 Column 1	GR	2114	9.6	2130	10	99.2
	2009-5 250	CT #4 Row 5 Column 1	GR	2138	7.8	2130	10	100.4
	2009-6 250	CT #4 Row 6 Column 1	GR	2139	8.9	2130	10	100.4
	2009-7 250	CT #4 Row 1 Column 2	GR	2155	7.8	2130	10	101.2
	2009-8 250	CT #4 Row 2 Column 2	GR	2137	9.2	2130	10	100.3
	2009-9 250	CT #4 Row 3 Column 2	GR	2002	9.7	2130	10	94.0
	2009-10 250	CT #4 Row 4 Column 2	GR	2116	8.6	2130	10	99.3
	2009-11 250	CT #4 Row 5 Column 2	GR	2138	8.3	2130	10	100.4
	2009-12 250	CT #4 Row 6 Column 2	GR	2098	8.0	2130	10	98.5

Remarks:

Copies:

Reviewed By: _____



Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

**EBA Engineering
Consultants Ltd.**



COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature** **Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

Soil Description: GRAVEL and SAND - trace silt

Date Backfill Placed: 2005

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-25 250	CT 3A Row 1 Column 2	GR	2106	4.0	2150	6	98.0
	2009-26 250	CT 3A Row 2 Column 2	GR	2077	4.3	2150	6	96.6
	2009-27 250	CT 3A Row 3 Column 2	GR	1987	3.9	2150	6	92.4
	2009-28 250	CT 3A Row 5 Column 2	GR	1971	4.5	2150	6	91.7
	2009-29 250	CT 3A Row 4 Column 2	GR	2104	4.1	2150	6	97.9
	2009-30 250	CT 3A Row 6 Column 2	GR	2027	5.5	2150	6	94.3
	2009-31 250	CT 3A Row 1 Column 3	GR	2195	3.7	2150	6	102.1
	2009-32 250	CT 3A Row 2 Column 3	GR	2013	3.3	2150	6	93.6
	2009-33 250	CT 3A Row 3 Column 3	GR	2079	4.4	2150	6	96.7
	2009-34 250	CT 3A Row 4 Column 3	GR	2128	5.0	2150	6	99.0
	2009-35 250	CT 3A Row 5 Column 3	GR	1981	4.6	2150	6	92.1
	2009-36 250	CT 3A Row 6 Column 3	GR	2055	4.3	2150	6	95.6

Remarks: #31 - possibly on rock

Copies:

Reviewed By: _____



Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

**EBA Engineering
Consultants Ltd.**



COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

Soil Description: GRAVEL and SAND - trace silt

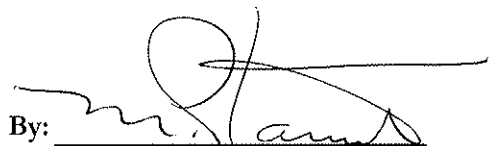
Date Backfill Placed: 2005

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-37 250	CT 3B Row 1 Column 1	GR	2096	3.7	2150	6	97.5
	2009-38 250	CT 3B Row 2 Column 1	GR	2004	4.1	2150	6	93.2
	2009-39 250	CT 3AB Row 3 Column 1	GR	1987	4.3	2150	6	92.4
	2009-40 250	CT 3B Row 4 Column 1	GR	2075	3.4	2150	6	96.5
	2009-41 250	CT 3B Row 5 Column 1	GR	2015	4.7	2150	6	93.7
	2009-42 250	CT 3B Row 6 Column 1	GR	2160	3.4	2150	6	100.5
	2009-43 250	CT 3B Row 1 Column 2	GR	2045	3.8	2150	6	95.1
	2009-44 250	CT 3B Row 2 Column 2	GR	2015	3.5	2150	6	93.7
	2009-45 250	CT 3B Row 3 Column 2	GR	1972	3.7	2150	6	91.7
	2009-46 250	CT 3B Row 4 Column 2	GR	1931	5.8	2150	6	89.8
	2009-47 250	CT 3B Row 5 Column 2	GR	2224	3.6	2150	6	103.4
	2009-48 250	CT 3B Row 6 Column 2	GR	1976	3.6	2150	6	91.9

Remarks:

Copies:

Reviewed By: _____



Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

EBA Engineering
Consultants Ltd.



COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature** **Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

Soil Description: #49-54; GRAVEL and SAND - trace silt / #55-60; Till, waste rock cover pad

Date Backfill Placed: #49-54; 2005 / #55-60; 2007

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-49 250	CT 3B Row 1 Column 3	GR	2006	4.2	2150	6	93.3
	2009-50 250	CT 3B Row 2 Column 3	GR	1967	4.0	2150	6	91.5
	2009-51 250	CT 3B Row 3 Column 3	GR	2090	4.6	2150	6	97.2
	2009-52 250	CT 3B Row 4 Column 3	GR	2064	4.8	2150	6	96.0
	2009-53 250	CT 3B Row 5 Column 3	GR	1935	7.0	2150	6	90.0
	2009-54 250	CT 3B Row 6 Column 3	GR	2112	5.8	2150	6	98.2
	2009-55 250	CT #1 Row 1 Column 1	GR	2078	10.1	2130	10	97.6
	2009-56 250	CT #1 Row 2 Column 1	GR	2081	8.6	2130	10	97.7
	2009-57 200	CT #1 Row 3 Column 1	GR	2055	7.9	2130	10	96.5
	2009-58 250	CT #1 Row 4 Column 1	GR	2061	9.3	2130	10	96.8
	2009-59 250	CT #1 Row 5 Column 1	GR	2134	8.0	2130	10	100.2
	2009-60 250	CT #1 Row 6 Column 1	GR	2068	8.6	2130	10	97.1

Remarks:

Copies:

Reviewed By: 

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

Soil Description: Till, waste rock cover pad

Date Backfill Placed: 2007

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-61 250	CT #1 Row 1 Column 2	GR	2068	11.0	2130	10	97.1
	2009-62 250	CT #1 Row 2 Column 2	GR	2017	11.4	2130	10	94.7
	2009-63 250	CT #1 Row 3 Column 2	GR	1921	11.6	2130	10	90.2
	2009-64 250	CT #1 Row 4 Column 2	GR	1747	10.2	2130	10	82.0
	2009-65 250	CT #1 Row 5 Column 2	GR	2023	11.4	2130	10	95.0
	2009-66 250	CT #1 Row 6 Column 2	GR	2045	9.9	2130	10	96.0
	2009-67 250	CT #1 Row 1 Column 3	GR	2135	7.1	2130	10	100.2
	2009-68 250	CT #1 Row 2 Column 3	GR	2097	9.4	2130	10	98.5
	2009-69 250	CT #1 Row 3 Column 3	GR	2121	9.2	2130	10	99.6
	2009-70 250	CT #1 Row 4 Column 3	GR	2217	7.6	2130	10	104.1
	2009-71 250	CT #1 Row 5 Column 3	GR	2080	8.8	2130	10	97.7
	2009-72 250	CT #1 Row 6 Column 3	GR	2047	10.8	2130	10	96.1

Remarks:

Copies:

Reviewed By: _____



Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

EBA Engineering
Consultants Ltd.



COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature** **Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

Soil Description: Till, waste rock cover pad

Date Backfill Placed: 2005

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-85 250	CT 2B Row 1 Column 3	GR	2153	7.7	2130	10	101.1
	2009-86 250	CT 2B Row 2 Column 3	GR	2182	8.1	2130	10	102.4
	2009-87 250	CT 2B Row 3 Column 3	GR	2180	6.9	2130	10	102.3
	2009-88 250	CT 2B Row 4 Column 3	GR	2138	7.7	2130	10	100.4
	2009-89 250	CT 2B Row 5 Column 3	GR	2108	8.3	2130	10	99.0
	2009-90 250	CT 2B Row 6 Column 3	GR	2056	7.1	2130	10	96.5
	2009-91 250	CT 2A Row 1 Column 1	GR	2152	7.1	2130	10	101.0
	2009-92 250	CT 2A Row 2 Column 1	GR	2136	9.6	2130	10	100.3
	2009-93 250	CT 2A Row 3 Column 1	GR	2211	7.2	2130	10	103.8
	2009-94 250	CT 2A Row 4 Column 1	GR	2263	7.3	2130	10	106.2
	2009-95 250	CT 2A Row 5 Column 1	GR	2132	7.3	2130	10	100.1
	2009-96 250	CT 2A Row 6 Column 1	GR	2197	7.4	2130	10	103.1

Remarks:

Copies:

Reviewed By:



Data presented herein is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

**EBA Engineering
Consultants Ltd.**



COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature** **Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

Soil Description: Till, waste rock cover pad

Date Backfill Placed: 2007

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-109 250	CT L2 Row 1 Column 1	GR	2213	7.5	2130	10	103.9
	2009-110 250	CT L2 Row 2 Column 1	GR	2127	8.3	2130	10	99.9
	2009-111 250	CT L2 Row 3 Column 1	GR	2122	7.4	2130	10	99.6
	2009-112 250	CT L2 Row 4 Column 1	GR	2160	5.2	2130	10	101.4
	2009-113 250	CT L2 Row 5 Column 1	GR	2217	4.8	2130	10	104.1
	2009-114 250	CT L2 Row 6 Column 1	GR	2126	7.3	2130	10	99.8
	2009-115 250	CT L2 Row 7 Column 1	GR	2202	5.5	2130	10	103.4
	2009-116 250	CT L2 Row 1 Column 2	GR	2151	6.5	2130	10	101.0
	2009-117 250	CT L2 Row 2 Column 2	GR	2172	8.0	2130	10	102.0
	2009-118 250	CT L2 Row 3 Column 2	GR	2084	9.2	2130	10	97.8
	2009-119 250	CT L2 Row 4 Column 2	GR	2186	7.7	2130	10	102.6
	2009-120 250	CT L2 Row 5 Column 2	GR	2156	7.4	2130	10	101.2

Remarks:

Copies:

Reviewed By: _____



Data presented herein is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

EBA Engineering
Consultants Ltd.



COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature** **Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

Soil Description: Till, waste rock cover pad

Date Backfill Placed: 2007

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-121 250	CT L2 Row 6 Column 2	GR	2174	6.8	2130	10	102.1
	2009-122 250	CT L2 Row 7 Column 2	GR	2153	7.1	2130	10	101.1
	2009-123 250	CT L2 Row 1 Column 3	GR	2178	7.4	2130	10	102.3
	2009-124 250	CT L2 Row 2 Column 3	GR	2188	7.6	2130	10	102.7
	2009-125 250	CT L2 Row 3 Column 3	GR	2180	7.4	2130	10	102.3
	2009-126 250	CT L2 Row 4 Column 3	GR	2095	9.3	2130	10	98.4
	2009-127 250	CT L2 Row 5 Column 3	GR	2223	5.9	2130	10	104.4
	2009-128 250	CT L2 Row 6 Column 3	GR	2187	6.5	2130	10	102.7
	2009-129 250	CT L2 Row 7 Column 3	GR	2199	5.6	2130	10	103.2
	2009-130 250	CT L1 Row 1 Column 1	GR	1836	7.6	2130	10	86.2
	2009-131 250	CT L1 Row 2 Column 1	GR	1624	7.8	2130	10	76.2
	2009-132 250	CT L1 Row 3 Column 1	GR	1683	8.0	2130	10	79.0

Remarks:

Copies:

Reviewed By: _____



Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

**EBA Engineering
Consultants Ltd.**



COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature** **Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

Soil Description: Till, waste rock cover pad

Date Backfill Placed: 2007

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-133 250	CT L1 Row 4 Column 1	GR	1847	8.5	2130	10	86.7
	2009-134 250	CT L1 Row 5 Column 1	GR	1736	6.9	2130	10	81.5
	2009-135 250	CT L1 Row 6 Column 1	GR	1599	6.8	2130	10	75.1
	2009-136 250	CT L1 Row 7 Column 1	GR	1814	7.4	2130	10	85.2
	2009-137 250	CT L1 Row 1 Column 2	GR	1607	5.9	2130	10	75.4
	2009-138 250	CT L1 Row 2 Column 2	GR	1841	7.0	2130	10	86.4
	2009-139 250	CT L1 Row 3 Column 2	GR	1764	5.9	2130	10	82.8
	2009-140 250	CT L1 Row 4 Column 2	GR	1752	6.0	2130	10	82.3
	2009-141 250	CT L1 Row 5 Column 2	GR	1662	5.9	2130	10	78.0
	2009-142 250	CT L1 Row 6 Column 2	GR	1743	7.2	2130	10	81.8
	2009-143 250	CT L1 Row 7 Column 2	GR	1813	7.0	2130	10	85.1
	2009-144 250	CT L1 Row 1 Column 3	GR	1707	7.7	2130	10	80.1

Remarks:

Copies:

Reviewed By: _____



Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

EBA Engineering
Consultants Ltd.



COMPACTION DENSITY TEST SUMMARY REPORT

ASTM Designation D2922 & D3017

Project: Faro-Vangorda Waste Rock Cover **Test Apparatus:** Nuclear **Troxler No:** 38814
Trials, Anvil Range, YT **Specified Compaction:** 95 % Std. Proctor Max. Dry Density
Project No.: W14101280 **Specified Moisture (MC):** See Below
Client: SRK **Temperature** **Air:** 19 °C **Soil:** _____ °C
Attention: Josef Miskloczi **Date Tested:** See below **By:** JMP
Contractor: _____ **Construction Period:** _____

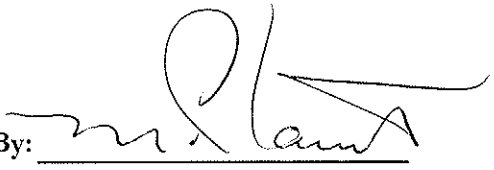
Soil Description: Till, waste rock cover pad

Date Backfill Placed: 2007

Date yyyy/mm/dd	Test No. Probe (mm)	Location:	Elev. (m)	Dry Density (kg/m ³)	MC %	Max. Dry Density (kg/m ³)	Opt. MC %	Comp % SPD
2009/08/19	2009-145 250	CT L1 Row 2 Column 3	GR	1753	6.6	2130	10	82.3
	2009-146 250	CT L1 Row 3 Column 3	GR	1842	7.5	2130	10	86.5
	2009-147 250	CT L1 Row 4 Column 3	GR	1792	7.3	2130	10	84.1
	2009-148 250	CT L1 Row 5 Column 3	GR	1750	6.4	2130	10	82.2
	2009-149 250	CT L1 Row 6 Column 3	GR	1757	9.4	2130	10	82.5
	2009-150 250	CT L1 Row 7 Column 3	GR	1837	9.3	2130	10	86.2

Remarks:

Copies:

Reviewed By: 

Data presented hereon is for the sole use of the stipulated client. EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of EBA. The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

Appendix F
Summary of Erosion Damage Repairs – Technical Memorandum

Memo

To:	Jozsef Miskolczi, SRK	Date:	3 July 2009
cc:	Maritz Rykaart, SRK	From:	Michelle Murphy, SRK
Subject:	Erosion control at Vangorda Cover Trial, Faro Mine Complex	Project #:	1CY001.030

1 Background

Cover trials are being conducted at the top of the Vangorda Waste Rock dump in order to determine the most suitable cover for covering the waste rock dumps at the Faro Mine Complex. The trials have been running for several years and each of the eight cells are instrumented and monitored regularly.

During the most recent winter and spring, significant erosion damage occurred on and around the test cells. In order to protect the cover trials and the integrity of the instrumentation, the erosion required repair and additional protection measures so that snowmelt and water flow would not do further significant damage.

1.1 Preliminary Assessment

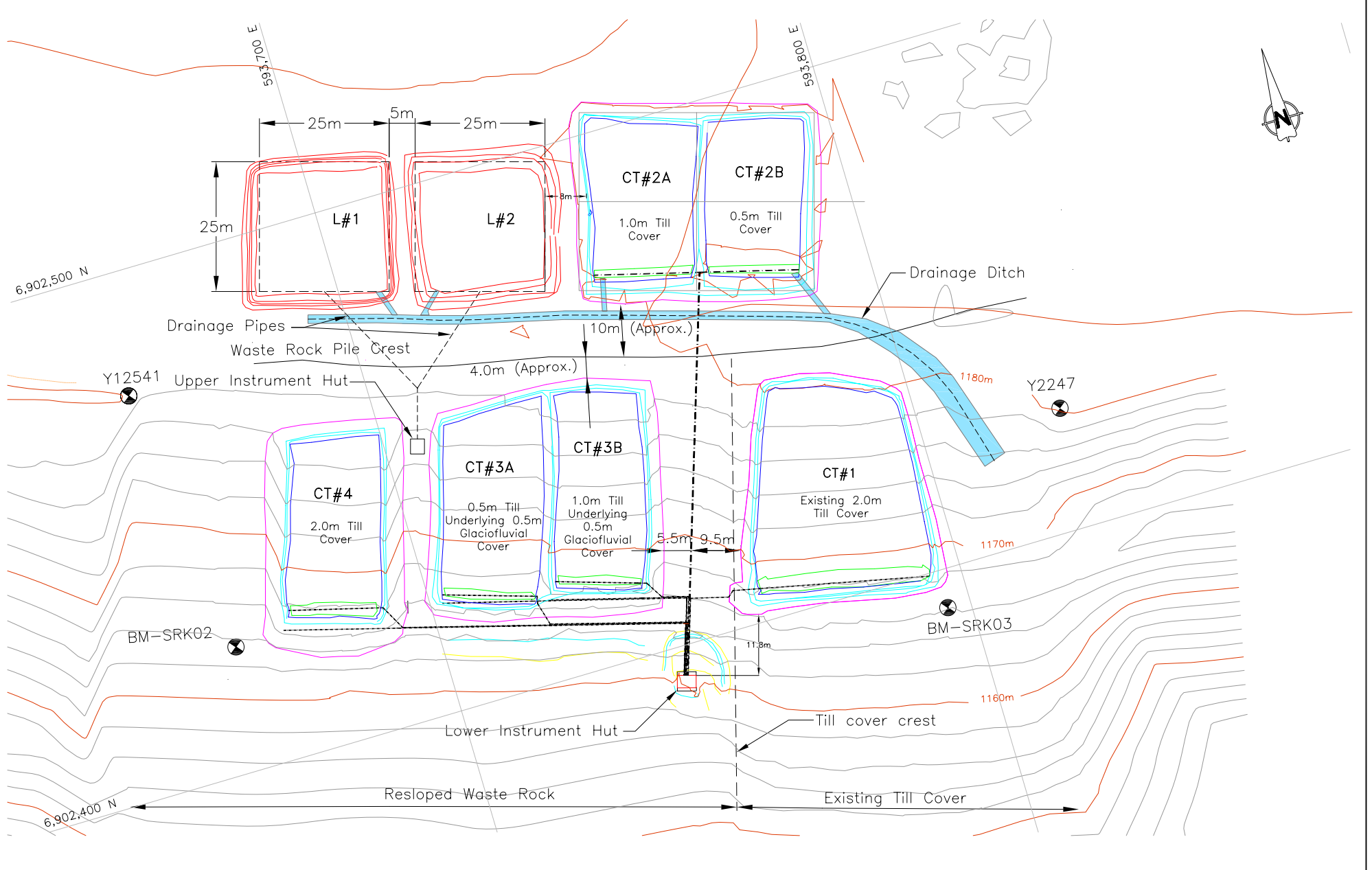
SRK engineer Jozsef Miskolczi did a preliminary assessment of the area and found major erosion on the slope between CT#4 and 3A. Fines had washed away, leaving mainly rocks exposed. As well, the lower pipeline carrying water from CT#4 to the lower monitoring hut had been damaged and he fixed it temporarily. In addition, water had eroded two channels around the lower monitoring hut as well as erosion gullies below CT#1 and a large channel to the west of CT#4.

Snowmelt had accumulated and pooled on the flat surface of the dump just above L1, L2 and CT#2A and 2B. The diversion channel constructed at the base of L1, L2, CT#2A and 2B was overwhelmed and water pushed past a berm constructed to protect the lower cells. The berm eroded and allowed water to cause the above-mentioned damage. Figure 1 shows the general layout of the test covers and lysimeters.

It was recommended by SRK that these problems be repaired and protective measures be put in place so that this scale of erosion could possibly be prevented in the future.

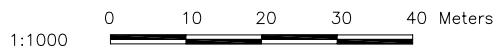
2 Summary of Work

Denison Environmental Services (DES), the Care and Maintenance Contractor for the Faro Mine Complex, assisted with manpower and equipment for completion of the work.



LEGEND

Benchmark



1:1000



SRK JOB NO.: 1CY001.030
FILE NAME: Test Covers Asbuilt with Ditch.dwg



Faro Mining Complex

Erosion Control at Vangorda Cover Trial
Faro Mine Complex

**Trial Covers and
Lysimeter Layout Plan**

DATE: Jan. 2010	APPROVED: JM	FIGURE: 1
--------------------	-----------------	--------------

2.1.1 Access Road

An access road was cut from the top of the Vangorda dump on the south slope, to just below the test cells. There are access points from both the east and west side of the cells, so equipment can drive straight through and do not have to turn around or back out.

2.1.2 Berms

Three berms were constructed: between L1 and L2 (Berm 1), L2 and CT#2A (Berm 2) and at the crest of the slope above CT#4, 3A and 3B (Berm 3). See the table below for details.

Table 1: Berm Dimensions and Locations

Berm	Location	Height (m)	Top Width (m)	Length (m)
1	L1 and L2	0.75	1.0	5
2	L2 and CT#2A	1.1	1.0	8
3	CT#4,3A, 3B	Varies from 1.0 to 1.5	1.9	91

A dry till was used to construct the berms, and compacted with the back of the bucket of the excavator. This method of construction is not ideal and erosion of the berm may be expected. In order to mitigate possible erosion, two stabilizing methods were used. Berms 1 and 2 were clad with an approximately 0.2m thick layer of rock and Berm 3 was covered with 10 oz. geotextile which was weighed down with approximately 0.2m thick layer of soil and rock. See Figures 2a and 2b.

2.1.3 Drainage Ditch

A drainage ditch had already been constructed along the south edge of L1, L2 and CT#2A and 2B, draining out towards the east, away from the lower test cells, but required improvement.

The ditch was surveyed using a Dumpy level and a 1% grade was selected. During construction it was found that the excavator was having difficulty digging out the channel with the tip of the bucket as there was very little room to manoeuvre next to the ditch. The ditch is considerably deeper than before, however the final overall grade is 0.7%. See Figure 3 for a profile of the ditch with final surveyed points.

Wires crossing from CT#2A/2B across to the lower monitoring hut were further exposed in the now deeper and wider ditch. They were covered with a 6' length of 3" PVC pipe to protect them.

2.1.4 Erosion

The table below describes the erosion repair.

Table 2: Erosion Repair

Location	Material used	Description
West of CT#4	Till and rock	The dozer repaired this erosion by pushing nearby material into the gully and then driving over it with his tracks to compact it
Between CT#4 and CT#3A	Rock and fines	The loader dumped material ahead of the excavator which smoothed it out and tamped it in with the back of the bucket. It also shaped the channel so that water will run away from the berms and toward the centre.
West berm of CT#3A	Moist till	The loader dumped till sourced from the Grum till dump and the excavator shaped the berm and compacted it with the back of the bucket.
Around the lower monitoring hut	Rock and clean gravel	The excavator used the bucket to compact and stabilize the side walls of the existing erosion channel and then placed large rocks into the channel and compacted them. It also placed clean gravel in the channel.
Base of CT#1	Moist till	In constructing the upper bench of the access road, some of the erosion was already covered over. Remaining erosion was filled in with moist till and compacted with the excavator bucket.
Upper part of CT#3A, exposed wires	Till and rock	Rock and till were placed by hand over the exposed wires
Snowmelt pond	Dry till	The dozer reshaped the area so that water will flow northeast, away from the cells.

2.1.5 Pipe

There is a 3” and a 2” water bearing pipe that runs between CT#4 and the lower monitoring which were damaged as that section eroded. They had been repaired but only temporarily and would need to be repaired and covered again. That being the case, the remainder of the pipe was exposed up to the berm of CT#4 and the length of the pipe spanning the eroded channel, about 12’, was cut and removed to allow access to the excavator.

Once the work was completed, a new section of pipe was fit into the couplers at either end of the span and glued in place with PVC glue. The pipe was then covered over with soil, but no rocks.

A second pipe towards the top of the slope was also exposed, but had been exposed for years. It was lightly covered with soil.

2.1.6 Additional Work

There was a small road on the east side of CT#2B which ran south into what is now the drainage ditch. Although the snowmelt pond area was re-graded to push water away from the cells, in the case that water did start to flow toward the cells, this road could be used to drain that water into the drainage ditch. The excavator pushed a breach in the drainage ditch berm so that water could flow through if necessary.

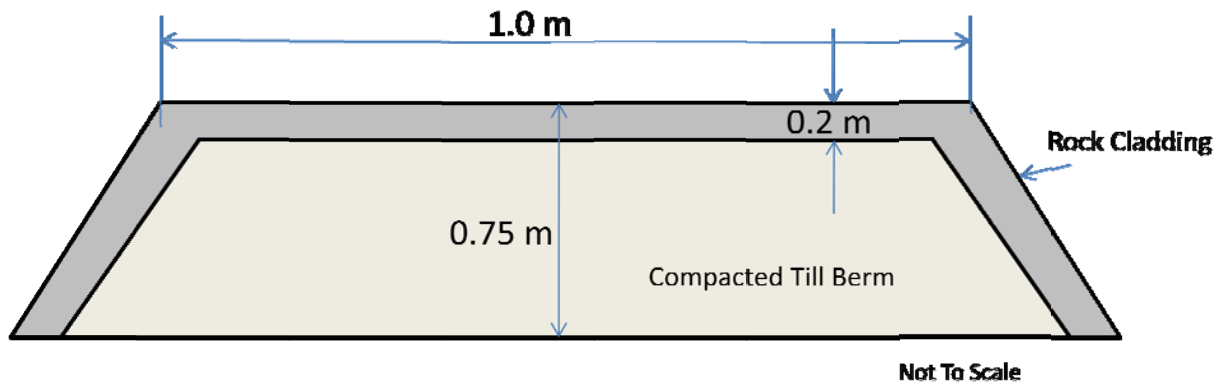


Figure 2a: Berm 1 section. This is a typical section for Berm 1 and 2.

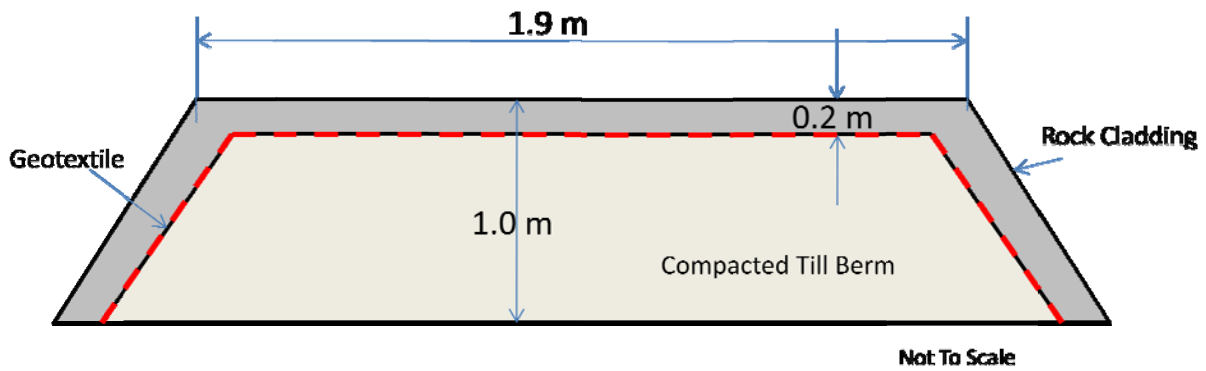


Figure 2b: Berm 3 section, showing geotextile layer.

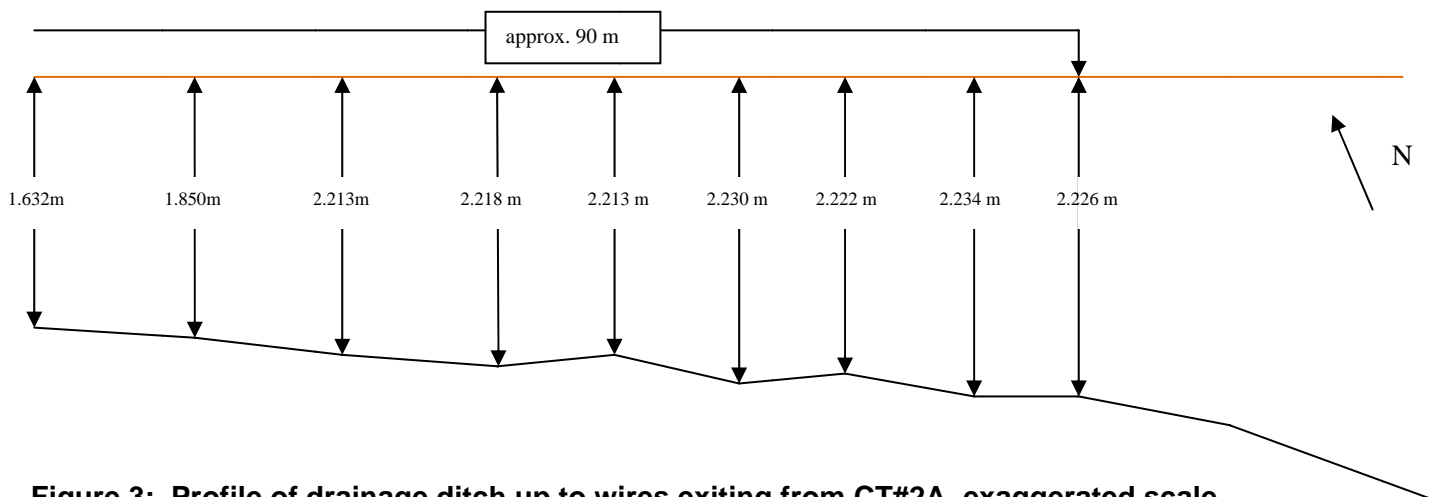


Figure 3: Profile of drainage ditch up to wires exiting from CT#2A, exaggerated scale. Some very minor high spots, overall grade is 0.7% downhill



Photo 1: Access road from west side, below CT#4



Photo 2: Access road from the east side, below CT#1



Photo 3: Berm 3 under construction, geotextile overlying compacted till and then clad with rock



Photo 4: Berm 2 in foreground, Berm 3 in background



Photo 5: Berm 1



Photo 6: Drainage ditch, looking east. New pipe to protect wires



Photo 7: Drainage ditch, looking west



Photo 8: Drainage ditch, draining south onto slope



Photo 9: West side of CT#4, erosion has been repaired and compacted



Photo 10: Between CT#4 and CT#3A, erosion repaired, berm repaired and pipelines fixed and covered with soil



Photo 11: Repairing erosion around the lower monitoring hut by shoring up the gully and placing rock and clean gravel



Photo 12: Re-graded 'snowmelt pond', looking northeast



Photo 13: Possible drainage path for ponding water, if necessary, connecting to the drainage ditch. To the east of CT#2B