Rio Algom Mining LLC

December 3, 2015

Mr. Scott T. Anderson
Utah Division of Environmental Quality
Division of Waste Management and Radiation Control
PO Box 144880
195 North, 1950 West
Salt Lake City, Utah
84114-4880

RE: Work Plan for the Lisbon Facility Hydrogeological Supplemental Site Assessment; Radioactive Material License Number UT 1900481; Rio Algom Mining LLC, San Juan County, Utah

Dear Mr. Anderson:

Rio Algom Mining LLC (RAML) is pleased to submit the enclosed *Work Plan for the Lisbon Facility Hydrogeological Supplemental Site Assessment* consistent with the requirement specified in your October 15, 2015, letter to RAML. The attached Work Plan provides the technical approach and procedures for performing the evaluations that will support the revision of the *Supplemental Site Assessment to Address Out-of-Compliance Status at Trend Wells RL-1 and EF-8* (Montgomery & Associates, July 2014), including the following:

- Characterization of the Lisbon Valley Fault (LF) geochemistry and hydrogeology as well as additional characterization of the contaminant plumes associated with the tailings impoundments,
- Geochemical modeling to define the origin of dissolved uranium in groundwater in the vicinity of the LF and its relationship to the uranium emanating from the tailings impoundments,
- Revisions to the Site Conceptual Model and Flow and Transport Model to enable a defensible calculation of Alternative Concentrations Limits for closure of the Site and transfer to the Department of Energy.

As discussed with your staff on November 10, 2015, it is necessary that we perform the field work associated with characterization of Coyote Wash, a perennial stream to the north of the Facility, no later than January 2016 in order to capture the seasonal variations this important feature may have on Site conditions. We understand that your staff understands the importance of this work and agrees with the schedule.

The schedule for all activities provided in the Work Plan is aggressive and we are hoping for a timely review process in order to be able to stay on track. Please do not hesitate to call me or Ms. Theresa Ballaine at (209) 736-4803 if you have questions about the Work Plan.

Sincerely,

Rio Algom Mining Company LLC

Anthony Baus

Anthony Baus
Site Manager

Enclosure

WORK PLAN FOR THE LISBON FACILITY HYDROGEOLOGICAL SUPPLEMENTAL SITE ASSESSMENT

Radioactive Material License Number UT 1900481
San Juan County, Utah

Prepared for:

Rio Algom Mining LLC
P.O. Box 218
Grants, NM 87020

Prepared by:

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December 3, 2015

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ACRONYMS AND ABBREVIATIONS

ACL	Alternate Concentration Limit
BCA	Burro Canyon Aquifer
BLM	Bureau of Land Management
COC	constituent of concern
Confluence	Confluence Environmental Inc.
CSM	Conceptual Site Model
DEQ	Utah Department of Environmental Quality
DOE	Department of Energy
DPP	drive-point piezometer
DST	drill-stem test
DWMRC	Utah Division of Waste Management and Radiation Control
DWMRC Response	*Responses to Comments from the Utah Division of Radiation Control on 2014 Supplemental Site Assessment Report* dated March 26, 2015
EDD	electronic data deliverable
Energy Labs	Energy Laboratories
GWB	Geochemist's Workbench
INTERA	INTERA Incorporated
Kd	sorption coefficient
K_ds	In-situ Distribution Coefficients
LF	Lisbon Valley Fault
LTI	Lower Tailings Impoundment
LTSM	Long-Term Surveillance and Maintenance
mg/L	milligrams per liter
POC	Point of Compliance
POE	Point of Exposure
PRISM	Parameter Regression on Independent Slopes
RAML	Rio Algom Mining LLC
RFI	Request for Information

SAP	Site-Wide Groundwater Sampling and Analysis Plan
SCM	surface-complexation model
Site	Lisbon Facility
SSA Report	Supplemental Site Assessment Report
SWB Model	Soil Water Balance Model
TAL	Target Action Level
TDS	total dissolved solids
UTI	Upper Tailings Impoundment
Work Plan	Work Plan for the Lisbon Facility Hydrogeological Supplemental Site Assessment, Radioactive Material License Number UT 1900481

1.0 INTRODUCTION

INTERA Incorporated (INTERA) has prepared this *Work Plan for the Lisbon Facility Hydrogeological Supplemental Site Assessment, Radioactive Material License Number UT 1900481* (Work Plan) in response to the Request for Information (RFI) issued by the Utah Division of Radiation Control (now Utah Division of Waste Management and Radiation Control [DWMRC]) dated October 17, 2014. The RFI was based on DWMRC's review (DRC, 2014) of the July 22, 2014, report titled *Supplemental Site Assessment to Address Out-Of-Compliance Status at Trend Wells RL-1 and EF-8, Lisbon Facility* (Montgomery & Associates, 2014) (SSA Report) and the associated Stipulation and Consent Agreements between the Utah Department of Environmental Quality (DEQ) and Rio Algom Mining LLC (RAML) (DEQ, 2012, 2013). The DWMRC's comments clearly indicated the need for additional site investigation to define the groundwater flow system, the exposure pathways, and the geochemical processes that influence the occurrence and mobility of uranium in the vicinity of the Lisbon Facility (Site).

To address the issues in the DWMRC's RFI, RAML and its contractors developed *Responses to Comments from the Utah Division of Radiation Control on 2014 Supplemental Site Assessment Report* (DWMRC Response), dated March 26, 2015 (**Appendix A**). The DWMRC Response provides the general approach for how each of the RFIs is to be addressed. RAML received comments on the DWMRC Response (**Appendix B**), which cite the importance of collecting Site-specific data that support hypotheses developed for the Site. The comments provided by DWMRC stressed the importance of adding the following activities to the required third phase of Site characterization activities:

- Characterization of the Lisbon Valley Fault (LF) geochemistry and hydrogeology through collection of core data
- Detailed evaluation of geochemical data to delineate the origin of dissolved uranium in groundwater in the vicinity of the LF, especially its relationship to uranium emanating from the tailings impoundments
- Characterization and improved representation of model boundaries and associated boundary conditions, especially along the western and northern boundaries, leading to development of a Site water balance, delineation of exposure pathways, and a revision of the Conceptual Site Model (CSM)

This site investigation described in this Work Plan will provide a comprehensive understanding of the Site hydrogeological and geochemical systems, which will in turn provide a solid foundation for: (1) addressing the DWMRC's RFIs, (2) developing revised Alternate Concentration Limits (ACLs), and (3) transferring the Site to the Department of Energy (DOE). The Site characterization details described in this Work Plan are based on the best available information for the Site and are subject to change based on unexpected Site conditions or improved understanding of Site conditions leading to Work Plan revisions. Proposed changes to the approach described herein will be discussed with DWMRC prior to implementation.

The DWMRC comments have been grouped into the key Work Plan Elements provided in **Table 1.** **Table 1** is a cross reference for these Work Plan Elements, the DWMRC's comments, and the Work Plan Tasks described in this document.

Table 1. Work Plan Elements Identified from DWMRC Response (Appendix A)

Element ID	Work Plan Elements	DWMRC Specific Comment	RAML Work Plan Task
1	Develop a Site water balance	21	1.1
2	Characterize confined conditions in the Burro Canyon Aquifer (BCA)	5	1.3
3	Characterize the LF as a flow boundary and a potential pathway for constituents of concern (COCs)	2, 3, 14, 41, 47	1.3, 3
4	Characterize the geochemical signature of the LF and compare it to the plume	3, 14, 28, 29, 30, 31	2.1, 2.3
5	Conduct geochemical characterization and analysis	3, 14, 23, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 39, 40, 46, 62	2
6	Drill additional monitoring wells for COC plume delineation	62	3
7	Evaluate flow model boundaries and appropriate boundary conditions	20, 21, 62	1.1, 1.3, 3, 4
8	Improve hydraulic parameter estimates for the BCA	15, 16, 17, 19,	1.3
9	Evaluate density effects on COC transport	6, 7, 8, 42	4
10	Update the CSM	6, 7, 10, 13, 21, 22, 23, 25, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48	1, 2, 3
11	Develop a defensible Site flow and solute transport model	20, 49-58	1-4
12	Calculate ACLs	59, 60, 61	5
13	Prepare ACL application	**Appendix B**	6

2.0 WORK PLAN ELEMENTS

The Work Plan is divided into the following technical tasks:

- Task 1: Hydrologeological Evaluation
- Task 2: Geochemical Evaluation
- Task 3: Well Installation
- Task 4: Flow and Transport Model
- Task 5: New ACLs and Target Action Levels (TALs)
- Task 6: Reporting

Figure 1 illustrates the Site located near La Sal, Utah, and illustrates the area within which the hydrogeological and geochemical evaluations of the groundwater flow system will be completed. The anticipated activities associated with each task are detailed below.

2.1 Task 1 – Hydrogeological Evaluation

A hydrogeological evaluation of the Site, in conjunction with the geochemical evaluation (Task 2), will be performed to provide a better understanding of groundwater flow and solute transport and to update the CSM (**Table 1,** Element 10). As part of the hydrogeological evaluation of the Site, INTERA will perform the following subtasks:

- Develop a Site water balance.
- Develop a three-dimensional geologic block model.
- Conduct hydraulic testing to further characterize the hydraulic parameters controlling groundwater flow.

2.1.1 Task 1.1 – Site Water Balance

A water balance of the Site is essential in developing a defensible CSM as it identifies all inputs and outputs to the groundwater and surface water flow system. The DWMRC Response defines this need (**Table 1,** Element 1), and its execution will provide the basis for model defensibility required by the DWMRC.

As part of the Site water balance, RAML will evaluate surface water and groundwater flow in the region encompassing the Site. All processes that influence groundwater flow will be evaluated, including tailings seepage, groundwater recharge, evapotranspiration, groundwater flow from the La Sal Mountains, and surface water-groundwater interaction. Incorporating these processes into a Site water balance will greatly improve our understanding of groundwater flow at the Site and support development of the updated CSM and the Site-wide groundwater flow model.

Areal recharge to groundwater resulting from precipitation will be estimated using Site-specific data and a distributed Soil Water Balance Model (SWB Model) (Westenbroek et al., 2010) that incorporates the physical processes occurring at the ground surface, including the melting of snow, the routing of surface runoff, interception of rainfall captured by vegetation or transpired from plant surfaces, evapotranspiration, and surface runoff (SCS, 1993). The SWB Model is a modified version of the Thornthwaite-Mather soil water balance approach (Thornthwaite and Mather, 1957). Data used to estimate recharge include precipitation, evapotranspiration, air temperature, wind speed, surface slope, soil type, and vegetation cover. Much of these data are currently available from the nearby meteorological station in La Sal, Utah. Additional data, including daily, spatially distributed temperature and precipitation, can be obtained from the Parameter Regression on Independent Slopes Model (PRISM) dataset (PRISM, 2015). Detailed soil information, including soil type, can be obtained from the Soil Survey Geographical database (NRCS, 2015), which contains information collected by the National Cooperative Soil Survey during the past century.

Field data from temperature/soil moisture sensors will be used to verify components of the SWB Model. Temperature and soil moisture sensors will be deployed at multiple sites in the shallow subsurface to quantify the onset, duration, and location of runoff and shallow recharge events along ephemeral channels and adjacent to hill slopes on-site and along Coyote Wash following precipitation (**Figure 2; Appendix C**). Data will be collected using data loggers for approximately one year in order to capture seasonal fluctuations.

Due to the anticipated low areal recharge in the immediate vicinity of the Site, groundwater flow originating in the La Sal Mountains to the northeast of the Site may account for a large proportion of the volumetric groundwater flow in the vicinity of the Site. As part of development of a water balance of the Site and surrounding area, groundwater flow from the La Sal Mountains migrating to the south and west toward the Site will be estimated. Groundwater flow from the La Sal Mountains will be estimated using water levels at wells located on-site as well as wells to the north of Coyote Wash in the vicinity of La Sal in conjunction with SWB Model results and regional hydrogeology. If available, data characterizing the hydrochemistry of groundwater flowing from the La Sal Mountains may also be used to help characterize the contribution of groundwater originating in the La Sal Mountains to the water balance for the Site and surrounding area.

Coyote Wash to the north of the Site represents a naturally occurring hydraulic boundary in the surface water flow system. Coyote Wash may also represent a hydraulic boundary for the groundwater flow system in that area and, therefore, may be an appropriate choice for the northern extent of the groundwater flow model. However, further to the east, and south of La Sal, Coyote

Wash rises above the regional water table and no longer represents a hydraulic boundary. In areas where Coyote Wash is above the water table, groundwater flows beneath the wash from the La Sal Mountains toward the Site. To determine if Coyote Wash to the north of the Site acts as either a groundwater discharge or recharge boundary, or if it alternates between the two scenarios depending on seasonal precipitation patterns, drive-point piezometers (DPP) installed at three locations (three piezometers at each location) (**Figure 2; Appendix C**) will be used to characterize the hydraulic nature of the boundary. The DPPs are narrow-diameter stainless steel pipes with a 6-inch perforated zone at the bottom to allow water to flow in. A pointed tip at the bottom allows for the DPPs to be driven into the ground using a hand-held hammering device. A shallow (~2 feet [ft]) DPP and a deep (~4 ft) DPP will be placed at the edge of the surface water channel in Coyote Wash to provide information on vertical hydraulic gradients beneath the creek. A deep DPP will be placed approximately 10 ft away from the other two and will help establish lateral gradients in the wash. Data from the drive points will be used to further calibrate the SWB Model, and to determine the type of boundary condition to apply for the portion of Coyote Wash to the north of the Site. Water levels will be collected using data loggers for approximately one year.

Seepage of water from the closed tailings impoundments is the source of COCs in groundwater at the Site. COC concentrations downgradient of the tailings impoundments are a function of the seepage volume and concentrations of COCs in the seepage, and of processes occurring along the flow path. As a result, characterization of the tailings water seepage is an important component of the Site water balance and flow and solute transport model (**Table 1,** Elements 1 and 11). Lewis (2001) provides an estimate of tailings water seepage over a 1,000-year period starting in 1990. The tailings water seepage was estimated using the unsaturated-saturated groundwater flow code HYDRUS-2D (Simunek et al., 1999). The tailings water seepage model developed by Lewis (2001) will be reviewed and updated, if necessary, to reflect new information collected on the tailings or climate at the Site that may affect recharge through the tailings. Tailings water seepage estimates from the HYDRUS-2D model will be applied in the flow model and, along with estimated concentrations of COCs in the tailings water seepage (Task 2.1), constitutes the COC source term in the flow and solute transport model (Task 4).

2.1.2 Task 1.2 – Geologic Model

An important component of the CSM is an accurate and complete description of the geologic and hydrogeologic units that occur at the Site (**Table 1,** Element 10). A three-dimensional geologic block model of the Site and surrounding area will be developed using Leapfrog Hydro (ARANZ, 2015). A geologic block model incorporates all that is known regarding the hydrogeology of a site into a single model that provides a tool for visualization of the spatial structure of the groundwater flow system, leading to a clearer understanding of the structural controls imposed on groundwater flow. Using Leapfrog Hydro, a numerical flow model grid will be developed directly from the geologic model, allowing for direct transfer of the hydrostratigraph defined in the three-dimensional geologic model to the three-dimensional numerical flow model.

2.1.3 Task 1.3 – Hydraulic Testing

Aquifer testing will be conducted on both existing wells and newly installed wells to address uncertainties in the conceptualization of groundwater flow at the Site including: (1) the extent of the area where the BCA behaves as a confined aquifer, (2) accurate characterization of the aquifer hydraulic parameters (hydraulic conductivity and aquifer storage), and (3) characterization of the type of boundary represented by the LF (**Table 1,** Elements 2, 3, 10, and 11).

To evaluate aquifer confined conditions, and to further evaluate the hydraulic parameters of the aquifer, water level responses to barometric pressure fluctuations will be used to estimate hydraulic conductivity of the formation surrounding the well and will enable evaluation of confining conditions (Toll and Rasmussen, 2007). Data loggers (Trolls) will be installed in 15 existing wells (**Figure 2**) to measure head fluctuations resulting from changes in barometric pressure. These wells will be located on both sides of the Lisbon Valley Anticline. A separate barometric pressure probe (Troll) will be installed above the water table in one well to provide reference barometric pressure data.

Hydraulic tests will be conducted in the core holes drilled in the LF (**Figure 3**). Jacobs and Kerr (1965) describe a variety of rocks altered by the LF that were exposed in the incline that provided access to the North Alice uranium mine located approximately 1 mile southeast of MW-116 along the LF zone (**Figure 3**), including: (1) a broken and mineralized zone approximately 4 ft wide at the fault core, (2) a sheared and altered zone in the Burro Canyon that is 10 to 20 ft wide, (3) a silicified sandstone in the Burro Canyon on the order of 30 ft wide, (4) a sheared and altered zone in the Chinle formation approximately 4 ft wide, and (5) a bleached zone several feet wide in the Chinle formation. These altered zones may be of either high or low hydraulic conductivity, depending on whether the fractures are open or are mineralized. In the four core hole locations (C-125, C-126, C-127, and C-128) (**Figure 3;** Task 3), straddle-packer testing will be performed to quantify the hydraulic conductivity of the various rock units encountered in and near the fault (**Appendix D**). Test intervals will likely be on the order of 5 to 10 ft long, and will be selected based on examination of the core, borehole flow meter tests, geophysical logs (described below), and other available information so as to provide a clear understanding of the hydraulic properties of the various rock types in and adjacent to the fault.

Geophysical logging will be conducted in each of the four core holes drilled through the LF. The logging will be conducted using industry-standard methods for open-hole logging. The purpose of the logging is to document subsurface physical properties and to verify the lithologic descriptions of the boreholes. The logging suite will document the borehole diameter and rugosity, lithologic contrasts (such as the contact between sandstone and shale), water saturation and water quality, and potential presence of naturally occurring radionuclides (i.e., uranium-bearing zones). The proposed logging suite is as follows: caliper, resistivity (16”, 64”), self potential, natural gamma ray, and neutron.

The logging activities will be supervised by the project field geologist under the supervision of the project’s Utah Professional Geologist.

The specific type(s) of hydraulic tests performed in the straddled intervals will depend on the hydraulic conductivities encountered. The straddle-packer tool will include a downhole shut-in valve and a hydraulic piston that can be extended or retracted to create a near-instantaneous pressure change in an isolated interval (**Appendix D**). If examination of core and geophysical logs suggests that an interval will have low hydraulic conductivity, a pulse-withdrawal test will be performed by retracting the piston with the interval shut in to decrease the pressure in the interval and then monitoring the pressure recovery. The pressure-recovery data will be simulated using the code nSIGHTS (Geofirma/INTERA, 2011) to obtain an estimate of the hydraulic conductivity of the test interval. nSIGHTS is a publically available and widely used code in the radioactive waste disposal community (United States, France, Switzerland, Japan, Canada, S. Korea, Taiwan) for interpreting hydraulic tests conducted on fractured and low-permeability formations (e.g., Beauheim et al., 2013). As such, the nSIGHTS tool is well-suited for the testing to be conducted at the Lisbon Site. Pulse tests are appropriate for hydraulic conductivities of approximately $1E^{-10}$ m/s or lower. If the hydraulic conductivity is found to be higher than this value, the pulse test will be completed in a matter of minutes, and a more appropriate test, such as a slug test, will be performed.

Rising-head slug tests will be performed in intervals expected to be of higher hydraulic conductivity, e.g., those with open fractures or other visible porosity. Slug tests may be performed either by (1) removing some of the water in the tubing string supporting the packers while the shut-in valve is closed, and then opening the shut-in valve to allow water to flow into the tubing; or (2) using a pneumatic wellhead assembly to pressurize the air column in the tubing enough to push the water column down, and then rapidly venting the air, allowing the water level to recover (**Appendix D**). If the early slug-recovery data indicate that the test will take more than a few hours to reach full recovery, the test will be converted to a drill-stem test (DST) by closing the shut-in valve. Full-pressure recovery will be achieved much more rapidly with the shut-in valve closed than it would with the shut-in valve open. In either case, the data will be interpreted using the code nSIGHTS to obtain an estimate of the hydraulic conductivity of the test interval. If possible, water quality samples will be collected from the higher hydraulic conductivity intervals while they are isolated with straddle packers.

Upon completion of the straddle-packer testing, core holes C-125 and C-126 will be converted to monitoring wells MW-125 and MW-126, respectively, by completing the wells in the highest hydraulic conductivity intervals encountered within the fault zone. This will likely involve plugging the lower portions of the holes before installing well screen. Further hydraulic testing on MW-125 and MW-126 will not be conducted. If the C-127 and C-128 core holes are stable, they will be left open and monitored while the nearby MW-127 and MW-128 monitoring wells are tested, after which they will be plugged and abandoned.

Monitoring wells MW-123, MW-124, and MW-128 will be hydraulically tested in one of two ways involving a pneumatic wellhead assembly. MW-123 and MW-124 will be tested using the pneumatic slug testing method described above. In MW-128, a pneumatic sinusoidal test will be performed to provide information on the BCA hydraulic conductivity and the hydraulic role played by the LF zone, that is, if the fault zone at that location acts as a hydraulic barrier or as a hydraulically conductive zone. Pneumatic sinusoidal tests use sinusoidally varying air pressure in the well casing above the water column to create sinusoidally varying flow in and out of the well, which causes a sinusoidal pressure signal to propagate through the aquifer (Fort et al., 2015; **Appendix D**). By steadily increasing the period of the sinusoidal signal and measuring any changes in the phase lag between the air pressure wave and the flow wave, the presence and nature (increased or decreased hydraulic conductivity) of a hydraulic barrier can be detected. Pneumatic sinusoidal tests are often preferable to pumping tests because they do not require that an appropriately sized pump be installed and they do not result in any produced water. To limit the pneumatic sinusoidal testing time to no more than two days, the tested well should be no farther than 50 ft from the fault. If testing of C-126 shows that the fault zone is within 50 ft of existing monitoring well MW-116 and the Wingate sandstone on the footwall side of the fault is below the water table opposite the BCA, pneumatic sinusoidal testing could be performed in MW-116 instead of in MW-128. In that case, only a pneumatic slug test would be performed in MW-128.

A pumping test (**Appendix D**) will be conducted in monitoring well MW-127 with the objectives of determining the hydraulic conductivity of the aquifer and the hydraulic role played by the LF in that vicinity. Pneumatic testing will almost certainly not be possible in MW-127 because the water level in that well is expected to be less than 20 ft below the ground surface.

2.2 Task 2 – Geochemical Evaluation

The DWMRC Response (**Appendix A**) provided general approaches to dealing with geochemical uncertainties in the CSM that were described in the SSA Report (Montgomery & Associates, 2014)

(**Table 1,** Elements 5 and 10). Overarching issues raised by these comments can be summarized in terms of the following questions:

1. Are distinctive features of groundwater associated with the LF (e.g., low pH, high total dissolved solids [TDS]) the result of naturally occurring geochemical processes?
2. Could COCs (uranium, arsenic, selenium, molybdenum) in fault groundwater come from a tailings source?
3. Could COC transport be attenuated along the fault zone by geochemical reactions?
4. Could COC transport be similarly attenuated along flow paths in the North and South plumes of the BCA?

These issues will be addressed in field, laboratory, and modeling investigations that are described below. The results of the investigations will be used to reduce uncertainties in the CSM, and to strengthen the technical basis for selection of credible and defensible ACLs for the Site.

2.2.1 Task 2.1 – Geochemical Characterization

Geochemical data that are needed to address uncertainties in the CSM and uncertainties related to DWMRC Questions 1, 2, and 3 (noted above) will be obtained in this task. The work scope includes several activities that will be carried out during planned field investigations at the Site (Task 1). The activities will address (1) the petrography of the LF zone; (2) hydrochemical characteristics of Site groundwater and surface water, and of groundwater located within or near the LF zone; and (3) characterization of COC source-term concentrations that will be used in the Site groundwater flow and solute transport model (Task 4). These activities are described in the following sections.

2.2.1.1 Petrographic Investigations

Site-specific data characterizing the petrography of the LF zone are needed to evaluate whether geochemical conditions within this zone result from naturally occurring processes such as localized gas-water-rock interactions, possibly with little or no impact from mixing or reactions with tailings solutions (Montgomery & Associates, 2014). Because such data are not presently available, four new core holes and wells will be drilled at the Site to intersect the fault's altered hanging wall and footwall (Task 3). Up to ten samples will be collected from each core hole for detailed analysis. Visual inspection of the core for evidence of hydrothermal alteration (e.g., argillization, silicification, sulfidation) and weathering will be used to guide sample selection. Petrographic analyses of drill core samples obtained in previous investigations near wells MW-116 and MW-107S/D (Montgomery & Associates, 2014) will also be conducted if it is determined that the cores intersected significant sections of the LF zone.

The petrographic analyses will be carried out by an INTERA associate (Dr. Paula Hansley) using facilities at the Colorado School of Mines in Golden, Colorado. Thin sections of the samples will be prepared. Petrographic analyses using transmitted and reflected light microscopy will be used to determine the mineralogy and paragenesis of the samples. Digital photomicrographs will be used to characterize sample textures. Energy dispersive qualitative chemical analyses and digital images of minerals will be obtained by scanning electron microscopy. The mineralogy of bulk samples will be characterized by quantitative X-ray diffraction. A split of each sample will be analyzed for whole-rock chemistry, including all major ions and COCs.

The results of these analyses will be evaluated to identify mineralogical constraints on conceptual models of gas-water-rock interactions within the LF zone. The results will be compared and integrated with similar studies related to copper and uranium mineralization along the LF outside the Site's boundaries (Hahn and Thorson, 2006; Jacobs and Kerr, 1965; USDOI, 1997; DEQ AWQMS, Undated). The conceptual model will be evaluated quantitatively using a numerical geochemical model of gas-water-rock interactions (Task 2.3), and model results will be compared with the hydrochemistry of fault groundwater and other data as appropriate. Agreement between model results and field data would support the hypothesis that geochemical conditions along the LF result from naturally occurring processes.

2.2.1.2 Hydrochemical Investigations

These investigations will be carried out with two objectives in mind: (1) to determine whether different types of Site water (recharge, surface water, groundwater, tailings solutions, fault groundwater) have unique characteristics that can be readily distinguished, and (2) to provide Site-specific data characterizing the hydrochemistry of the LF. Both objectives address DWMRC Questions 1, 2, and 3 (noted above) concerning whether geochemical conditions within this zone result from naturally occurring processes, possibly with little or no impact from mixing or reactions with tailings solutions (Montgomery & Associates, 2014). Field activities will be carried out in coordination with the project *Site-Wide Groundwater Sampling and Analysis Plan* (SAP) (**Appendix E**).

Chemical Characteristics of Site Water

The presence of, and interactions among, distinctly different water types within and near the Site's boundaries are important features of the CSM. Investigations will be carried out in this task to better define distinctive chemical characteristics, or chemical "signatures," of these solutions. A systematic approach that includes as many of the following steps as necessary to determine these signatures will be carried out:

- Develop and maintain a Site hydrochemical database in accordance with the SAP (Task 2.2) (including critical assessments of analytical quality and sample representativeness).
- Identify empirical trends among the concentrations (or concentration ratios) of solution constituents using time-series and binary (i.e., solute-solute correlation) plots.
- Identify chemical signatures based on empirical trends among the concentrations of multiple aqueous constituents (e.g., using Piper and Stiff diagrams).
- Identify chemical signatures based on multivariate geostatistics (hierarchical cluster analysis, principal component analysis).
- Identify plausible equilibrium constraints such as may be interpreted from plots of solution chemistry data on thermodynamic diagrams (Eh-pH, activity-activity) for relevant chemical sub-systems (e.g., UO_2-S-CO_2-HF-HCl-H_2O; CuO-FeO-S-CO_2-H_2O).

The results of these analyses will be evaluated and integrated to define possible chemical signatures of different Site water types. The chemical signatures identified in this activity will provide a basis for determining whether the water types have (or may have) evolved as a result of mixing and geochemical reactions. In particular, the results will be used to determine the extent to which tailings solutions may have interacted with naturally occurring groundwater along the LF.

Lisbon Valley Fault Hydrochemistry

To develop a better understanding of the geochemistry of the LF zone, four new groundwater monitoring wells will be drilled in close proximity to the fault (Task 3). The wells will be sampled in accordance with the SAP (Task 2.2; **Appendix E**). The data obtained from these new wells will supplement sampling data from existing monitoring wells MW-116 and MW-107S/D, which are also located close to the fault.

This task will include activities to develop a better understanding of the chemical characteristics of LF groundwater and to extend the analyses of the chemistry of these solutions. These proposed activities are described in the following paragraphs.

The January 2015 sampling and analysis event at well MW-116 indicated that groundwater from this location contain exceptionally high concentrations of aluminum, copper, iron, cadmium, and zinc. This well is believed to be located within the LF zone, which suggests that the elevated concentrations of these specific metals could be a distinguishing feature of fault groundwater compared to other groundwater in the area (including plume water from the tailings impoundments). These metals will therefore be included as analytes in future sampling events at MW-116, MW-107S/D, and the four new wells described in Task 3. They will also be included in sampling events at Point-of-Compliance (POC) wells OW-UT-9 and EF-3A for comparison with the LF solutions. The results of this investigation will be used to provide constraints on conceptual models of gas-water-rock interactions in the LF (Task 2.3), and to determine whether elevated concentrations of aluminum, copper, iron, cadmium, and/or zinc are distinctive characteristics of fault-impacted groundwater.

2.2.1.3 Chemical Constraints on the Source Term

The “source term” in a groundwater flow and solute transport model refers to solute (including COC) fluxes from a source region, which at the Lisbon Site can be taken to be the footprints of the tailings impoundments. The source term will be estimated in this task based on a review of historical data characterizing the chemistry of solutions that have been sampled at POC wells OW-UT-9 and EF-3A, which are located close to (i.e., within several hundred feet of) the upper and lower impoundments, respectively. Reasonable upper bounds on uranium, selenium, arsenic, and molybdenum concentrations determined in this review will be used with estimated seepage fluxes from the tailings impoundments (Task 1.1) to define conservative source-term concentrations for these solutes. These concentrations will be used in the Site groundwater flow and solute transport model (Task 4) to develop defensible ACLs for these constituents.

2.2.2 Task 2.2 – Site-Wide Hydrochemical Monitoring, Database Management, Annual Sampling, and Analysis Report

Hydrochemical data will continue to be collected and analyzed according to the procedures in the SAP (**Appendix E**). Confluence Environmental, Inc. (Confluence), will continue to provide groundwater sampling services. INTERA will field-supervise all comprehensive sampling events. Analytical services will continue to be provided by Energy Laboratories (Energy Labs). The analytical suite will remain the same with the proposed addition of aluminum, copper, iron, cadmium, and zinc to the analyses of selected wells (Task 2.1). These metals will be used as another line of evidence to determine whether tailings water has reached MW-116 (see Task 2.3). Preliminary results show high levels of copper in MW-116 (1,260 milligrams per liter [mg/L]) and low levels of copper in OW-UT-9 (0.05 mg/L) and EF-3A (0.3 mg/L); no aluminum analyses are available for wells other than MW-116. If the source tailings water is not high in these constituents, another source for the metals must exist at or near the fault zone.

INTERA will manage field parameter, water level, and geochemical data in the existing RAML Lisbon database, which can be accessed through EnviroData. Field parameters and water levels supplied by Confluence will be checked for accuracy and manually entered into the database. Electronic data deliverables (EDDs) provided by Energy Labs will similarly be checked for accuracy against provided lab reports and imported into the database in a format consistent with the current database structure.

Data compiled in the database will be used to generate the 2015 annual groundwater monitoring report for the Site for submittal on March 1, 2016. The annual report will contain (in accordance with the DWMRC Radioactive Materials License #UT1900481, Amendment5, Condition 53G) sampling methodology; field parameter measurements; laboratory information; a data evaluation; data tables; concentration vs. time plots for the compliance wells; groundwater elevation contour maps; contaminant concentration contour maps for arsenic, molybdenum, selenium, and uranium; and a comparison of measured uranium concentrations to predicted concentrations in compliance wells. The Site groundwater flow and transport model is currently under revision as described in this Work Plan. As soon as this revised model is approved by the DWMRC, it will be used to compare measured vs. predicted concentrations for uranium in compliance wells.

2.2.3 Task 2.3 – Geochemistry of the LF Zone

This task will develop a conceptual understanding of processes controlling the chemistry of groundwater in the LF zone. An understanding of these processes that is as quantitative as possible while being consistent with the available Site data is an essential requirement of the CSM and will also be used to address DWMRC Questions 1, 2, and 3 (noted above). In particular, this task will determine whether the geochemical conditions within the LF zone are naturally occurring.

Groundwater in or near the LF within the Long-Term Surveillance and Maintenance (LTSM) boundary appear, based on chemical analyses of groundwater samples from wells MW-116 and MW-107S, to be characterized by low pH, high TDS, and elevated concentrations of various solutes including sulfate, aluminum, copper, iron, and uranium. These characteristics could result from groundwater reactions with minerals that were deposited in the hanging wall of the fault zone during earlier periods of hydrothermal activity. For example, hydrothermally altered rocks in this zone contain pyrite, clay, organic matter (hardened asphalt), copper sulfides, and other minerals (Jacobs and Kerr, 1965, p. 425-426; Morrison and Parry, 1986, p. 1855). Supergene weathering of these altered rocks is evidenced by a zone of secondary oxidized minerals (e.g., azurite, cuprite, native copper), to a depth of about 150 ft, overlying a zone of primary hypogene sulfide mineralization (predominantly chalcocite) (Hahn and Thorson, 2006, p. 525; Adkins et al., 2009, p. 29). Also noteworthy is the fact that, in at least a few occurrences of the BCA within the LF zone where disseminated copper mineralization exists, elevated concentrations of uranium and other radionuclides have also been measured in groundwater samples (Hahn and Thorson, 2006, p. 524). These observations suggest that at least some groundwater presently flowing into and along the fault zone was initially oxidizing, and that the resultant oxidation of sulfide minerals has generated acidic, high-TDS solutions, such as have been sampled in wells MW-116 and MW-107S

(Table 11 in Montgomery & Associates, 2014). The present-day hydrochemistry of the LF zone may thus be controlled largely by natural processes stemming from an early period (or periods) of hydrothermal alteration of the hanging wall.

Conceptual models of geochemical processes within the LF zone will be developed using: (1) site-specific characterization data (Task 2.1, Task 2.2), including data charactering the chemistry of fault groundwater (i.e., from MW-116, MW-107S, and four new wells [Task 3]); and (2) the petrography of the fault zone. Equilibrium/kinetic constraints will be interpreted based on these data using Eh-pH, phase-equilibrium, solubility, and other diagrams. The models will build upon principles of supergene weathering (e.g., Ague and Brimhall, 1989; Xu et al., 2001), and will consider as an initial working hypothesis that sulfide minerals in the hanging wall (and possibly footwall) of the fault are subject to oxidation by local meteoric recharge and/or shallow groundwater (possibly including the BCA impacted by the South Plume). Refinements to the working conceptual model will also be considered, including the possibility that uranium and other metals in fault groundwater come ultimately from external sources such as uranium occurrences in the Morrison and Chinle Formations or metals in the Mancos Shale (Hahn and Thorson, 2006, p. 524). The conceptual models will be evaluated quantitatively based on numerical simulations of coupled fluid flow and gas-water-rock interactions carried out using the reaction-path ("*React*") and 1D reactive-transport (*X1t*) modules in the Geochemist's Workbench (GWB) geochemical modeling software package and supporting thermodynamic databases (Bethke, 2008). Agreement between model results and Site characterization data would provide support for the view that present-day conditions along the LF are the result of naturally occurring geochemical processes.

The conceptual model refinements developed in this task may (i.e., if feasible) be used to determine whether COC transport could be significantly attenuated within the fault zone. For example, based on the working hypothesis noted above, groundwater flow through the zone of sulfide mineral oxidation (i.e., the "redox front") should cause the groundwater to become strongly reducing on the downstream side of the front. Under such conditions, the mobility of redox-sensitive COCs such as uranium may be strongly reduced by precipitation of low-solubility minerals such as amorphous uranium dioxide (Langmuir, 1997; Arthur et al., 2006). If so, redox fronts associated with the LF could be treated in the CSM as geochemical zones that effectively attenuate COCs along this potential transport pathway away from the Site.

2.2.4 Task 2.4 – Attenuation of COC Transport in the North and South Plumes of the BCA

Available Site data suggest that geochemical conditions along the North and South plumes of the BCA change progressively in terms of pH and ionic character to become increasingly more favorable for the sorptive attenuation of uranium transport as flow-path distances increase from the Upper Tailings Impoundment (UTI) and Lower Tailings Impoundment (LTI), respectively.

Attenuation of uranium by sorption on mineral surfaces is not presently accounted for in the CSM and could be an important process in constraining the selection of defensible ACLs for the Site. Task 2.4 will develop quantitative estimates of the extent to which sorption could attenuate COC transport in these plumes. The results of this work will also be used to address DWMRC Question 4 (noted above).

Task 2.4 will include two main activities: (1) estimation of *in-situ* distribution coefficients (K_ds) to quantify the extent of COC transport attenuation in the BCA, and (2) development of a complementary modeling approach to evaluate whether uncertainties in local environmental conditions could significantly affect predictions of transport behavior based on the K_d approach.

A K_d represents the (assumed) equilibrium ratio of the mass of a given sorbate (i.e., COC) per unit mass of sorbent (usually in units of mg g^{-1}) divided by the concentration of the sorbate in a coexisting aqueous solution (mg ml^{-1}). Retardation factors, representing the extent of solute transport attenuation in the groundwater flow and solute transport model, can be calculated as a function of K_d and the bulk density and porosity of the sorbent phase. *In-situ* K_ds can be estimated for geologic media such as the BCA if COC concentrations are known both in the host rock and coexisting aqueous phase (Langmuir, 1997). This is advantageous because *in-situ* K_ds are more representative than, and often differ significantly from, K_ds determined experimentally using batch or column methods.

BCA-specific, *in-situ* K_ds for uranium, arsenic, selenium, and molybdenum will be estimated in this task using drill core sampling data and groundwater quality data at four sites within the LTSM boundary: MW-102DB and MW-109 (near or within the North plume), MW-117M (South plume), and MW-118 (near the LF) (**Figure 3**). Core holes were drilled at each of these locations prior to completion as monitoring wells (Montgomery & Associates, 2014). Based on visual inspection of the core from each of these locations for the presence and relative abundance of potential sorbent phases (e.g., ferric oxyhydroxides), a representative range of samples from sections of each core that were within the saturated zone of the BCA will be analyzed for uranium, arsenic, selenium, and molybdenum. Petrographic analyses will also be carried out using the methods described in Task 2.1. The corresponding monitoring wells (or well MW-102, which is essentially co-located with MW-102DB) are screened in the BCA, and chemical analyses of groundwater samples from these wells are available (Montgomery & Associates, 2014). Measured uranium, arsenic, selenium, and molybdenum concentrations in the core samples and corresponding groundwater samples will be used to estimate *in-situ* K_d values for these COCs. Retardation factors will be calculated using the *in-situ* K_ds together with estimates of the bulk density and porosity of the BCA (Task 1). The retardation factors will be used in the groundwater flow and solute transport model (Task 4) to evaluate the extent to which COC transport is likely to be attenuated in the BCA. If the extent of attenuation is determined to be significant, the estimated retardation factors will be used in the flow and solute transport model (Task 4) to determine defensible ACLs for the Site.

The K_d approach is useful for modeling solute transport under specific environmental conditions, but because K_ds are inherently empirical in nature, they cannot be used to address how future changes or uncertainties in such conditions might impact solute transport behavior. A complementary geochemical modeling approach will therefore be developed in this task to gain insights concerning the extent to which such changes or uncertainties might impact predictions based on the K_d approach.

The sorption behavior of uranium, arsenic, selenium, and molybdenum in the BCA will be evaluated using a surface-complexation model (SCM) (e.g., Dzombak and Morel, 1990). Such models are useful for conditions at the Lisbon Site because they can describe changes in COC sorption as chemical conditions and aqueous speciation change along flow paths in the North and South plumes. Equilibria between aqueous chemical species and species formed at mineral surfaces (i.e., surface complexes) are modeled in an SCM using mass-action equations. The equations are incorporated in conventional reactive-transport modeling software such as the *X1t* module of the GWB (Bethke, 2008). Sorbent minerals for uranium in the BCA are likely to include iron oxyhydroxides.

Development of the sorption model will be carried out step-wise:

- Update interpretations of hydrochemical trends along probable flow paths in the North and South plumes by incorporating new sampling data, including data for local recharge and upgradient groundwater.
- Based on the observed trends, supported by aqueous-speciation calculations, refine conceptual models of important reactions controlling changes in groundwater chemistry as a function of distance along flow paths in the North and South plumes.
- Constrain the conceptual SCM using:
    - Data characterizing BCA mineralogy (based on results of core sampling, chemical analyses, and petrography used in the determination of *in-situ* K_ds).
    - Equilibrium constraints interpreted from Eh-pH, solubility, and other diagrams.
- Evaluate the conceptual SCM in numerical simulations using GWB and the Site groundwater flow model.
- Assess the reliability of the SCM by: (1) using model results to calculate K_d values that can be compared with results of the *in-situ* K_d values as described above, and, if possible, (2) comparing retardation factors calculated using the SCM with retardation factors

estimated from the relative velocities of reactive and non-reactive solute transport in the North and South plumes.

If the last step confirms that the SCM results are compatible with estimated *in-situ* K_ds, the model will be used to assess the extent to which uncertainties in environmental parameters (e.g., ranges in groundwater compositions) could affect COC transport, and, hence, selection of defensible ACL values for uranium, arsenic, selenium, and molybdenum.

2.3 Task 3 – Coring and Well Installation

DWMRC comments on the draft SSA Report identify two aspects of the groundwater system that will greatly benefit from drilling cores and wells: further delineation of the North and South COC plumes and characterization of the LF as a flow boundary and as an exposure pathway. Four core holes and six new wells are planned (**Table 1,** Elements 6, 7, 10, 11; **Table 2; Figure 3**) to address these issues.

Task 3 includes the following activities:

- Confirm locations for new wells, cores, or borings to be installed.
- Apply for well permits from the Bureau of Land Management (BLM).
- Clear underground utilities.
- Solicit and evaluate bids from drillers.
- Develop a health and safety plan to reflect Site-specific requirements.
- Oversee drilling operations.

Drilling operations require appropriate permits from BLM. One aspect of the permitting process is for BLM to conduct wildlife surveys of the Site to determine if there are sensitive areas where access restrictions are required. The surveys are conducted in March and April to allow for identification of raptor nesting sites. Due to the time frame for obtaining drilling permits, it is anticipated that well drilling will commence in mid- to late-summer 2016. New monitoring wells will be constructed following Utah Division of Water Rights (2011) guidelines (**Appendix F**).

Two wells were specifically identified by DWMRC to answer questions about plume extent and exposure pathways for both the South and North plumes (**Table 1,** Element 6). DWMRC suggested that the South plume may extend to the southwest and west of EF-3A and may be affecting groundwater near MW-116 and the LF (**Appendix A**).

To test this potential pathway, well MW-123 will be located to the west of well EF-3A, roughly between the fault and the well (**Figure 3**). Aquifer testing (Task 1.3) will be conducted on well MW-123 to characterize hydraulic parameters of the aquifer at that location.

DWMRC suggested that further delineation of the leading edge of the North plume is needed to the south or west of well MW-119 (**Appendix A**). After careful consideration of the known location of the North plume based on COC concentrations at wells, and evaluation of flow directions at the Site, it was determined that the direction the North plume could take that poses the largest risk would be in a direction northwest from MW-119. Therefore, MW-124 will be located northwest of MW-119, south of the LTSM boundary, and west of the Lisbon Valley Anticline (**Figure 3**).

RAML will drill four core holes and four new monitoring wells within and adjacent to LF zone. The LF is a regional normal fault located on the western margin of the Site. Coring the rock above (i.e., the hanging wall), within, and below the fault (i.e., the footwall) will provide a visual record of the nature of the fault which will aid in the interpretation of how the fault may influence groundwater flow and geochemistry (**Table 1,** Elements 3 and 4). Water levels recorded in these new boreholes, when incorporated in the calibration of the groundwater flow model, are anticipated to provide valuable guidance in understanding the larger-scale behavior of the LF (Task 4).

The methods for collection, description, and handling of rock core are described in **Appendix G.** The cores will be logged for rock type, fracturing, and mineralization. Core samples from selected intervals near and in the fault zone will be analyzed for petrography and whole rock chemistry. These data will be used to identify potential chemical impacts to groundwater from minerals within the fault zone (Task 2.3). Hydraulic tests will be conducted on the core holes to evaluate zones exhibiting higher flow rates that could represent a preferential exposure pathway for COCs adjacent to the fault (Task 1.3) within the damage zone. Hydraulic testing of core holes may include borehole geophysics, straddle packer tests, aquifer testing of entire open hole, and borehole flow meter tests.

Concentrations of sulfate, aluminum, and copper in water samples from MW-116 are anomalously high relative to concentrations at other nearby Site wells. Uranium concentrations at MW-116 are also elevated and are nearly as high as at well EF-3A closer to the LTI. Due to the proximity of MW-116 to the LF, one hypothesis is that the LF is the source for the high constituent concentrations, including uranium (Section 2.2.3). To address DWMRC comments concerning the source of the high concentrations near the LF, and to test the hypothesis that the source of the high concentrations are from the LF, a core and monitoring well will be drilled at two locations along the LF.

One location, C-125/MW-125 (**Figure 3**), will be upgradient from MW-116 and the South plume area along the LF. Core hole C-125 will be hydraulically tested, and the core material will be sampled and analyzed for whole rock chemistry. The core hole will be reamed and converted to monitoring well MW-125 and will be screened over the fault zone. Water samples will be collected and analyzed for the same constituents as for other Site wells.

The second location, C-126/MW-126 (**Figure 3**), will be near MW-116, but further to the west toward the LF. The core hole will be reamed and converted to monitoring well MW-126. Hydraulic testing, core sampling and analysis, and water sampling and analysis will be conducted the same as for C-125/MW-125.

Core C-127 is to be placed in the LF fault zone at the northwest end of the Site near the northern LTSM boundary and south of Coyote Wash (**Figure 3**). Core C-127 will provide information on the geometry of the LF, which will be used to locate monitoring well MW-127 a short distance to the east of the fault. MW-127 will be used to characterize the hydraulic parameters of the BCA at this location as well as the extent to which the LF may act as a barrier or a conduit to groundwater flow. If the LF does not act as a barrier to flow toward the west, there is potential for groundwater from the BCA to flow across the fault to the Navajo formation.

Core C-128 and well MW-128 are similar in nature to core C-127 and well MW-127, but will be drilled further to the southeast along the LF where it is determined that the Wingate formation is likely to occur on the west side of the fault. The Wingate formation is known to be water-bearing at other locations where it is found and, if the LF is shown to not act as a barrier to flow at this location, there is potential for groundwater to flow across the fault to the west.

Table 2. Proposed Lisbon Site Core Holes and Monitoring Wells

Well ID	Core with Rock Samples Collected for Analysis	Formation*
MW-123		BCA
MW-124		BCA
C-125	Y	LF
MW-125		LF
C-126	Y	LF
MW-126		LF
C-127	Y	LF
MW-127		BCA
C-128	Y	LF
MW-128		BCA

*BCA = Burro Canyon Aquifer; LF = Lisbon Valley Fault

2.4 Task 4 – Flow and Transport Model

A numerical flow and solute transport model of the Site will be developed under this task. The modeling will be done in two phases. A preliminary model will be developed early in the project and will be used to test and demonstrate various processes and mechanisms associated with flow and solute transport at the Site. The final model will incorporate all data collected during the course of the project as reflected in the revised CSM (**Table 1,** Element 11).

The flow model will be developed using a version of the United States Geological Survey's flow code MODFLOW (McDonald and Harbaugh, 1988), either MODFLOW-2005 (Harbaugh, 2005) or MODFLOW-USG (Panday et al., 2013). Final code selection will be determined based on evaluation of the governing flow processes occurring at the Site and on the capabilities for simulating those processes in the respective codes. Solute transport at the Site will be simulated with the MT3DMS code (Zheng, 2010). Development of the model input files and evaluation of model output will be accomplished using Groundwater Vistas (ESI, 2011), Leapfrog (ARANZ, 2015), ArcGIS (ESRI, 2011), and other programs deemed appropriate as needed (e.g., Excel, Python, Fortran, Surfer).

The flow model will be fully three-dimensional to account for lateral and vertical variations in stratigraphy and COC concentrations within the aquifer. Stratigraphy and geologic structure in the model will be represented by a three-dimensional geologic block model developed using Leapfrog Hydro (ARANZ, 2015) (Task 1.2). The lateral extent of the model domain will be based on natural boundaries to the extent possible. Should testing of the LF for barrier effects indicate that the LF can be treated as a no-flow boundary, the western model boundary will coincide with the LF and be assigned as a no-flow boundary condition. If the LF has a low-permeability core zone restricting flow across the fault, but an adjacent damage zone of enhanced permeability parallel to the strike of the fault, then this damage zone will be incorporated in the model. Should testing of the LF indicate that it does not act as a barrier to flow, expansion of the model to the west may be necessary, and an appropriate model boundary location will be determined at that time. Coyote Wash would represent the minimum model extent to the northwest, where it intersects the trace of the LF, and northeast where it intersects a northeast-southwest trending watershed divide that extends to the LF south of the tailings impoundments. A groundwater divide is assumed to exist in close proximity to the watershed divide; therefore, the eastern model boundary will be assumed to coincide with the watershed divide. A larger model domain will also be considered that may extend to the La Sal Mountains to the northeast and further north than the location of Coyote Wash north of the Site. The final model boundaries will be determined based on the revised CSM. Information that will play a role in determining the model extent includes the regional pattern of recharge, geology and hydrogeology, and surface water features. A guiding principal in the selection of the model domain will be to ensure the chosen boundary locations and assigned hydraulic conditions do not "pre-condition" the outcome of the transport simulation.

Groundwater flow in the three-dimensional domain will be modeled assuming uniform fluid density. Density effects are expected to be limited to the regions local to the LF and to the tailings impoundments; therefore, large-scale transport behavior of the COC plumes can be modeled assuming uniform fluid density. This is supported by evaluation of density effects at the location of well clusters at the Site (**Appendix A**) where it has been shown that vertical hydraulic gradients using corrected and non-corrected heads measured at the wells are similar, and that the density corrections did not reverse flow directions for any of the vertical hydraulic gradient calculations.

The solute transport model will be used to simulate the migration of COCs from the UTI and the LTI. Initial concentrations used in the model will be taken from the most recent analysis of groundwater samples collected from Site wells. Source terms in the model for COCs at the UTI and LTI will be estimated from COC concentrations at wells close to the tailings impoundments that are thought to closely represent tailings water seepage concentrations (wells EF-3A and OW-UT-9) (Task 2.1), combined with seepage fluxes from the tailings estimated using HYDRUS-2D (Task 1.1).

The flow and solute transport model will be based on a conventional approach whereby a single, deterministic model will be developed. The hydrostratigraphic framework will be based on the geologic block model, with adjustments adopted as necessary during model calibration. The revised CSM will inform the flow and solute transport model and provide parameter ranges for model calibration. A standard, head-based flow model calibration will first be performed. Calibration parameters will include hydraulic conductivity and aquifer storage. Transport parameters will be calibrated to COC concentration data measured at Site wells starting in 2012. The transport parameters to be calibrated include dispersivity, the distribution coefficient, K_d (Task 2.4), and the effective porosity.

A sensitivity analysis will be performed on the calibrated model to identify which model inputs have the most impact on calibration and on the conclusions of the modeling analysis. An uncertainty analysis of the model will be conducted. The uncertainty analysis will quantify the uncertainty in the modeled plume predictions resulting from uncertainty in estimates of aquifer parameters, stresses, and boundary conditions. Results of the sensitivity and uncertainty analyses will be considered in determining ACLs and TALs.

The calibrated model will be used as a predictive tool with the following objectives:

- Simulate transport of COCs in groundwater for the 200-year compliance period.
- Evaluate the long-term monitoring plan for the Site.

- Provide a basis for development of new ACLs and TALs.

2.5 Task 5 – New ACLs and TALs

ACLs are site-specific and constituent-specific groundwater protection standards assumed to be adequate for the future LTSM period of 200 years. It must be demonstrated that the suggested ACL at the POC is adequately protective of human health and the environment at the Point of Exposure (POE). The License also includes additional compliance locations designated as trend wells with designated TALs.

New ACLs for POC and POE wells and TALs for trend wells will be proposed (**Table 1,** Element 12). New ACLs and TALs will be determined from a combination of (1) geochemical modeling, (2) flow and solute transport model results, and (3) historical concentration data for Site wells and constituent background concentrations. Additional details for this part of the analysis will be developed as the tasks described earlier are completed. The process defined in the ACL Application submitted for the Site (Lewis, 2001) will be followed in general.

2.6 Task 6 – Reporting

Documentation of all tasks will be provided in a revised SSA Report. The report will include: (1) documentation of all 2015 and 2016 Site characterization activities (e.g., drilling, aquifer testing, and groundwater sample analysis and interpretation); (2) the updated CSM; (3) a description the flow and solute transport model; and (4) presentation of all results, conclusions, and recommendations, including development of preliminary ACLs. A meeting with the DWMRC to review the updated CSM will be held prior to completion of the revised SSA Report. A final draft report will include revisions based on all comments from RAML and the DWMRC. After completion of the SSA Report and acceptance by the DWMRC, an ACL application and associated License amendment will be developed and submitted to the DWMRC.

3.0 SCHEDULE

The field component of this Work Plan is scheduled to be completed in 2016. Geochemical and hydrogeological analyses and modeling are scheduled to begin in 2015 and to be completed in 2017, at which time ACLs and TALs will be determined. It is anticipated that the completed SSA Report and ACL application will be submitted in mid-2017. RAML will work closely with BLM and DWMRC in order to meet this schedule. The proposed schedule is provided in **Appendix H**. This schedule is based on the assumption that unanticipated delays in the regulatory process and field program do not occur.

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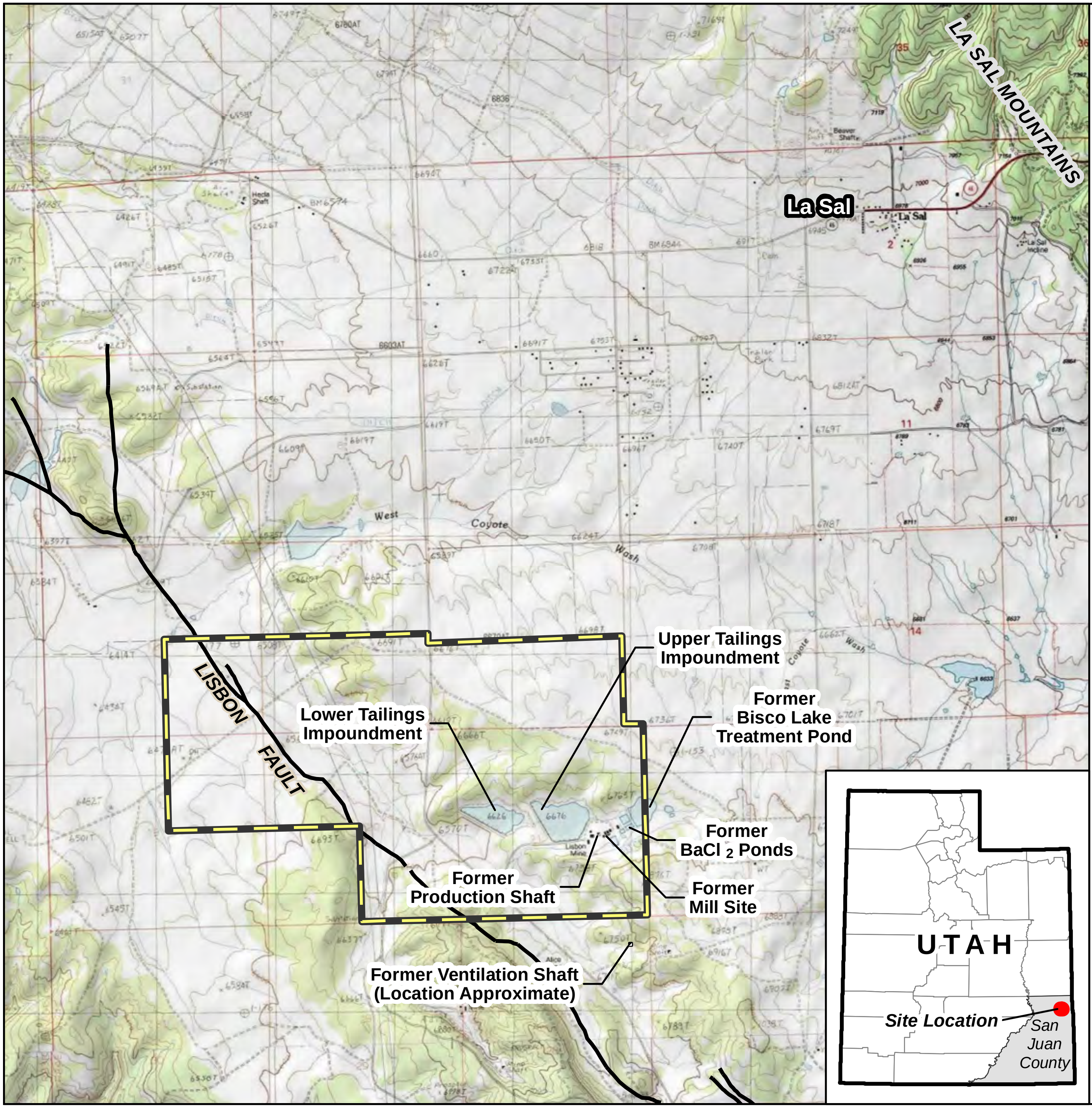
FIGURES

INTERA



▭ Long Term Surveillance and Maintenance Boundary

— Lisbon Fault

USGS Topographic Map, 2013

Figure 1
Site Location
Lisbon Facility

FILE: S:\Projects\Rio_Lisbon_SupplmentalSiteCharacterization\Graphics\GIS\MapDocs\SSA_Phase3\Fig01_LocationMap.mxd 12/1/2015

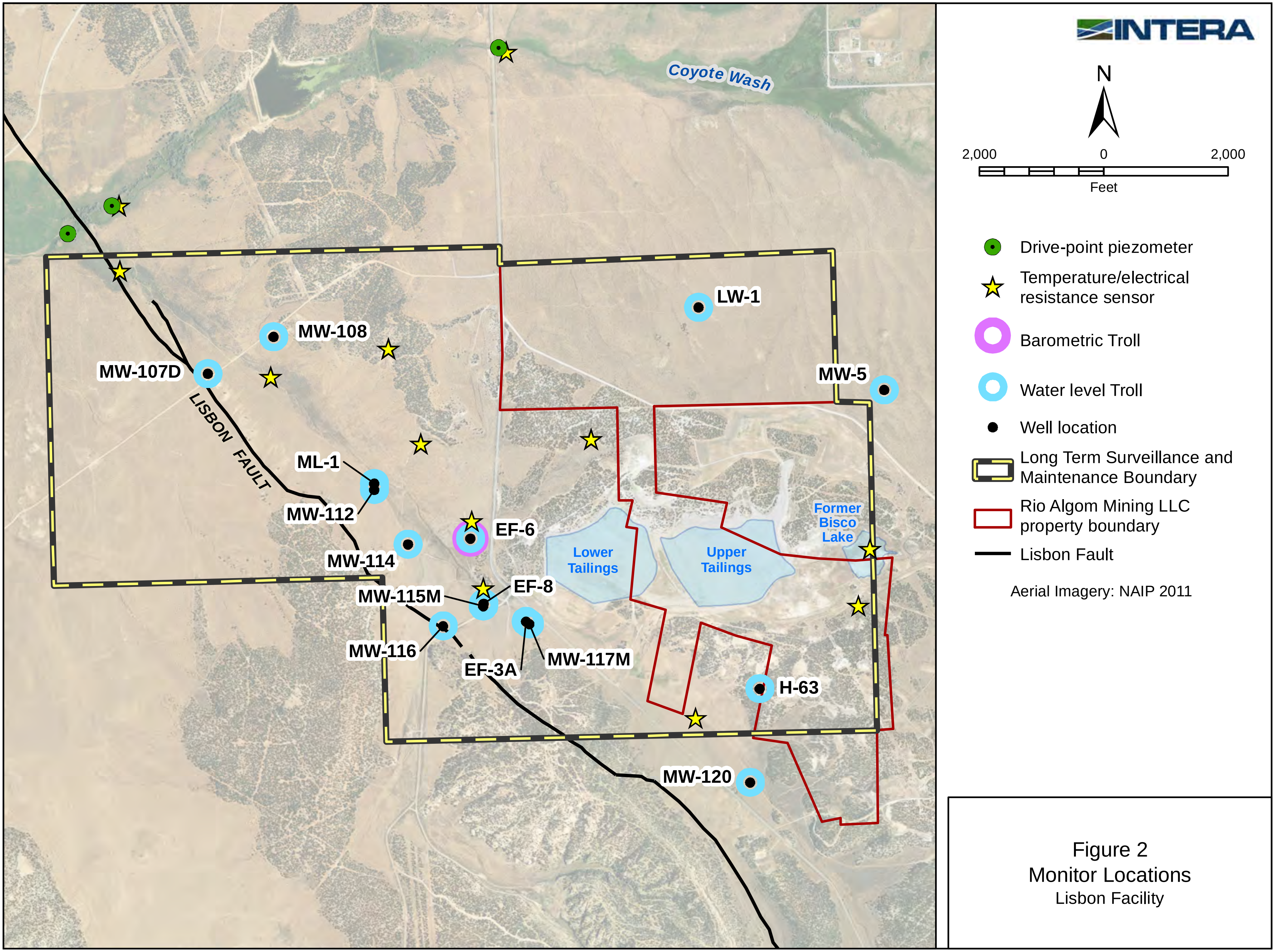


Figure 2
Monitor Locations
Lisbon Facility

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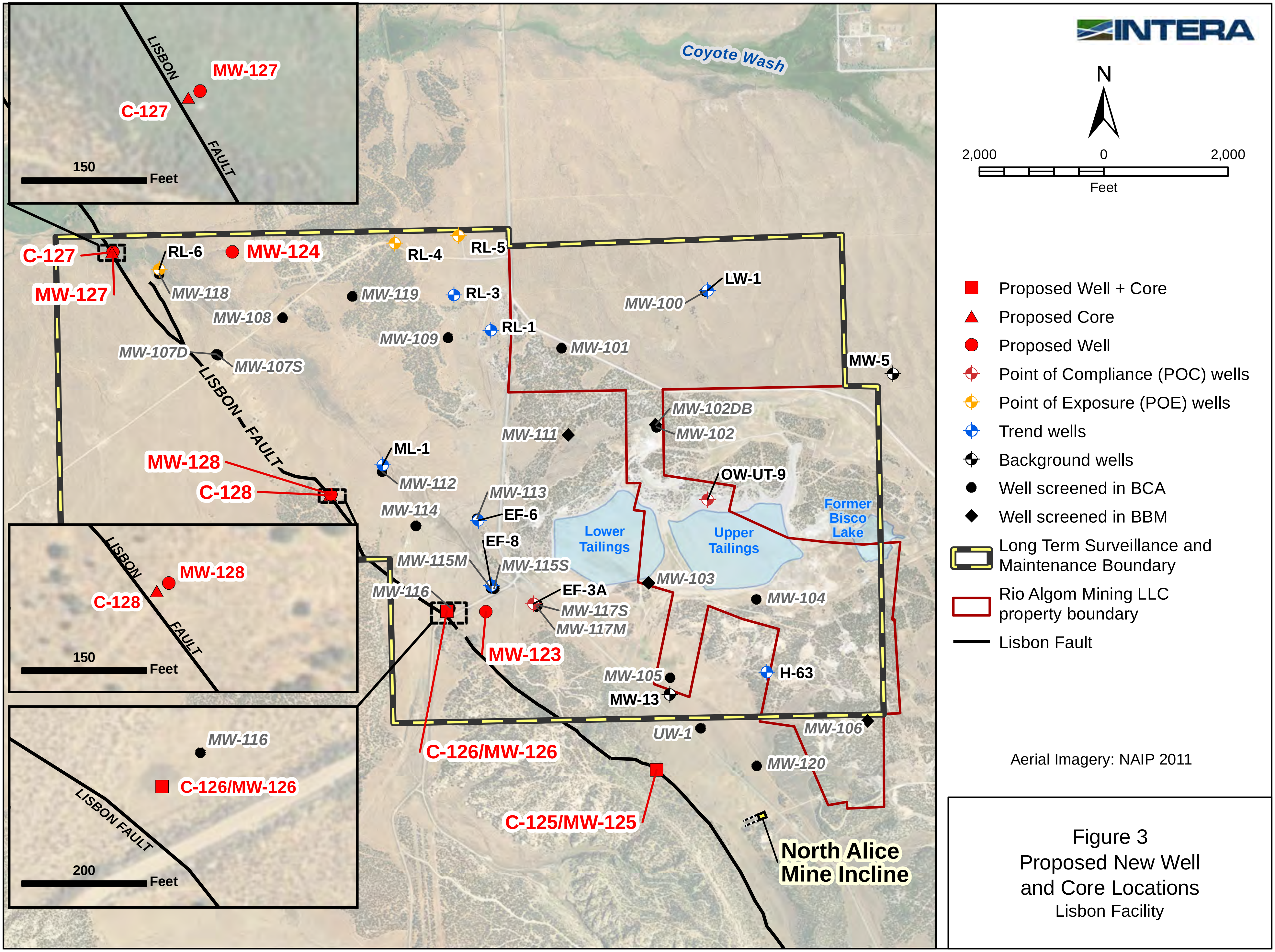

Figure 3
Proposed New Well
and Core Locations
Lisbon Facility

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APPENDIX A

Responses to Comments from the Utah Division of Radiation Control on 2014 Supplemental Site Assessment Report (DWMRC Response)

Rio Algom Mining LLC

March 26, 2015

Mr. Rusty Lundberg
Utah Division of Environmental Quality
Division of Radiation Control
PO Box 144850
168 North, 1950 West
Salt Lake City, Utah
84114-4850

RE: Responses to Request for Information from the Utah Division of Radiation Control on *Supplemental Site Assessment to Address Out-of-Compliance Status at Trend Wells RL-1 and EF-8, Lisbon Facility,* Final Report, July 22, 2014, Montgomery & Associates (Response)

Dear Mr. Lundberg:

Rio Algom Mining LLC (RAML) is pleased to submit the referenced Response. The enclosed document provides responses to a Request for Information (RFI) from the Utah Division of Radiation Control (DRC) dated October 17, 2014. The RFI provided comments on the July 22, 2014, report titled: *Supplemental Site Assessment to Address Out-Of-Compliance Status at Trend Wells RL-1 and EF-8, Lisbon Facility*, prepared by Montgomery & Associates (M&A) on behalf of RAML. The Supplemental Site Assessment (SSA) was conducted in accordance with Stipulation and Consent Agreements (SCAs) between DRC and RAML (DRC, 2012 and 2013). The overall scope of the SSA was outlined in a work plan titled *Revised Final Work Plan, Supplemental Site Assessment to Address Out-of-Compliance Status at Trend Wells RL-1 and EF-8* (M&A, 2012). The second phase of the SSA was outlined in a second work plan titled "Phase 2 of Supplemental Site Assessment to Address Out-of-Compliance Status at Trend Wells RL-1 and EF-8" (M&A, 2013b). Currently, all activities at the Lisbon Facility (Site) are conducted in accordance with Utah Radioactive Materials License No. UT1900481, Amendment No. 5 (License) (DRC, 2014b).

After a preliminary review of the RFI, RAML met with DRC on December 17, 2014, to discuss the general approach and tentative schedule for preparing responses. On January 22, 2015, RAML convened a web meeting/conference call with DRC to provide an update on the status of the responses. Initially, RAML had intended to provide the conceptual details of a field investigation that would be conducted in 2016 in response to the comments. However, after further analysis of the comments, RAML has determined that more extensive data evaluations and possibly an initial phase of field work are needed in 2015 before the details of the 2016 field program can be developed. RAML has since secured the services of INTERA Incorporated (INTERA) to lead this next phase of work.

RAML appreciates DRC's thorough review of the SSA. Upon reviewing the RFI and considering DRC's comments in detail, RAML agrees with the majority of DRC's comments and suggestions. In general, RAML strived to fully address DRC's comments in this Response, and RAML will revise the SSA accordingly. However, because the RFI raises several key technical issues that may affect the overall fate and transport analysis of the groundwater impacts at the Site, some of DRC's comments, including those concerning the groundwater model, proposed Alternate Concentration Limits (ACLs), and compliance groundwater monitoring wells, cannot be addressed completely without some additional data collection and modeling. RAML will submit a revised SSA once the additional work is completed.[1]

A summary of the key outstanding technical issues are as follows:

- Additional data are needed to confirm groundwater flow paths in the vicinity of the Lisbon Fault (LF).
- Additional data are needed to confirm that the source for uranium and sulfate in MW-116 can be attributed to mineralization along the LF.
- The effects of density differences arising from tailings seepage to groundwater have been identified and require further consideration. The potential for confining and/or semi-confining (saturated thickness) conditions have been identified, but the effects on fate and transport of the groundwater plume require further analysis.
- The attenuation of uranium in groundwater has not yet been incorporated into the Conceptual Site Model. This process may be important to the fate and transport of uranium in groundwater, and, ultimately to the risk analysis and establishment of ACLs for the site.

Once DRC has completed its review of the Response, RAML requests the opportunity to meet with DRC to further discuss RAML's revised understanding of the Site conditions and a pathway for resolution of the technical issues described above. In particular,

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[1] As RAML and DRC agreed during the January 22, 2015, meeting, it is premature to submit a revised SSA until the additional work is completed.

RAML is proposing to conduct the additional modeling and field investigations summarized below. Once RAML and DRC reach agreement on the approach, RAML will submit work plans for approval by DRC.

Phase I – Short Term Goals (6-12 months)

- **Complete a water balance for the Site area**, which will greatly enhance the understanding of data gaps and areas to focus on for future field investigations and modeling.
- **Evaluate site boundary conditions (both location and type)**, particularly the western and northern boundaries that have a dramatic effect on flow and transport calculations.
- **Evaluate slug test data analysis for implementation to the revised model.** DRC has expressed concerns about some of the permeability measurements, and RAML agrees that it is important to evaluate these data prior to their incorporation into the revised fate and transport model.
- **Complete general geochemical evaluations** (e.g., Piper plots, box plots, statistical analyses) to look for trends and outliers.
- **Evaluate water quality data** to determine if MW-116 water quality has a distinct chemical signature compared to other Site groundwater and tailings pore water. The design for additional field investigations of the LF will be informed by this initial analysis.
- **Review pertinent investigations of the LF** and, as necessary, complete additional field mapping to ensure accurate siting of potential wells and/or borings in the LF area.
- **Assess surface water features** in the area and perform additional field investigations as necessary for incorporation into the CSM.
- **Continue the groundwater monitoring program** in accordance with the Groundwater Monitoring Plan.

Phase 2 – Long Term Goals

- **Install a well (and possibly several boreholes) in the vicinity of the LF near the site,** as indicated by the results of the Phase 1 analysis., Collect a core from surface to the total depth in order to obtain necessary mineralogical, geochemical, and groundwater quality data for the assessment of a potential additional source of uranium and other constituents of concern within the LF.

- **Install and sample additional wells** as necessary to complete characterization of the uranium plume.
- **Perform geochemical modeling** to test conceptual models of fluid-rock interactions along the LF with the goal of determining whether present-day conditions result in mobilization of uranium and sulfate in groundwater.
- **Perform groundwater flow and transport modeling** to evaluate potential risks to human health and the environment based revisions discussed above.
- **Revise and submit the SSA and a proposal for ACLs.**

Please do not hesitate to call me or Ms. Theresa Ballaine at (209) 736-4803 if you have any questions.

Sincerely,

Rio Algom Mining Company LLC

Anthony Baus

Anthony Baus
Site Manager

Enclosure

Rio Algom Mining LLC

March 26, 2015

Responses to Comments from the Utah Division of Radiation Control on 2014 Supplemental Site Assessment Report

LISBON FACILITY, SAN JUAN COUNTY, UTAH

Prepared by:

INTERA Incorporated and Montgomery & Associates

Prepared for:

Rio Algom Mining LLC

March 26, 2015

Responses to Comments from the Utah Division of Radiation Control on 2014 Supplemental Site Assessment Report

LISBON FACILITY, SAN JUAN COUNTY, UTAH

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Acronyms & Abbreviations

ACL	Alternate Concentration Limit
amsl	above mean sea level
BBM	Brush Basin Member hydrostratigraphic unit
BCA	Burro Canyon Aquifer
bgs	below ground surface
BLM	U.S. Bureau of Land Management
CSM	conceptual site model
DEQ	Utah Department of Environmental Quality
DO	dissolved oxygen
DRC	Utah Division of Radiation Control
EFH	equivalent freshwater head
EPA	U.S. Environmental Protection Agency
ft	feet
ft/d	feet per day

ft/ft	feet per foot
ft/y	feet per year
gpm	gallons per minute
HUC	Hydrologic Unit Code
Jmb	Morrison formation
K	hydraulic conductivity
Kbc	Burro Canyon formation
$K_{x,y}$	horizontal hydraulic conductivity
K_z	vertical hydraulic conductivity
License	Radioactive Materials License
LF	Lisbon fault
LTGMP	Long Term Groundwater Monitoring Plan
mg/L	milligrams per liter
M&A	Montgomery & Associates
RAML	Rio Algom Mining LLC
RFI	Request for Information
RTCs	responses to comments
SCA	Stipulation and Consent Agreement
Site	Lisbon Facility
SSA	Supplemental Site Assessment
TDS	total dissolved solids
UGQS	Utah Groundwater Quality Standard
USGS	U.S. Geological Survey

1 RESPONSES TO COMMENTS

Rio Algom Mining LLC ("RAML") provides the following responses to comments ("RTCs") from the Utah Division of Radiation Control ("DRC") on the July 22, 2014 report titled: *Supplemental Site Assessment to Address Out-Of-Compliance Status at Trend Wells RL-1 and EF-8, Lisbon Facility* (DRC, 2014a, Montgomery & Associates ["M&A"], 2014). The comments were received from DRC in a Request for Information ("RFI") letter dated October 17, 2014. Responses to DRC comments are included in this section. The comments have been numbered to enable cross-referencing between comments and responses. For some responses, figures from the Supplemental Site Assessment ("SSA") report have been revised and provided with the response. For some responses, new figures have been prepared and are referred to with "RTC" added to the figure number, for example, **Figure RTC-1.**

1.1 General Comment 1

DRC notes that a Long Term Groundwater Monitoring Plan ("LTGMP") was not submitted with the Site Assessment as required by the Stipulation and Consent Agreements ("SCAs"). RAML states in the Site Assessment that the LTGMP, including assessment of monitoring procedures, will not be submitted until after DRC review and approval of the Site Assessment.

Detailed analysis of the comparability and representativeness of water quality data from all sampling methods needs to be completed prior to developing new Alternate Concentration Limits ("ACLs"). The purpose of the DRC allowing the Licensee use of previously unauthorized alternative sampling methods for sampling was to conduct an experiment and analysis and see whether the proposed alternative methods would work. That analysis is required to be part of the Site Assessment.

RESPONSE

A groundwater monitoring plan and a comparative analysis of sampling methods were submitted to DRC on March 6, 2015. The comparative analysis presents several years of data collected at the Lisbon Facility using three sampling methods. Based on the analysis of the data, the modified low-flow purge method is recommended for future sample collection. The Groundwater Monitoring Plan for the Lisbon Facility (M&A, 2015) incorporates the requirements of the current

Utah Radioactive Materials License No. UT1900481, Amendment No. 5 ("License"), proposes a monitoring plan for the new wells, and includes a detailed Quality Assurance Plan. The proposed monitoring program for the new wells outlined in the plan is considered interim at this time. After approval of new ACLs in the future, the interim plan will be revised and submitted to DRC for approval as a long-term groundwater monitoring plan.

1.2 General Comment 2

The SSA contains many expressed speculations, hypotheses, guesses or beliefs throughout it that are not supported within the SSA by an accompanying presentation of site evidence. Any hypotheses or speculations presented in the SSA should be identified as such and should be justified in the SSA using site field data, site laboratory data, literature references, or a combination thereof. Otherwise, these speculations, in the absence of supporting data, would best be avoided.

RESPONSE

RAML recognizes that there is some uncertainty in the understanding of Site conditions – most importantly the uncertainty in the fate and transport of contaminants in the groundwater – needs to be reduced through further evaluation of Site conditions. RAML has and will continue to work with DRC to develop the necessary data and information to reduce this uncertainty, reach consensus on a defensible CSM and flow and transport model, and to establish appropriate ACLs that-protect public health and the environment.

1.3 General Comment 3

Comments on statements in the SSA should also be applied to all corresponding or relevant information in the appendices.

RESPONSE

Comment understood.

1.4 Specific Comment 1 – Section 1.1 "Introduction", Page 1, Paragraph 2

DRC notes that reference is made in the paragraph to the SCAs but the documents are not included in the reference section. Please add the 2012 and 2013 SCAs to the reference section.

RESPONSE

The SSA report includes both the 2012 and 2013 Stipulation and Consent Agreements in Section 8, *References Cited*, under Utah Department of Environmental Quality ("DEQ").

1.5 Specific Comment 2 – Section 2.3 "Site Geology", Page 6, Paragraph 2

The paragraph refers to the Lisbon Valley Fault as a "reverse" fault. The Lisbon Valley Fault is a normal fault. See references, http://geology.utah.gov/geothermal/ngds/Activefaults/2511S.pdf, and Utah Geological Survey, 2004, Geologic Map of the La Sal 30'X 60' Quadrangle, Compiled by Hellmut Doelling.

RESPONSE

RAML agrees that the Lisbon Valley Fault ("LF") is a normal fault. Future reports will describe the LF as a normal fault.

1.6 Specific Comment 3 – Section 2.4.2 "Core Sampling"

The DRC would like to see a detailed description of the MW-116 core, from the top of the saturated zone of the BCA down to total drilling depth. This area has anomalous concentrations of various constituents, including uranium, in groundwater, and the DRC needs to better understand the local hydrogeological setting and the local aqueous geochemistry to assess potential contamination (or the lack thereof).

RESPONSE

The core from MW-116 extends from near ground surface to approximately 58 feet below ground surface ("bgs") and was terminated above the water table.

Core is not available below the water table. **Figure RTC-1** shows a detailed lithologic log of the MW-116 core. Core samples and drill cuttings from the MW-116 site will be examined by a geochemist for evidence of hydrothermal alteration, weathering reactions, and uranium mineralogy in the hanging wall of the LF.

In order to better assess the geochemistry and hydrogeology of the LF, RAML will conduct additional characterization of the LF including collection of core from the LF below the water table as part of the additional field investigations.

1.7 Specific Comment 4 – Section 3.1 "Hydrogeologic Conditions", Page 21

Please clarify in the first paragraph of the section that an exception to previously logged lithological information was a 10-ft-thick section of sandstone, with about four feet of fracturing, found about 20 feet below the top of the Jmb in MW-102DB.

RESPONSE

RAML agrees with the clarification proposed by DRC. When describing the lithology in future documents, RAML will specify that an exception to the generalized lithology was identified at MW-102DB, where a 10-ft-thick section of sandstone, with about four feet of fracturing, was encountered about 20 feet below the top of the Jmb.

1.8 Specific Comment 5 – Section 3.1 "Hydrogeologic Conditions", Page 22, 2nd Bullet Comment Regarding Section A-A' Figure 6

Groundwater appears to be confined in the BCA not only in Area 3, near MW-108, but also to be confined in Area 4, near the MW-112, MW-114, MW-115, MW-116 and MW-117 well clusters. Groundwater near MW-108 was first noted being produced at 100 ft bgs, but after well completion, the water level rose to 25 ft bgs. It is interpreted by the Licensee in Appendix B that the “aquifer is confined at this location, most likely by the fine-grained siltstone layers.” However, after well completion of MW-112, MW-114, MW-115M, MW-116 and MW-117M, according to Appendix B, water levels also rose significantly above the point at which water was first noted coming into the borehole: by 46 feet, by

12 feet, by 25 feet, by 15 feet, and by 28 feet respectively. This behavior is reasonably consistent with the behavior of a confined aquifer. Cross section B-B' in Figure 7 and cross section E-E' in Figure 8 show that a thick low-permeability layer of siltstone, mudstone or shale exists in the upper part of the Jbc at these five well locations. This thick zone of siltstone, mudstone or shale could potentially serve as a confining layer.

This low-permeability layer does not appear to exist along section B-B' to the northwest, e.g. at MW-118 and MW-107D. There, after well completion, water levels only rose zero feet, and 10 feet, respectively. This is generally more consistent with an unconfined aquifer, or with a partially confined aquifer, with perhaps some lag time having been required for MW-107D before water levels fully stabilized after drilling. The low-permeability layer also does not appear to exist along section B-B' to the southeast (e.g. at MW-105 and MW-120). There, after well completion, water levels in each well only rose 5 feet. This is generally more consistent with an unconfined aquifer or with an aquifer with a partially confining layer, with perhaps some lag time having been required before water levels fully stabilized after drilling.

This leads to a discussion about saturated thickness. This realization that, outside of boreholes or wells, the BBA in much of the syncline area is normally only saturated within the more-permeable lower portion, and that the upper portion is not saturated, or, at best, is only variably saturated, means that the saturated thickness map in Figure 12 requires significant revision. Mapped saturated thickness in a confined aquifer should represent the difference in elevation between the base of the aquifer and the top of the saturated portion of the aquifer, not the water level found in a penetrating well, which may be well above the top of the saturated aquifer. Thus, the saturated thickness values shown in Figure 12 in the areas of MW-108, MW-112, MW-114, MW-115M and MW-117M should be markedly reduced, since they currently represent distance from the base of the aquifer to the water levels in wells.

RESPONSE

RAML agrees that some degree of confined conditions could exist over a larger area southwest of the LVA axis than only near MW-108. Also, RAML agrees that groundwater occurs under unconfined conditions in the area northeast of the LVA axis based on the data. Hydrogeologic conditions encountered at MW-108 indicate confined conditions. However, at the other wells cited in Specific

Comment 5, which are all located on the southwest side of the LVA axis, the hydrogeologic conditions encountered during drilling were not as clearly indicative of confined conditions.

Based on the information collected during drilling of boreholes and completion of wells, the BCA shows strong vertical heterogeneity in some locations with finer-grained siltstone and sandstone of lower hydraulic conductivity overlying coarser-grained sandstone of higher hydraulic conductivity. At these locations, aquifer conditions vary from semi-confined to confined. In semi-confined regions, the saturated thickness would extend into the upper fine-grained part of the formation. Hydraulic responses in the fine-grained formation would be slower than in the underlying part of the formation, but groundwater would continue to flow within the fine-grained upper part.

Conceptually, RAML agrees with the definition of saturated thickness presented by DRC in Specific Comment 5. However, RAML does not agree that an extensive zone of confined groundwater can be conclusively delineated based on the available data. Therefore, RAML does not recommend adjusting the contours of saturated thickness on Figure 12. Due to confined conditions encountered at MW-108, the saturated thickness in the vicinity of that well may be smaller, and may help to address continuity issues related to flow discussed further below. If additional drilling or aquifer testing is conducted in areas where confined conditions may exist, RAML may modify the drilling or aquifer test methods to improve delineation of confined conditions to the extent possible.

1.9 Specific Comment 6 – Section 3.1 "Hydrogeologic Conditions", Page 22, 6th Bullet Comment Regarding Section A-A' Figure 6

Please further describe the degree of upward vertical gradient at well pair MW-107S/MW107D.

RESPONSE

To evaluate hydraulic gradients at the Site, RAML first provides the following overview of density effects on hydraulic head due to salinity contrasts in groundwater at various depths. This overview is also relevant to subsequent comments regarding hydraulic gradients. A response to Specific Comment 6 is provided following the overview.

Overview of Salinity and Density Effects on Hydraulic Heads and Hydraulic Gradients

Hydraulic head measurements are corrected for density differently depending on whether hydraulic gradient is being calculated between two wells horizontally or vertically (Post et al., 2007). Equivalent fresh water heads ("EFH") are used when calculating horizontal hydraulic gradients while environmental heads are used when calculating vertical hydraulic gradients. Environmental heads are calculated using the EFH and the average of density of the water column above the screen.

Due to the use of large well screens at the Site (small well screens of 10-20 feet provide for more accurate results), and the proximity of adjacent well screens vertically for a given well cluster, density corrections used to calculate vertical gradients are considered approximate. However, vertical hydraulic gradients using corrected and non-corrected heads were similar, and none of the density corrections reversed the direction for any vertical hydraulic gradient. Even though similar types of errors affect equivalent fresh water heads used in horizontal hydraulic gradient calculations, the overall uncertainty is smaller.

For evaluation of vertical gradients in the comment responses provided below, RAML will provide vertical hydraulic gradients for each case using data collected in April 2014 and adjusted for density as environmental heads. The spatial distribution of EFHs at the Site are provided in **Figure RTC-2** and **Table RTC-1** contains the EFH calculations.

Vertical Gradient between MW-107S and MW-107D

An upward vertical gradient of 0.0044 ft/ft was estimated for well pair MW-107S/MW-107D. This is smaller than the horizontal gradient of 0.023 ft/ft between wells MW-108 and MW-107D.

1.10 Specific Comment 7 – Section 3.1 "Hydrogeologic Conditions", Page 23, 3rd Bullet Comment Regarding Section B-B' Figure 7

Please further describe the degree of downward gradient at the listed well pairs.

The apparent decrease in head with depth appears to be, at least in part, an artifact of fluid density associated with higher salinity. Once corrected to account for density differences, the heads at various depths may not be that different, if at all. Or, when corrected, it is possible that heads may actually indicate flow in the opposite direction. By way of example, the following (from Table 11) are maximum values of electrical conductivity (related to salinity, and therefore to fluid density) for the various wells in the MW-117S/MW-117M/ EF-3A well cluster (listed from most shallow to most deep):

Well No.	Head (ft amsl)	Conductivity (uS/cm)
MW-117S	6,503.96	1,520
MW-117M	6,503.95	3,260
EF-3A	6,503.43	8,070

As can be seen here, conductivity, and thus density, increases as a function of depth in this area. Accordingly, equivalent fresh water heads for the deeper-screened wells would be greater than the point values or environmental values measured in and currently reported for these wells.

RESPONSE

While fluid density is an important consideration when calculating vertical gradient, as described in Specific Comment Response 6, these calculations can be problematic. Depending on the representativeness of the measurements, these calculations can result in errors in the direction of groundwater flow.

A downward vertical gradient of 0.0003 ft/ft and 0.010 ft/ft was estimated for well pairs MW-117S/MW-117M and MW-117M/EF-3A, respectively. The downward gradient for well pair MW-117M/EF-3A is similar in magnitude, but opposite in direction, to the upward gradient of 0.020 at nearby well pair MW-113/EF-6 (cf. Specific Comment Response 13). Both wells are in the vicinity of the syncline southwest of the LVA.

1.11 Specific Comment 8 – Section 3.1 "Hydrogeologic Conditions", Page 23, 5th Bullet Comment Regarding Section B-B' Figure 7

Please explain why uranium concentrations increase as a function of depth and provide data to help explain. Are density differences associated with the increase in uranium concentrations as a function of depth?

RESPONSE

In areas closer to the tailings impoundments, stratification of groundwater due to total dissolved solids and related density differences is evident. This is due to the tailings leachate exhibiting a much higher TDS and density than the background groundwater. The resulting downward (negative) buoyancy effect leads to more dense water underlying less dense water. Since the high TDS tailings seepage also contains elevated levels of uranium, higher concentrations of uranium are associated with higher TDS and higher density groundwater. This effect is observed for the companion wells MW-112/ML-1, MW-115S/MW-115M/EF-8, and MW-117S/MW-117M/EF-3A, and is demonstrated in **Figure RTC-3a** (uranium vs TDS) and **Figure RTC-3b** (uranium vs density).

1.12 Specific Comment 9 – Section 3.1 "Hydrogeologic Conditions", Page 23, 1st Bullet Comment Regarding Section C-C' Figure 7

The statement with this bullet does not appear to be worded correctly. The wording should be amended. Monitoring Wells MW-118 and MW-108, located NW of the LVA axis, appear to have a saturated thickness in the BCA much greater than 25 feet. MW-119 does have a small saturated thickness. Most of the other wells along Section C-C' appear to be located to the NE of the axis of the LVA, rather than to the NW.

RESPONSE

RAML agrees that the bullet is worded incorrectly and it will be corrected in the revised document. The saturated thickness along Section C-C’ northeast of the LVA axis is relatively thin (generally less than 25 feet) in wells along this transect northeast of the LVA axis. Wells southwest of the LVA axis have greater saturated thicknesses.

1.13 Specific Comment 10 – Section 3.1 "Hydrogeologic Conditions", Page 23, 2nd Bullet Comment Regarding Section C-C' Figure 7

Please discuss the degree of upward hydraulic gradient at well pair MW-102/MW-102DB.

RESPONSE

An upward vertical gradient of 0.190 ft/ft was estimated for well pair MW-102/102DB. This is the largest hydraulic gradient observed at the Site. The cause of the high heads observed in the BBM at well MW-102DB is not yet understood. Heads in nearby well OW-UT-9 adjacent to the Upper Tailings are similar, although hydraulic connectivity between MW-102DB and OW-UT-9 has not been established (see Specific Comment response 33).

1.14 Specific Comment 11 – Section 3.1 "Hydrogeologic Conditions", Page 23, 3rd Bullet Comment Regarding Section C-C' Figure 7

It appears that the BCA wells referred to in this section are northeast and not northwest of the LVA.

RESPONSE

RAML agrees that the wells referred to in the bullet are northeast, not northwest, of the LVA and this will be addressed in the revised document.

1.15 Specific Comment 12 – Section 3.1 "Hydrogeologic Conditions", Page 24, Section E-E'

Section E-E' appears to need some modification where the water level is drawn through the Brushy Basin Member (“BBM”). The water level in the Jmb at MW-111 is currently drawn higher than the water level in the Kbc at MW-101, but the water level at MW-111 (6553.5 ft amsl) should be 6.5 feet lower than at MW-101 (6560 ft amsl).

Also, if the water in the Jmb is flowing out to the more-permeable Kbc, then the head loss through the Jmb should be shown in areas of the Jmb west of MW-111. The water level in the Jmb may drop down to the level of the water level in the Kbc on the west of the subsurface Jmb structural high.

RESPONSE

RAML agrees with DRC’s comment regarding Section E-E’ and corrections to Section E-E’ will be addressed in the revised document.

1.16 Specific Comment 13 – Section 3.1 "Hydrogeologic Conditions", Page 24, 3rd Bullet Comment Regarding Section E-E'

Please discuss the degree of upward hydraulic gradient at well pairs MW-100/LW-1 and MW-113/EF-6.

RESPONSE

An upward vertical gradient of 0.011 ft/ft was estimated for well pair MW-100/LW-1 northeast of the LVA. This compares to an estimated horizontal hydraulic gradient of 0.01 ft/ft in the vicinity of MW-100/LW-1 based on estimated water level contours adjacent to the well pair.

An upward gradient of 0.020 ft/ft was estimated for wells MW-113 and EF-6 southwest of the LVA. For comparison, the horizontal gradient from well EF-6 to MW-114 was estimated at 0.003 ft/ft.

1.17 Specific Comment 14 – Section 3.1 "Hydrogeologic Conditions", Page 24, 4th Bullet Comment Regarding Section E-E'

Please provide more specific information to justify the claim that the uranium concentrations are consistent with “naturally occurring mineralized and geochemical conditions” at this location. With groundwater concentrations of uranium in this well reaching 20 mg/L, compared with Utah State groundwater limits of 0.030 mg/L (i.e., 667x), the justification here should be as rigorous as possible.

Alternative hypotheses for the high concentrations (e.g., transport of contaminants from the former Lower Tailings area toward the Lisbon Fault (“LF”) through the EF-3A area and through the MW-116 area) should be examined and considered in the Site Assessment. Analyses should be based on appropriate geochemical and hydrogeological data. Please also account for the extremely high concentrations of sulfate in the groundwater, as well as other anomalous chemical concentrations.

Based on available data, there appears to be no obvious reason why the contamination observed in groundwater at MW-116 may not be part of a plume extending from the Lower Tailings area, through the EF-3A area, to the MW-116 area, before the plume moves northward along fractures associated with the LF. This interpretation would appear to be consistent with existing hydrogeological and geochemical data.

The plume along the NE part of the LVA has traveled about 7,000 feet. There is no reason explained in the Report why the plume to the SW of the LVA cannot have similarly traveled a large distance. That plume is in rock having generally a much higher hydraulic conductivity than the rock to the NE of the LVA. The hydraulic gradients generally appear greater. Therefore, unless other factors are involved, it seems that the plume to the SW of the LVA, over a period of several years, should have traveled at least as far as the fractures associated with the Lisbon fault zone. This could potentially account for the poor groundwater quality in groundwater sampled from MW-116.

RESPONSE

The response has been divided into two parts to address, first, the issue of the source for the uranium and sulfate concentrations in groundwater from MW-116, and second, DRC's comments about alternative exposure pathways.

Source of Contamination near LF

There is evidence that rocks near the LF could be a source of uranium and sulfate. The hanging wall and footwall have been extensively altered by hydrothermal fluids that apparently ascended along the LF shear zone, possibly in multiple pulses (Jacobs and Kerr, 1965; Morrison and Parry, 1986). Fractured rocks in this zone were exposed in an incline of the North Alice mine (located less than a mile south of the Lisbon site LTSM boundary), and were filled with pyrite, clay, hardened asphalt, copper sulfides, and oxidized copper minerals (Jacobs and Kerr, 1965, p. 425). Oxidation of these sulfide minerals could constitute a source of the acidity and elevated sulfate concentrations observed in MW-116 groundwater [oxidizing conditions in these solutions may be indicated by dissolved oxygen ("DO") concentrations that are above the detection limit (SSA Report, Table 3)]. Uranium ore has been mined from both the hanging wall and footwall of the LF (Jacobs and Kerr, 1965, p. 426), which suggests that these rocks may also be a source of uranium.

RAML agrees that additional justification is needed to demonstrate that the concentrations of uranium and sulfate (and other constituents, also see Comment

37) in groundwater from the MW-116 area (near the LF) are naturally occurring and not part of the plume extending from the Lower Tailings area. RAML's plans to address this uncertainty are described below.

A detailed review and synthesis of the available literature will be carried out to further assess whether the hanging wall and footwall of the LF could be a source of uranium and sulfate in groundwater. The literature review will also support the the design of field investigations to map the LF location and to characterize groundwater quality in the LF region. These additional historical and site characterization data will be used in support of determining whether geochemical conditions at these locations are conducive to the mobilization of uranium and sulfate in groundwater as a result of fluid-rock interactions.

The lithology of drill core samples obtained from the MW-116 sampling location is described in the SSA report (Appendix B, p. 10-12). The corehole was drilled to a depth of 58 feet bgs. The companion monitoring well, MW-116, was installed within 10 feet of this coring location, and was drilled to a total depth of 123 feet bgs. However, this borehole apparently did not intersect the LF plane (SSA report, Appendix B, p. 11). Whether the corehole and borehole encountered regions of the hanging wall that may have been impacted by faulting is also unclear. Additional petrographic investigations of these drill core samples and borehole cuttings are planned (see also Comment 6). Evidence of possible hydrothermal alteration and subsequent weathering reactions (e.g., by supergene effects) will be a focus of these investigations.

Geochemical analysis tools will be used with site hydrochemical, geologic, and petrographic data to evaluate whether or not mineralization along the LF is a source for uranium, sulfate and other minerals for impacts to groundwater quality at the Site. This work will develop and test conceptual models of fluid-rock interactions along the LF. The models will be based on empirical observations (e.g., using solute-solute scatter plots and Piper diagrams) and equilibrium/kinetic constraints that may be indicated by Eh-pH, phase-equilibrium, solubility, and other diagrams. The conceptual models will be evaluated quantitatively based on simulations of fluid-rock interactions, and results will be compared with measured solute concentrations in fault-associated groundwater (e.g., from MW-116, MW-107S). Agreement between model results and field observations could provide justification for the view that present-day conditions along the LF have caused uranium and sulfate to be mobilized in groundwater. Geochemical models will be used to characterize in detail the aqueous-speciation, sorption, solubility and transport behavior of uranium in LF groundwater.

Empirical and/or geostatistical methods will be used with RAML's site-wide hydrochemical database to determine if MW-116 water has a distinct chemical signature compared to other site groundwater (including plume waters) and tailings pore-water. The empirical methods will be used to identify correlations among solute concentrations such as may be revealed in time-series plots, scatter plots, and Piper diagrams. If feasible given the dataset, multivariate geostatistical methods (e.g., principal component analysis) will also be used to determine if distinctly different water types throughout the Lisbon site can be clearly identified. Results will be used to evaluate whether fault-associated waters have a unique chemical signature, and whether mixing of these solutions with plume waters from the Lower Tailings area may have occurred.

Alternate Exposure Pathway Hypothesis

RAML will assess the possibility that contaminated groundwater from the Lower Tailings area may have migrated to the LF in the area near MW-116 and, from there, continued to migrate to the northwest in close proximity to, or within the LF. RAML will conduct additional field investigations and modeling to better delineate the LF exposure pathway.

1.18 Specific Comment 15 – Section 3.2.1 "Slug Test Results"

It appears that field analysis data test sheets are provided for MW-105 and MW-119 but no slug test data was provided (Table 5 of the Site Assessment). Please provide the slug test data for these wells.

RESPONSE

Slug test field notes and analyses for all tested wells, including MW-105 and MW-119, are provided in Appendix F of the SSA Report. The estimated hydraulic conductivity (K) values for MW-119 are included on page 3 of Table 5 in the SSA report. Information on the slug tests conducted at well MW-105 is included on page 4 of Table 5; however, water levels responded too fast to provide reliable estimates of hydraulic conductivity. Additionally, a DVD included with the SSA Report contains data files (in comma separated variable format) for all slug tests performed, including those conducted on MW-105 and MW-119.

1.19 Specific Comment 16 – Section 3.2.1 "Slug Test Results" Page 26, 2nd Paragraph

The anisotropy value chosen for the slug-test analysis (estimated mean horizontal K calculations) conflicts with core test results for the BCA wells. The majority of core data for the Kbc indicates a ratio of vertical to horizontal K components to be no more than 0.1. This means that analyses of the slug tests for the BCA are incorrect. All of them are shown in Appendix F to have been analyzed with "Anisotropy Ratio (Kz/Kr) = 1." The correct single value (if a single value is to be used universally for BCA slug testing analysis) would be "Anisotropy Ratio (Kz/Kr) = 0.1." Please recalculate the K values.

RESPONSE

Slug test data have been reanalyzed using an anisotropy ratio of 0.1. Results are presented in **Table RTC-2**. Analyses are presented in **Appendix RTC-A**. All wells showed an increase or no change in estimated K when corrected for anisotropy. The average increase in estimated K for all tests was 10%. The maximum increase in estimated K for any test was approximately 60%. Many wells showed no discernible change in estimated K.

1.20 Specific Comment 17 – Section 3.2.1 "Slug Test Results" Page 26, 3rd Paragraph

The written value of 1.4 ft/d for geometric mean K for the BCA appears to conflict with the reported value of 1.9 ft/d as given in the following statement on Page 6 of Appendix J (and other locations in the Site Assessment). "The geometric mean of all estimated horizontal K values of the BCA across the entire Site was estimated to be 1.9 feet per day (ft/d)."

Also please clarify in this paragraph that the estimate does not account for results from MW-105, where the water-level recovery was too fast to determine a K value, or from MW-122, where the well was dry, and no testing occurred.

RESPONSE

Before correcting slug test analyses for anisotropy, the geometric mean of all BCA K estimates from slug tests conducted during the SSA was 1.4 feet per day ("ft/d"). After correcting slug test analyses for anisotropy, the geometric mean of all BCA K estimates from SSA slug testing is 1.5 ft/d. The value of 1.9 ft/d reported in the SSA report referred to the geometric mean of all hydraulic conductivities developed during previous investigations and during the SSA. As noted by DRC, the geometric mean values do not include results from well MW-105, where the water-level recovery was too fast to determine a K value, or from MW-122, where slug testing was not conducted because the well was dry when slug testing took place.

1.21 Specific Comment 18 – Section 3.2.2 "Laboratory Test Results" Page 27 1st Paragraph

Figure B-52 appears to be in error. It states that the bluish gray shale found at MW-118 at a drilling depth of 64 feet was Kbc. However, Figure B-23 (Monitor Well MW-118 construction schematic) shows greenish-blue shale encountered at a depth of 65 feet as Jmb.

The text on Page 12 of Appendix B states: "MW-118: ... Prior to well drilling at the MW-118 location, a PQ corehole was advanced to obtain undisturbed samples for detailed lithologic characterization. The core was advanced to a depth of 78 feet bgs, approximately 13 feet below the Kbc/Jmb contact. ... Greenish blue homogeneous Jmb shale was encountered from 65 to 78 feet bgs."

The text Page 27 refers to MW-118 BBM core, which means that BBM is present at the location, which is not indicated in Figure B-52.

The greenish blue Jmb shale found at MW-118 is correlative with the greenish blue shale found at MW-107D. Page 17 of Appendix B states: "MW-107S and MW-107D: ... Greenish blue homogeneous Jmb shale was encountered from 80 to 85 feet bgs."

Please revise statements in the Site Assessment on this topic to be consistent with each other.

RESPONSE

Figure B-52 incorrectly identifies the shale encountered at a depth of 65 feet in borehole MW-118 as Kbc. This shale should have been identified as Jmb. **Figure RTC-4** shows a revised graphic core log for well MW-118.

1.22 Specific Comment 19 – Section 3.2.2 "Laboratory Test Results" Page 27 3rd Paragraph

Statements in this paragraph indicating that, for the BBM, Kv is similar or equal to Kh appear to conflict with a statement on Page 9 of Appendix J: "Based on laboratory estimates, vertical K is estimated to be at least an order of magnitude lower than horizontal K for the BCA and BBM." Please reconcile these statements or amend them so as to make them consistent with each other and field and laboratory data.

RESPONSE

RAML agrees with DRC's comment regarding Kv and Kh. Further evaluation of the laboratory K estimates indicates that the anisotropy ratio (vertical hydraulic conductivity [$K_{v]}$/horizontal hydraulic conductivity [K_h]) of the BBM is highly variable. Anisotropy ratios in the BBM range from approximately 0.04 to 8.70. The geometric mean anisotropy ratio is approximately 0.66 while the median anisotropy ratio is 0.70. These findings will be made clear in the revised document.

1.23 Specific Comment 20 – Section 3.3.1 "Groundwater Elevations" Page 28 1st Paragraph

Figure 10 appears to have several errors that need to be fixed:

1. The locations for Wells MW-13 and MW-105 are not the same as in other figures and appear to be incorrect.

2. Lines of hydraulic head, which correspond with equipotential lines, do not currently intersect no-flow boundaries at right angles, which, in an isotropic, homogeneous environment, they must (e.g., see Domenico and Schwartz, 1990). This would apply to intersections with the "dry zone" (except where recharge is modeled as occurring) and also with the LF, where the BCA abuts nearly impermeable rock, such as the Chinle Formation. Following this generally accepted scientific and engineering principle will dramatically change the current contouring on the map.

   If RAML is assuming that the BCA is non-isotropic, that is, it is anisotropic, horizontally, then it should (1) explain why that assumption is being made (and provide adequate scientific justification), and (2) -discuss anisotropy in the description of the groundwater contours and incorporate anisotropy in a revised version of the model.

3. The 6,595.-ft contour is on the wrong side of MW-116, which has a groundwater level of 6492.98: The contour should be on the upgradient, instead of the downgradient, side of the well. The 6,490-ft contour should also be moved. It should be closer to MW-116.

4. Flow from east to west across the top of the contoured head map is not balanced in terms of mass flux. Continuity demands that the mass flux balances between any two streamlines. Assuming constant fluid density, what needs to be proven is equivalent volumetric flux across any vertical cross-sectional saturated area located at the same equipotential line between two laterally bounding streamlines. This means that the volumetric flux over the crest of the LVA should match the volumetric flux bounded by the same streamlines downgradient on the western slope of the LVA and over the syncline.

   Instead, the latter is orders of magnitude larger, based on values reported on maps in Figures 9, 10 and 12 and an assumption of Darcian flow. The reported K, the reported saturated thickness, and the calculated hydraulic gradient are each much larger on the western slope than on the crest, between the same two streamlines. If flow is non-Darcian, then the model is of questionable value.

RESPONSE

The responses below are in the same numerical order as in the comment.
Figure 10 has been revised and is provided as **Figure RTC-5**. The groundwater elevations and resulting contours shown on **Figure RTC-5** are adjusted to EFH.

1. The correct locations of MW-105 and MW-13 are shown on the **Figure RTC-5**.

2. Head contours in Figure 10 do not extend to the northern no-flow model boundary (not shown in Figure 10) and so are not fully constrained at the location of the LTSM boundary. However, given the close proximity of the LTSM boundary to the no-flow model boundary, it is reasonable to expect that flow would be essentially parallel to the model boundary and

flow would be in an east-to-west direction for the region east of the syncline. The no-flow boundary condition for the northern boundary of the model is currently under evaluation and will likely change.

3. **Figure RTC-5** shows the correction noted by DRC.

RAML agrees that the collective information presented on Figure 9 (K values), Figure 10 (groundwater elevation contours), and Figure 12 (saturated thickness contours) indicates an imbalance of groundwater mass flux, which poses questions about continuity. This issue will be revisited following additional site characterization and updates to the CSM. A water balance for the Site will be developed in parallel to the additional characterization. The water balance will lead to a more accurate head contour map and help improve the Site's CSM.

1.24 Specific Comment 21 – Section 3.3.2 "Groundwater Flow Directions and Hydraulic Gradients" Page 29 1st Paragraph

Contrary to what is written here in the Site Assessment, Upper Colorado-Kane Springs is not a groundwater basin. It is neither defined in terms of groundwater, nor is it a basin. It is a sub-basin, defined in terms of surface water drainage. Please correct this terminology.

Please provide a reference or figure to support the statement that a topographic divide exists immediately east of the site. Support for the statement is not evident on any of the maps provided in the Site Assessment (including Figure 11). It is not apparent that such a divide immediately east of the site exists, either for groundwater or for surface water. Immediately east of the site is sloping ground that slopes to the northeast, leading to a valley.

A watershed divide, by contrast, is typically a topographic ridgeline or crest line that separates flows to separate surface water bodies located on either side of it. No such feature is evident in Figure 11, which shows the topography east of the site.

Please confirm any claims of groundwater flow directions (e.g., flow into the Animas Groundwater Basin) with published literature or map references.

RESPONSE

RAML understands that the State of Utah does not designate groundwater basins. However, there are principal aquifers of the Colorado Plateau. The Site is located in one of the principal aquifers, the Dakota-Glen Canyon aquifer system. The Dakota-Glen Canyon aquifer covers a large region and is comprised of numerous water-bearing units. Descriptions of the BCA aquifer are generally broad based and not especially useful for characterizing specific aspects of groundwater flow in the vicinity of the Site.

The State of Utah does recognize the areal extent of surface water drainages, or watersheds. The Site is located in the West Coyote Creek Subwatershed (Hydrologic Unit Code [“HUC”] 12# 140300050604) within the Upper Colorado-Kane Springs Subbasin (HUC 8# 14030005). A watershed boundary exists approximately one-half mile east of eastern LTSM boundary and is illustrated on **Figure RTC-6**. The East Coyote Wash Subwatershed (HUC 12# 140300020802), which is within the Upper Dolores Subbasin (HUC 8# 14030002), is located east of the boundary. While a topographic divide between the eastern boundary of the Site and Coyote Creek is not clearly evident, a topographic divide does exist where the two subwatersheds meet along East and West Coyote Creek northeast of the tailings ponds.

RAML acknowledges that groundwater divides do not necessarily coincide with watershed boundaries. The best information available for characterizing the groundwater flow system in the vicinity of the Site are water level measurements taken from wells and surface water bodies local to the Site. Without water levels east of the tailings impoundments that would provide information on groundwater flow patterns in that area, a groundwater divide is assumed to occur in the vicinity of the boundary between the West Coyote Creek Subwatershed and the East Coyote Wash Subwatershed. Based on this assumption, groundwater contours east of the Site are assumed to flow generally from east to west across the eastern LTSM boundary as shown in Figure 10 of the SSA and the updated version of this figure, **Figure RTC-5**.

RAML will evaluate groundwater flow in the region encompassing the Site. This will include evaluating all processes that influence groundwater flow, such as recharge, evapotranspiration, and groundwater-surface water interaction. Incorporating these processes into a site water balance will help to identify areas where deficiencies may exist in our conceptualization of groundwater flow.

Depending on the significance of the weaknesses in the conceptual model, additional site characterization may be proposed.

1.25 Specific Comment 22 – Section 3.3.2 "Groundwater Flow Directions and Hydraulic Gradients" Page 30

Please confirm or correct groundwater flow directions listed under bullets on this page. It appears that stated flow directions do not agree with flow directions depicted on maps and figures in the site assessment attachments.

Under the fourth bullet on this page RAML uses wells ML-1/MW-112 and MW-118 to calculate a hydraulic gradient for the area (0.009 ft/ft). A line drawn between these wells is not oriented perpendicularly to the hydraulic gradient. These wells should therefore not be used as the bounding wells to determine the hydraulic gradient. It would be better to use MW-119/MW-107 or MW-108/MW-107. The hydraulic gradient between MW-108 and MW-107 is about 0.024 ft/ft.

RESPONSE

RAML agrees that the reported hydraulic horizontal gradient between wells ML-1/MW-112 and MW-118 was not appropriate and that the gradient between wells MW-119/MW-107 or MW-108/MW-107 estimated by DRC is accurate. The horizontal gradient between wells MW-119 and MW-107S is approximately 0.025 feet per foot (“ft/ft”) and the horizontal gradient between wells MW-108 and MW-107S is 0.024 ft/ft.

Similarly, the reported hydraulic gradient between the MW-117S/MW-117M/EF-3A well triplet and MW-114 of 0.003 ft/ft would be more representative if it were reported between the monitor well pair MW-113/EF-6 and MW-114. Between these wells, the hydraulic gradient is also estimated to be approximately 0.003 ft/ft.

RAML also wishes to revise the 6th bullet of this section where a gradient between the EF-3A well cluster and well MW-114 is presented. Upon further evaluation, the gradient between the EF-8 well cluster and MW-116 is more appropriate for this region. The groundwater flow direction in this region is west-southwest and the average horizontal hydraulic gradient is 0.012 feet/foot.

The hydraulic gradients reported above are based on April 2014 water levels after adjusting groundwater elevations for density variations.

1.26 Specific Comment 23 – Section 3.3.2 "Groundwater Flow Directions and Hydraulic Gradients" Page 31

Comments regarding groundwater flow based on April 2014 contours state that a groundwater mound is evident in the BBM and is likely caused by seepage of water from Bisco Lake and tailings. Seepage of tailings solution into the BBM implies local contamination of groundwater in the BBM. If flow from a contaminated mound of groundwater has entered into the BBM, then it follows that, somewhere, at or downgradient from the point of inflow, the BBM should be contaminated, and probably not over a limited area. This zone of contamination should extend over an area greater than that of a single monitoring well location. Monitoring data for MW-103 (e.g., uranium concentrations) confirm that impacts to the BBM have occurred, at least at the specific location of this well. However, the shape of the contamination plume in the BBM has not been delineated as part of the site assessment.

RESPONSE

RAML agrees that the BBM would be expected to contain an area of contamination resulting from tailings seepage. Groundwater quality data from MW-103 indicate that contaminated groundwater exists in the BBM in the immediate vicinity of the Lower Tailings impoundment. Groundwater quality data from BBM wells MW-102DB, MW-106, and MW-111 indicate significantly better quality groundwater exists in the BBM farther from the tailings impoundments than that observed at MW-103. RAML agrees that groundwater quality in the BBM to the west and possibly to the east of the tailings impoundments has not been fully characterized. However, given the relatively low K observed for BBM wells, the extent of contamination in the BBM is anticipated to be small.

RAML will evaluate the extent of groundwater contamination and the potential for contaminant attenuation (see scoping approach outlined in Specific Comment 40) in the BBM, and may recommend installing additional monitor wells in the BBM during the next field program.

1.27 Specific Comment 24 – Section 3.3.3 "Vertical Gradient" Page 32 1st Paragraph

One of the two columns toward the right in Table 9 appears to be mislabeled. One says October 2012 Vertical Gradient, and the other, located to its right, just says Vertical Gradient. Judging from the site assessment and Table 9, it appears that the headers for these two columns should reflect that the data are from the Fall 2013 (October 2013) event and the Spring 2014 (April 2014) events, respectively.

RESPONSE

The header in the last column in Table 9 of the SSA report should have been labeled “April 2014 Vertical Gradient” and will be changed in the revised document.

1.28 Specific Comment 25 – Section 3.3.4 "Saturated Thickness of the BCA" Page 33

This paragraph summarizes findings of Figure 12 (Saturated Thickness in the Burro Canyon Aquifer, April, 2014) of the site assessment. It was noted that Figure 12 does not accurately depict the measured saturated thicknesses at several wells, particularly in areas where groundwater flow across the LVA likely occurs. Specifically:

- Well RL-1, shown almost touching the dry zone (0 feet of saturated thickness), has a stated saturated thickness of 10 feet. It is not touching, or even near, the 10-ft contour.

- Well RL-3, with a stated saturated thickness of 25 feet, is shown between the 10-ft and 20- ft contours, an obvious error.

- Well RL-4, with a stated saturated thickness of 20 feet, is not touching, or even near, the 20-ft contour. It is shown about halfway between the 10-ft and the 20-ft contours.

- Well RL-5, with a stated saturated thickness of 20 feet, is not touching, or even near, the20-ft contour. It is shown touching the 30-ft contour.

- Well LW-1, with a stated saturated thickness of 88 feet, is shown touching the 90-ft contour, slightly closer to the 100-ft contour than to the 80-ft contour.

- Well OW-UT-9, with a stated saturated thickness of 14 feet, is shown touching the 30-ft contour. The contours in the area are drawn incorrectly.

Additionally, please review the map and make corrections, as it appears that other wells are shown at locations with incorrect contouring.

The relatively thin saturated thickness is currently allowing groundwater and contaminant flow toward the west over the LVA crest. If groundwater levels fall, then the plume would first have to move north over LTSM boundaries before moving west toward the LF. Southeast of MW-109 and RL-1, the Kbc is currently dry along part of its crest because the elevations of the Kbc located in that part are greater than the elevations of the adjacent groundwater table. If the groundwater table drops several feet, as it could, for example, during a major drought, then more of the LVA crest located north of MW-109 and RL-1 (and north of MW-119) would have elevations greater than the elevations of the adjacent water table. This would potentially extend the dry zone in the Kbc north of the LTSM boundary line, and cause the uranium plume to move north of the LTSM boundary line. Figure 12 shows the BCA in the Vicinity of MW-119-as having only three feet of saturated thickness. With current water levels in the BCA, the large uranium plume runs NW parallel to the LVA (on the NE side of the LVA), then is modeled as crossing the LVA without reaching the LTSM.

RESPONSE

RAML acknowledges the discrepancies on Figure 12 characterizing the saturated thickness in the Burro Canyon aquifer. RAML has prepared **Figure RTC-7** to more accurately show contours of the saturated thickness.

Currently, hydraulic gradients between RL-3 and MW-119 indicate an east to west flow direction. RAML agrees that a decline in groundwater levels in this area could change the direction of groundwater flow and plume migration. During the period from March 2004 to October 2014, the groundwater elevations in wells RL-1, RL-3, RL-4, and RL-5 have declined about 1.2 ft, 1.2 ft, 1.3 ft and 1.8 ft, respectively. If these declines were to continue, it is possible that the dry zone in the BCA could extend farther to the northwest and force the uranium plume to migrate in a more northwesterly direction. If this occurred, the northern uranium plume could migrate past the northern LTSM boundary.

Monitor wells RL-4 and RL-5 are well positioned to identify if the northern plume begins to migrate northward toward the LTSM boundary. RAML will continue to evaluate processes influencing groundwater flow north of the LTSM to better understand the potential for northerly flow and transport from the Site. A water balance of the Site will be developed that will improve RAML's understanding of groundwater flow at the northern LTSM boundary.

1.29 Specific Comment 26 – Section 3.4 "Laboratory Testing of Vadose Zone Core Samples" Page 34 1st Paragraph

Page 2 of 19 of Appendix C showing the results from ACZ Laboratories reports a detection of uranium in leachate from hard rock sample 102-DB-123-123.5 of 0.0005 mg/L. This is the core sample for borehole 102DB. It is noted that this analysis is for a sample of the Kbc, which, in the associated completed well (MW-102), is screened over the cored interval. The groundwater sampled from the screened interval of MW-102 shows a high uranium concentration of 148 mg/L. Based on Figure 15, please describe why the concentrations in the groundwater are extremely high, yet the concentrations from leachate testing are very low.

RESPONSE

The report from ACZ Laboratories is for a Synthetic Precipitation Leaching Procedure analysis by U.S. Environmental Protection Agency Method 1312. This analysis was run on rock material from the MW-102DB core to assess the potential for water to leach metals from the rock. For the analysis, the leaching fluid was deionized water adjusted to a pH of 5 to mimic rainwater in the western United States. The SPLP analysis was run at the request of DRC to assess the effect of a thin band of black staining observed within the interval of the core (123 to 123.5 feet bgs). Results of the analysis for MW-102DB indicate that the concentration of uranium leached from the rock material in the MW-102DB core was 0.0005 mg/L. The uranium concentration from the SPLP analysis for the MW-102DB core is not directly comparable to the concentration of uranium in the groundwater at MW-102 because the SPLP analyses measures what is leachable from one core sample, and the groundwater sampling result is a measure of groundwater quality in the vicinity of the well which is influenced by many different factors including possible impacts from tailings seepage.

1.30 Specific Comment 27 – Section 3.5 "Groundwater Quality" Page 34

RAML states “Review of the groundwater quality data from the comprehensive events indicates that all three sampling methods provide comparable analytical results.” This assertion is yet to be substantiated. Data in Table 3 for the three sampling methods appear to have many discrepancies and/or inconsistencies between the methods. The DRC would like to see a thorough analysis of the data and submission of a LTGMP with the Site Assessment as required by the SCAs.

RESPONSE

RAML submitted a Comparative Analysis of Groundwater Sampling and a Groundwater Monitoring Plan to DRC on March 6, 2015. Once site evaluation work is complete, RAML will submit a long-term groundwater monitoring plan for DRC approval.

1.31 Specific Comment 28 – Section 3.5 "Groundwater Quality", Page 36 1st Paragraph

RAML states that the groundwater chemistry at monitoring well MW-116 (located adjacent to the LF) is notably distinct from nearby wells based on the finding that “trace metals concentrations are significantly higher than concentrations reported in nearby BCA wells located closer to the Site.”

This is not the case for uranium in groundwater at nearby EF-3A at 27.5 mg/L, higher than 20.8 mg/L at MW-116. Neither is it the case for dissolved arsenic at nearby MW-117M at 0.245 mg/L, and at nearby EF-3A at 0.206 mg/L, higher than 0.134 mg/L at MW-116. Neither is it the case for dissolved molybdenum at nearby EF-3A at 2.81 mg/L, higher than 1.25 mg/L at MW-116.

Please justify the statements and the claims that groundwater chemistry in the BCA adjacent to the LF is impacted by geochemical conditions of the fault zone (and without impact from the groundwater plume) with specific information (e.g., parameter lists and concentrations for each well).

RESPONSE

RAML concurs with the comment that the concentrations of uranium, arsenic, and molybdenum determined in groundwater sampled from MW-116 are not higher than their counterparts measured in wells nearer the Lower Tailings area. Justification for the claim that groundwater chemistry in the BCA adjacent to the LF is impacted by geochemical conditions of the fault zone (and without impact from the groundwater plume) will be further evaluated using the approach outlined in the response to Specific Comment 14.

1.32 Specific Comment 29 – Section 3.5 "Groundwater Quality", Page 36 1st Paragraph

The RAML statements regarding “the water quality detected at MW-107s, and to a lesser degree MW-107D, is similar to that of MW-116” appears to require amending. RAML should substantiate, quantitatively, the claim water quality in each well is similar. There are some large differences in water quality between the two wells. Uranium in GW in Well MW-107S is 0.0019 mg/L, whereas that in Well MW-116 is 20.8 mg/L (10,900 times as high). TDS in Well MW-107S is 1,960 mg/L, whereas that in Well MW-116 is 26,600 mg/L (14 times as high). Arsenic in Well MW-107S is 0.005 mg/L, whereas that in Well MW-116 is 0.134 mg/L (27 times as high). The Licensee should acknowledge these and other instances (e.g., Mg2 and Cr) where water quality is considerably different.

RESPONSE

RAML agrees that the statement about the similarity between water quality at MW-107S and D and MW-116 was overly simplistic and incomplete. RAML recognizes the distinct differences between the constituent concentrations in groundwater at the two well locations. The statement in the report cited by DRC in the comment was intended primarily to point out that groundwater at MW-107S and D had a depressed pH (and elevated inorganic constituents compared to most nearby wells) – a condition similar to that observed at MW-116.

Similarities and differences among groundwater samples from MW-116, MW-107S, and possibly MW-107D will be evaluated using the geochemical and geostatistical methods outlined in response to Specific Comment 14. The results of this work will be evaluated to determine if the similarities and differences in water chemistry can be explained by plausible geochemical processes affecting physico-chemical parameters (e.g., TDS, redox potential and pH) and the aqueous speciation, solubility, and sorption behavior of uranium, arsenic and possibly other constituents.

1.33 Specific Comment 30 – Section 3.5 "Groundwater Quality", Page 36 2nd Paragraph

Jacobs and Kerr (1965) only refer to acidic conditions at or near the LF once in their entire paper, speculating that “Solutions of acidic nature, possibly enriched in hydrogen sulphide, bleached the wall rock by reducing ferric oxide pigment and precipitated metallic sulphides.” However, they also make a statement in reference to sandstones present near the LF that “Silicification suggests higher pH values at times.” This indicates the presence near the LF at times of basic solutions (higher pH). DRC cannot see where Jacobs and Kerr (1965) assert that fluids of either high or low pH moved into the system specifically during tectonic activity. Together, the statements of Jacobs and Kerr (1965) do not appear to provide evidence that current hydrochemical conditions of the LF should be characterized by acid or low pH. The text of the Site Assessment should therefore be amended.

RAML needs to provide evidence for statements in this paragraph. Acidic conditions during tectonic activity of ages past do not necessarily result in acidic conditions now. Subsequent geochemical events over millions of years may modify geochemical conditions, potentially changing lower pH conditions to higher pH conditions. Jacobs and Kerr (1965) indicate that the presence of silicification noted near the LF indicates the possibility of higher pH conditions there in times past. Please make changes in the Site Assessment to reflect these considerations.

RESPONSE

RAML generally agrees that the study conducted by Jacobs and Kerr does not conclusively indicate that the observed groundwater quality at MW-116 is from naturally occurring conditions along the LF. Future references to this study, if made, will more appropriately cite its relevance to groundwater quality conditions near the Site.

The geochemical environment along the LF zone will be further investigated using the geochemical methods discussed in response to Specific Comment 14.

Conceptual models of fluid-rock interactions near the LF will be developed and tested using these methods. For example, groundwater sampled from MW-116 appears to be relatively oxidizing based on measured redox potentials and dissolved oxygen contents (SSA Report, Table 3). If so, these solutions could conceivably oxidize metal sulfides that, as noted by Jacobs and Kerr (1965), precipitated in the LF zone during an earlier period of hydrothermal activity. If so, equilibrium relations depicted in Eh-pH diagrams will be used to evaluate this hypothesis quantitatively. Similarly, the extensive silicification of the hanging wall of the LF noted by Jacobs and Kerr (1965, p. 427) could have resulted from cooling of hydrothermal solutions that initially contained relatively high concentrations of dissolved silica (i.e., because the solubility of SiO_2 minerals such as quartz, chalcedony, and amorphous silica increase with increasing temperature) and may therefore not have resulted from contact with high-pH solutions. This possibility will also be evaluated using the methods noted in Specific Comment 14.

RAML will conduct additional exploratory drilling and well construction in the vicinity of the LF to characterize the mineralogy, hydrogeochemistry, and hydrogeology of the fault zone. The scope and timing of further characterization of the LF will be addressed during meetings between RAML and DRC.

1.34 Specific Comment 31 – Section 3.5.1 "Common Constituents"

RAML's claims in this section that high sulfate concentrations measured at wells MW-116 and MW107S are "the result of naturally occurring hydrochemical conditions in the fault zone, and not the result of historical mining operations at the Lisbon Facility" need to be substantiated with specific evidence.

RESPONSE

See responses to Specific Comments 14 and 30.

1.35 Specific Comment 32 – Section 3.5.1 "Common Constituents", Page 38 3rd Paragraph

RAML statements that groundwater from BBM wells MW-103 and MW-106 appears similar in signature to groundwater from BCA wells near the tailings impoundments needs to clarify why the groundwater in well MW-106 which is located far upgradient from the tailings impoundments is similar in signature to groundwater from BCA wells located near the tailings impoundments. If it is similar, then what is the cause, and why is the finding significant?

RESPONSE

Information presented in paragraph three on page 38 of the SSA report was intended to note whether groundwater quality in the BBM at MW-103 and MW-106 was similar to groundwater detected in BCA wells near the tailings (i.e., saline) or similar to groundwater detected in wells in areas farther from the tailings (i.e., permanent hardness).

As shown on Figure I-6 of the SSA report, groundwater quality at MW-106 is characterized as saline. The saline nature of groundwater at MW-106 and BCA wells near the tailings could be coincidental, the result of different processes, or the result of some aspect of mining. If the latter is true, the saline groundwater in both areas may be related partly to historical leakage from Bisco Lake, where a groundwater mound existed during and for several years after mining. However, insufficient data are available on the water quality of Bisco Lake to confirm this hypothesis.

General chemical properties such as salinity or water hardness may not be sufficient to support interpretations of possible similarities among groundwater types. Better indicators of similarity may be shown, for example, in empirical diagrams (e.g., Piper plots, scatter plots) that reveal systematic changes in solution characteristics (e.g., pH, concentrations of conservative solutes, stable isotope ratios) along known groundwater flow paths. Multivariate methods can also be used to identify groundwater types that are similar in a statistical sense. Once such similarities have been identified, geochemical techniques, such as inverse modeling, can be used to identify key reactions that control the distinguishing characteristics of the different groundwater types. This general approach will be used to further assess whether groundwater samples from BBM wells MW-103 and MW-106 are similar to groundwater samples from BCA wells near the tailings. If so, possible reasons for the similarities, and their significance with respect to contaminant transport processes, will be evaluated.

1.36 Specific Comment 33 – Section 3.5.1 "Common Constituents", Page 38 3rd Paragraph

Statements that groundwater from wells MW-111 and MW-102D show no impact from tailings seepage due to characterization as alkali carbonate are not fully consistent with the interpretation found elsewhere in the Site Assessment. Specifically, there are concerns that tailings seepage from the tailings impoundments created mounding which causes the head in MW-102DB to be so much higher than in the companion well screened in the BCA. The term used elsewhere in the Site Assessment (see Page 33) describing the relationship between groundwater in the fractured section of the BBM in MW-102DB and the contaminated mound water beneath the Upper Tailings Impoundment is "hydraulically connected." Please clarify the RAML interpretations regarding this issue.

RESPONSE

The geochemical signature of the water sampled at MW-102DB is not similar to samples from MW-102 or OW-UT-9. For example, maximum values reported in Table 11 of the SSA report indicate that the following parameters are all higher by at least an order of magnitude in groundwater samples from MW-102 than from MW-102DB: As, Mo, Se, U, Na, Cl, CO_3, HCO_3, SO_4, EC, TDS. This observation suggests that the groundwater in the BBM at the location of MW-102DB has experienced little or no impact by mixing with low-quality tailings seepage water. Moreover, the hydraulic head in MW-102DB is approximately 6 ft higher than heads in the overlying BCA measured at MW-102, which indicates there is a potential for groundwater to flow from the BBM to the BCA at this location. Heads in the BBM at MW-102DB are comparable to heads measured in the BCA at OW-UT-9 near the Upper Tailings. Whether the higher heads measured in MW-102DB are related to the higher heads encountered near the Upper Tailings, or are due to other processes not yet identified is not clear. Additional data collected at, or in the vicinity of these wells may indicate a correlation between heads at MW-102DB and OW-UT-9 due to possible hydraulic connectivity through fractures or other features. However, the important result for MW-102DB is that it is not impacted by tailings seepage indicating that the BBM remains un-impacted in an area close to and overlain by impacted groundwater.

1.37 Specific Comment 34 – Section 3.5.2 "Trace Metals"

As a general statement for all parameters discussed under this section, any claims (“beliefs”) that elevated concentrations are due to hydrochemical conditions along the LF needs additional substantiation. Additionally, the Site Assessment needs to discuss the possibility that elevated concentrations may be due to more than one source of contaminants.

RESPONSE

See responses to Specific Comments 14 and 30. The approach outlined in the response to Specific Comment 14 will also be used to address Specific Comment 34, but with a focus on the aqueous-speciation, sorption, and solubility behavior of arsenic, selenium, and molybdenum (similar work for uranium is discussed in Specific Comment 14).

1.38 Specific Comment 35 – Section 3.5.2 "Trace Metals": Uranium

Sooty staining was noted for fractures in BCA rock encountered during drilling of MW-102 (see Appendix B). We don't know what this sooty staining is. It may possibly be sooty manganese or sooty pitchblende (low solubility, and kinetic requirements may keep concentrations down during core testing). Sooty pitchblende is a possibility for the staining. That type of deposit is described in Uranium Deposits of The World, Volume 2, by Franz J. Dahlkamp.

RESPONSE

RAML concurs with this comment, and also notes that sooty staining of pitchblende may be indicative of the supergene weathering of primary pitchblende (Walker, 1957, p. 15).

1.39 Specific Comment 36 – Section 3.5.2 "Trace Metals", Uranium

The Site Assessment, Figure 10, Groundwater Elevations, April 2014 seems to exhibit several errors. The 6,495-ft contour is drawn downgradient from Well MW-116, whereas it should be drawn upgradient. The groundwater level for MW-116 is 6,492.98 ft amsl. This means that the well should be located between the 6,490-ft and the 6,495-ft contours, which it is not. These two groundwater contours need to be shifted to properly account for the water level in the well. Also, the 6,500-ft contour needs some adjustment. When the contours are properly drawn, they show that Well MW-116 is directly downgradient from Well EF-3, which, like Well MW-116, exhibits relatively high concentrations of uranium and other contaminants. This suggests the possibility of contamination from a plume of leachate from the tailings impoundments. RAML should correct the groundwater contours in Figure 10. They should also discuss the potential for groundwater sampled from Well MW-116 having been contaminated by a westward-moving plume of contaminants and justify any conclusions made using site data.

RESPONSE

RAML agrees that the 6,495-ft groundwater elevation contour should be drawn on the upgradient side of MW-116, and that the 6,490-ft and 6,500-ft contours should adjusted to be consistent with the revised 6,495-ft contour. **Figure RTC-5** shows the revised contours (also adjusted to EFH). As DRC's comment states, this places well MW-116 directly downgradient from well EF-3A. RAML agrees that it is possible that seepage from the tailings, which is present in well EF-3A, has reached well MW-116. See the response to Specific Comment 14 for proposed additional analyses to assess groundwater quality near the LF and to help identify the source of uranium observed at well MW-116.

1.40 Specific Comment 37 – Section 3.5.2 "Trace Metals", Arsenic

RAML states that arsenic was detected above the Utah Groundwater Quality Standard in six of the 20 new wells. Please indicate where these detections were found and if there is any relationship between the concentrations and the delineated contaminant plumes.

RESPONSE

Arsenic concentrations exceeding the Utah Groundwater Quality Standard ("UGQS") of 0.05 mg/L were reported in six wells, including OW-UT-9 and MW-102 in the north plume; H-63, EF-3A, and MW-117M in the south plume; and MW-116 adjacent to the LF. Figure 16 of the SSA report shows contours of arsenic concentration in groundwater; the outer 0.05 mg/L contour delineates the area where concentrations exceed the UGQS. The elevated arsenic concentration at wells OW-UT-9, MW-102, EF-3A, and MW-117M are likely the result of tailings seepage from the Lisbon Mine. This conclusion is reasonable based on the close proximity of the wells to the Upper Tailings (OW-UT-9 and MW-102) and Lower Tailings (EF-3A and MW-117M). There is also evidence from Piper diagrams that waters sampled in these wells have evolved from tailings porewaters. The cause of the elevated arsenic concentration at H-63 is less clear; however, the arsenic concentration at this well was only slightly greater than the UGQS in November 2012 and was detected at concentrations below the UGQS in three subsequent samples in 2013 and 2014 (Table 11 of the SSA report).

1.41 Specific Comment 38 - Section 3.5.2 "Trace Metals", Selenium

Well MW-107D does not have the correct concentration given in the bulleted item. The actual concentration is orders of magnitude less.

RESPONSE

The maximum concentration of selenium reported in well MW-107D was 0.001 mg/L for the October 8, 2013 sample. This concentration is equivalent to the laboratory reporting limit for selenium. All other analytical results for selenium were reported as less than the detection limit of 0.001 mg/L. Therefore the concentration for selenium reported in Section 3.5.2 “Trace Metals”, is correct as shown.

1.42 Specific Comment 39 - Section 4.0 "Conceptual Site Model", Source Area

It is noted that groundwater in BBM Well MW-103 contains 9.66 mg/L uranium. The risk-based health standard for uranium adopted by the State of Utah for groundwater is, by contrast, only 0.030 mg/L. Thus, the existing uranium concentration in groundwater at MW-103 is 322 times as high as the State limit. Thus, it cannot properly be said that “meaningful impacts to groundwater in the BBM that pose a public health risk do not exist.” Please amend the language here in the Site Assessment, or justify the claims.

RESPONSE

RAML concurs that the statement “meaningful impacts to groundwater in the BBM that pose a public health risk do not exist” could be interpreted as disingenuous on its face. Assuming that a “meaningful risk” is defined as a complete exposure pathway (i.e., there is an identified pathway from the source to a receptor) then, based on the modeling done to date, there are no complete groundwater exposure pathways, which is the basis for this statement. However, RAML agrees that there is a need to expand the current CSM to consider other pathways. Risk pathways will be further evaluated in upcoming revisions of the flow and transport model.

1.43 Specific Comment 40 – Section 4.0 "Conceptual Site Model", Groundwater Contamination

DRC notes that per RAML language the contaminants are considered to be transported by advection, dispersion and dilution only. RAML states that other processes such as attenuation of uranium by chemical reactions with the tailings solution and mineral matrix are minimal. Is this determination made through results of the Site Assessment Activities or other studies which were conducted at or near the site? Please provide additional information regarding this determination and how it affects the outcomes of the contaminant transport model (e.g., conservative transport).

RESPONSE

The uranium transport analysis presented in the SSA identified advection and hydrodynamic dispersion as the governing transport mechanisms for uranium. Uranium attenuation processes were not considered in the analysis. By not including attenuation processes, a conservative transport result is obtained in terms of maximum uranium transport distances for given travel times.

If uranium attenuation does occur at the Site at a significant level, then uranium transport distances may be smaller, and travel times larger than what was reported. RAML will further evaluate uranium attenuation processes at the Site. Specifically, a scoping analysis will be carried out to determine if an alternative, non-conservative model of U transport at the Lisbon site is feasible and defensible. The approach will include the development of conceptual models of plausible uranium attenuation mechanisms in the BCA (e.g., sorption, ionexchange, solubility, and co-precipitation). The conceptual models will be evaluated quantitatively using a simplified 1-D reactive-transport simulator (PHREEQC), and results will be evaluated in relation to a pessimistic reference case in which no attenuation is assumed. The comparisons will serve as a basis for determining whether uranium transport in the BCA could be significantly attenuated by one or more mechanisms. If so, these mechanisms may be incorporated in future groundwater flow and transport models for the Lisbon facility.

1.44 Specific Comment 41 – Section 4.0 "Conceptual Site Model", North Plume

This Site Assessment does not provide adequate evidence for the assumed current rate of transport of 60 ft/y. Please provide evidence.

Darcian calculations show that velocities in the area of the plume tip may be greater than 60 ft/y. For instance, near Well RL-3, where the BCA has a K of 1.2 ft/day, the hydraulic gradient of the BCA downgradient from the well appears to be about -10 ft/600 ft, or -0.017 ft/ft. The mid-range effective porosity of sandstone is, according to a range of values shown by Domenico and Schwartz (2003), about 5%, or 0.05. Since groundwater velocity, v, equals – KI/ne, where K is hydraulic conductivity, I is hydraulic gradient in the direction of groundwater flow, and ne is effective porosity, it follows that groundwater velocity in this area, based on these assumptions, should be about (1.2 ft/d)(0.017 ft/ft)/0.05, or 0.4 ft/d, or 149 ft/y. If effective porosity was actually smaller than 5%, then the groundwater velocity would be greater. If flow occurs through fractures, and it is non-Darcian, then transport may be appreciably faster.

In an area downgradient from the existing leading edge of the plume, between MW-108 and MW-107S, the hydraulic gradient, based on Figure 10, is about -29 ft/1200 ft, or -0.024. The geometric mean hydraulic conductivity in the local area, based on Figure 9 values, is 1.6 ft/d (MW-107S has a K value of 2.5 ft/d, and MW-108 has a K value of 1.3 ft/d). Assuming an effective porosity for the sandstone of 0.05, this gives a groundwater velocity, based on the assumption of Darcian flow through an equivalent porous medium, of about 0.77 ft/d, or 281 ft/y. At this rate, the plume would reach the LF, located 2,000 ft away, in a little over seven years. If the effective porosity was less than 5%, then the plume would arrive at the LF even faster. If flow occurs through fractures, and it is non-Darcian, then transport may be faster. Near the LF, the plume could then traverse the northern LTSM boundary in the NW of the model domain in the highly fractured sandstone rock assumed to be present parallel to the LF.

To assess the overall likelihood of the plume moving beyond the borders of the LTSM, please provide estimates for plume velocity estimated using ranges of likely parameter values, and consider movement along the LF to the northwest portion of the model domain. The immediate concern is not necessarily with the NW plume moving beyond the northern LTSM boundary near the LA, but with the plume first moving to the fractures near the LF on the west and then moving past the northern LTSM boundary in those fractures near and parallel to the LF. However, should the groundwater table decline in elevation, then the plume along the NE side of the LVA might be forced to travel further toward the NW than anticipated by the conceptual model, and perhaps even move across the LTSM boundary, before it can cross the crest of the LVA and travel toward the LF in the west. These issues need to be addressed in the conceptual model and represented in groundwater modeling.

The migration velocity of the uranium, which, assuming no sorption as stated by RAML is assumed for the calculations above. Advective flow is likely to largely displace local groundwater, so dilution in the main part (core) of the plume is not a critical parameter. The hydraulic gradient and the hydraulic conductivity, coupled with the effective porosity, are what, in general, govern the contaminant velocity, not the saturated thickness.

RESPONSE

Due to spatial variability of the parameters used to calculate Darcy flux (hydraulic gradient and K) at the Site, care must be taken when calculating the seepage velocity for a specific flow zone. This is the case for calculating seepage velocities at leading edge of the northern plume. Six wells are identified in this area, MW-109, MW-119, RL-1, and RL-4, RL-3 and RL-5 exhibiting K's of 0.06 ft/d, 0.1 ft/d, 0.6 ft/d, 0.6 ft/d, 1.2 ft/d, and 3.3 ft/d, respectively. The hydraulic gradient varies spatially as well. Using the hydraulic gradient for the zone extending from the 6,540 ft contour to the 6,535 ft contour on either side of RL-3, and using K for RL-3 alone, and assuming Darcian flow, the seepage velocity magnitude is calculated as (using effective porosity of 0.05 suggest by DRC) 5/950 ft/ft x 1.2 ft/d x 1/0.05 = 0.126 ft/d or 46 ft/yr (in a westward direction). Using the geometric mean for K of 0.612 ft/d for wells in this flow zone (RL-1, RL-3, RL-4, RL-5 and MW-109), a seepage velocity of 24 ft/yr is calculated.

Using the hydraulic gradient downgradient from RL-3, a more appropriate K value is the geometric mean for wells RL-3, RL-4, MW-109, MW-119, or K = 0.452 ft/d. Using this K and the hydraulic gradient provided by DRC above, -0.017 ft/ft, a seepage velocity of 0.085 ft/d, or 31 ft/yr is obtained. The seepage velocity estimates of 24 ft/yr, 31 ft/yr, and 46 ft/yr are reasonably close given the spatial variability of flow parameters and the associated uncertainty of the calculations. This range of velocities is considered to be representative of seepage velocities at the leading edge of the northern plume and is lower than the 149 ft/yr suggested by DRC’s comment.

In the area downgradient from the leading edge of the plume, RAML agrees that DRC’s estimate of seepage velocity between wells MW-108 and MW-107S/D has been computed appropriately. RAML also agrees with DRC’s concerns over the potential for uranium transport to the north of the LTSM. RAML will conduct further analysis of flow and transport in the vicinity of the northern LTSM boundary to improve estimates of transport velocities and the potential for uranium migration across the LTSM boundary. The analysis will be informed by further site characterization including boring and well installation, evaluation of groundwater flow processes such as evapotranspiration and recharge, and development of a water balance of the Site as part of improving the overall CSM.

Finally, RAML based all transport velocity calculations on advective flow without any attenuation processes, as noted by DRC (see Specific Comment 40). RAML will conduct additional geochemical studies to determine whether uranium attenuation is occurring at the Site. If uranium attenuation is shown to be a defensible mechanism to consider for this Site, calculation of transport velocities will take this into consideration in the updated CSM and in the revised flow and transport model.

1.45 Specific Comment 42 – Section 4.0 "Conceptual Site Model", South Plume

RAML claims that density gradients and the presence of more dense groundwater near the Kbc/Jmb contact limit the flow of deeper groundwater; these claims are speculative, and they need to be justified with more evidence.

RESPONSE

The SSA report stated that the “denser groundwater in the deeper portion of the syncline may be relatively immobile.” It is feasible that structural controls (e.g., the synclinal trough, depressions in the BBM) combined with density contrasts between background water and tailings seepage migrating through the aquifer may lead to situations where the mobility of denser groundwater is reduced or the transport pathway is altered compared to groundwater migrating under the control of the potentiometric gradient alone. Transport processes associated with dense groundwater at depth will be more carefully explored as part of further CSM development.

1.46 Specific Comment 43 – Section 4.0 "Conceptual Site Model", South Plume

GW flux from the SE cannot be assumed to be small simply due to a physical restriction in the flow zone. Hydraulic gradients there are fairly large. Hydraulic conductivities in nearby areas are extremely large. To make the argument in the Site Assessment effectively, RAML must supply evidence to support the claim; otherwise, it would be better to delete the speculative comment.

RESPONSE

RAML agrees that a physical restriction in the groundwater flow system does not necessarily lead to a small groundwater flux. If steady-state (or quasi steady-state) conditions exist and there are no source or sink terms in the restriction itself, the volumetric flux through the restriction will be constant and equal to flow above and below the restriction based on continuity considerations. The increased hydraulic gradients in the restriction are expected given the generally smaller cross-sectional area that groundwater flows through. Alternatively, the hydraulic conductivity could be higher in the restriction and the hydraulic gradient would be affected less. Either way, RAML will refrain from using any future reference to flow from the southeast being smaller due to the presence of a restriction.

1.47 Specific Comment 44 – Section 4.0 "Conceptual Site Model", South Plume

RAML's claim that groundwater in areas southwest of the study area is generally flowing west toward the LF is not generally the case south and southwest from the tailings ponds. Specifically, it is not the case between MW-105 and MW-117S/M/EF-3A, where hydraulic gradients appear in Figure 10 to indicate northwesterly flow, parallel to the LF, rather than westward flow, toward the LF.

RESPONSE

RAML agrees that the groundwater elevation contours shown on Figure 10 indicate groundwater flow to the northwest and parallel to the LF in the area generally south and southeast of the tailings impoundments. It is noted that there is limited data with which to accurately define flow directions in this area. A clearer understanding of the LF’s influence on groundwater flow will be forthcoming following further hydrogeologic characterization of the LF and further development of the CSM.

1.48 Specific Comment 45 – Section 4.0 "Conceptual Site Model", South Plume states that "groundwater flow directions in the area southwest of the LVA are generally to the west toward the LF"

This statement was not specific enough. Groundwater flow directions in the area southwest of the LVA and north of wells MW-117S/M/EF-3A are generally to the west toward the LF.

RESPONSE

The statement in question cited by DRC was intended to apply to the area southwest of the LVA and west-southwest of the tailings impoundments. RAML will modify the revised report to specifically and correctly identify the area(s) of interest.

1.49 Specific Comment 46 – Section 4.0 "Conceptual Site Model", South Plume

The RAML concept of downward drainage along the LF is speculative. No evidence is presented in the Site Assessment for it. Please provide evidence for this concept, and, if proven, how does this affect the contaminant transport and model conclusions?

RESPONSE

RAML concurs that conclusive evidence of downward drainage along the LF is not available presently. Downward drainage across the LF is one of three possible LF pathways, the other two being along the LF and across the LF. Additional characterization of the mineralogy, extent, continuity, and hydraulic properties of the fault zone will provide data with which to better assess whether groundwater flows downward, laterally along, or across the fault zone and any associated fractures. As discussed earlier, RAML plans to evaluate the effects of the LF on site conditions in upcoming modeling and field investigations.

1.50 Specific Comment 47 – Section 4.0 "Conceptual Site Model", Exposure Pathway

RAML states in this section that transport of contaminants to the POE locations and beyond the LTSM is “low.” This conclusion remains to be proven. Available evidence suggests the potential for contaminants to move westward to fractures along the LF, which may then direct contaminants northward over the LTSM boundary. Until better well coverage is attained, conclusions about the relative likelihood of migration beyond the LTSM boundary being low are speculative. Additionally, RAML states in the second paragraph of this section that there is not enough field data to determine exposure pathways in areas of the LTSM.

RESPONSE

DRC’s comments on exposure pathways have raised several important questions that need to be resolved before the conclusion that the plume is not expected to migrate across the LSTM boundary can be fully supported, or whether a different conclusion is warranted. RAML will conduct additional characterization and modeling of the LF exposure pathway to address these questions.

1.51 Specific Comment 48 – Section 4.0 "Conceptual Site Model", Exposure Pathway

In the footnote on page 46, RAML states that rock on the west and southwest side of the LF is dry. RAML states on Page 29, "Dry conditions were observed at TRc well MW-121 for several months after installation. The most recent depth to water measurement indicates that a small amount of water has accumulated in the well (less than 1 foot). It appears that groundwater is slowly accumulating in the well." Thus, the Chinle Formation, in which MW-121 is screened, consists of rocks W-SW of the LF that are not dry. They may be relatively impermeable, releasing water to a well very slowly, but they are not dry.

RESPONSE

DRC is correct in noting that groundwater has been slowly entering well MW-121 and that the Chinle formation W-SW of the LF is not dry. A time series plot of water level in well MW-121 is provided in **Figure RTC-8**. At the time the SSA was prepared, less than 1 foot of water had accumulated in the well. As of late October 2014, approximately 4.4 ft of water has entered the well as a result of groundwater inflow from the Chinle formation.

1.52 Specific Comments 49 through 58 – Groundwater Model

Specific Comments 49 through 58 pertain to the groundwater model. As discussed on our conference call on January 22, 2015, responses to comments on the model will be developed further through meetings with the DRC and additional data collection and analysis. Processes to be evaluated and that may lead to improvements in the CSM are provided below.

Transient conditions at the Site may be related to past mining activities and/or climate variability. The following factors may contribute to an ongoing and possibly long-term transient condition at the Site:

- Tailings drainage
- Bisco Lake drainage
- Water level recovery from CAP pumping
- Variations in recharge due to climate variability

The following are possible additional sources of water at the Site to be evaluated:

- Recharge in the ephemeral drainage channel southwest of the LVA and northeast of LF
- Recharge from West Coyote Creek and/or Rattlesnake Reservoir
- Recharge along outcrops
- Aerially distributed recharge and identification of groundwater divides
- Flow of groundwater water from the BBM to the BCA
- Tailings drainage into the BCA

The following are possible sinks of water at the Site to be evaluated:

- Discharge into, across, or along the LF
- Evapotranspiration
- Surface water discharge
- Loss into the BBM

Once all groundwater sources and sinks are identified and quantified, a water balance will be developed for the Site. The water balance will help to identify groundwater flow patterns and to improve the mass continuity issue, and will lead to a defensible CSM. Once the CSM is deemed adequate, data gaps will be identified and field program designed to fill these gaps. The flow and transport model will be updated based on the revised CSM and the new data. The revised flow and transport model will be used to provide defensible predictions of contaminant transport at the Site.

1.53 Specific Comments 59 through 61 – Alternate Concentration Limits

Specific Comments 59 through 61 pertain to the proposed Alternate Concentration Limits and groundwater compliance monitor wells. As discussed on our conference call on January 22, 2015, responses to comments on the ACLs and compliance monitor wells will be deferred because it is understood that further refinement of the CSM and groundwater flow and transport model are needed before proposed ACLs and compliance wells can be fully considered by DRC.

1.54 Specific Comment 62 – Section 7.2 "Conclusions"

Additional work and characterization by RAML is needed before the groundwater transport of the contaminant plume is well understood. Uncertainty exists relative to the direction of groundwater flow once it approaches the LF. If flow is either down the curvilinear fault surface, as suggested in this Site Assessment, or in fractures in the BCF along the fault plane toward the NW corner of the Model Domain, as is suggested by Figure 10, or both, then significant uranium contamination levels within the flow could pose a risk to public health and the environment. Flow direction is insufficiently understood at present, and this uncertainty, among other factors mentioned in these comments, must preclude current acceptance of ACL proposals, since ACLs are inherently based on a presumption of conditions protective of public health and the environment.

RAML's claims that highly acidic and mineralized groundwater along the LF fault zone is not caused by the contaminant plume are not based on sufficient facts or evidence. The addition of uranium contamination to the groundwater in and near the fault system is unacceptable if it will result in transport offsite at concentrations in excess of State of Utah limits of 0.030 mg/L. The Site Assessment has not provided sufficient evidence that this will not happen.

There is uncertainty about the lateral extent of each uranium plume. The north plume may extend to the southwest of RL-3 (south of MW-119). Currently, no monitoring wells exist in the area to disprove this possibility. The south plume may extend southwest and west of EF-3, affecting groundwater at or near MW-116, and possibly in fractures associated with the LF. Currently, no monitoring wells exist southwest or due west of EF-3 to disprove this possibility.

The RAML determination that "there is no apparent complete exposure pathway from Site uranium contamination to the public and environment" does not consider the potential for migration occurring offsite to the northwest after either plume migrates to and along the fractures associated with the LF to cross the northern boundary. In addition, as shown in Figure 22, contamination is shown via modeling to cross the western boundary where exposure could potentially occur by 2165 and 2215.

RESPONSE

RAML understands that additional field investigations and data analysis are needed to address DRC's comments. Results of data analysis and modeling will be used to develop a work plan for the appropriate field investigations. RAML will collaborate with DRC to develop a responsive and efficient field investigation program, to reach a consensus on the CSM, to improve the groundwater flow and transport model, to complete a defensible risk analysis, and to develop a long term groundwater compliance program.

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TABLES

TABLE RTC-1. GROUNDWATER ELEVATIONS ADJUSTED FOR DENSITY VARIATIONS
RIO ALGOM MINING LLC, LISBON FACILITY

WELL NAME	WATER DENSITY (g/l)[a]	APRIL 2014 MEASURED HEAD (ft msl)[b]	APRIL 2014 EQUIVALENT FRESHWATER HEAD (ft msl)	APRIL 2014 HEAD CORRECTION (ft)	SEPTEMBER 2014 MEASURED HEAD (ft msl)	SEPTEMBER 2014 EQUIVALENT FRESHWATER HEAD (ft msl)	SEPTEMBER 2014 HEAD CORRECTION (ft)
EF-3A	1,004.47	6503.43	6503.94	0.51	6503.29	6503.79	0.51
EF-6	1,001.24	6500.13	6500.22	0.09	6500.36	6500.45	0.09
EF-8	1,000.70	6502.27	6502.46	0.19	6502.47	6502.66	0.19
H-63	999.98	6553.19	6553.20	0.01	6552.71	6552.72	0.01
LW-1	999.77	6578.92	6578.94	0.02	6578.14	6578.16	0.02
ML-1	1,000.27	6490.57	6490.65	0.08	6491.61	6491.70	0.08
MW-100	999.89	6578.45	6578.46	0.01	6577.73	6577.74	0.01
MW-101	1,010.46	6560.04	6560.09	0.05	6559.79	6559.84	0.05
MW-102	1,011.31	6577.84	6577.91	0.07	6577.63	6577.71	0.07
MW-102DB	999.94	6583.82	6583.84	0.02	6583.83	6583.85	0.02
MW-103	1,003.11	6581.41	6581.47	0.06	6580.89	6580.95	0.05
MW-104	1,000.23	6610.97	6610.97	0.00	6611.10	6611.10	0.00
MW-105	1,000.32	6551.08	6551.11	0.03	6550.60	6550.63	0.03
MW-106	1,001.21	6625.46	6625.50	0.04	6625.20	6625.24	0.04
MW-107D	1,000.09	6461.36	6461.37	0.01	6461.07	6461.08	0.01
MW-107S	1,001.01	6461.27	6461.28	0.01	6460.99	6460.99	0.01
MW-108	1,000.07	6489.91	6489.97	0.06	6489.75	6489.81	0.06
MW-109	1,001.86	6537.52	6537.54	0.02	6537.23	6537.25	0.02
MW-111	999.88	6553.48	6553.48	0.00	6565.76	6565.77	0.01
MW-112	1,000.05	6491.52	6491.55	0.03	6492.61	6492.64	0.03
MW-113	1,001.21	6499.48	6499.51	0.03	6499.84	6499.87	0.03
MW-114	999.87	6496.86	6496.89	0.03	6497.54	6497.57	0.03
MW-115M	1,000.33	6502.68	6502.76	0.08	6502.91	6502.99	0.08
MW-115S	1,000.07	6502.81	6502.83	0.02	6502.93	6502.95	0.02
MW-116	1,020.03	6492.98	6493.58	0.60	6492.88	6493.48	0.60
MW-117M	1,000.83	6503.95	6504.03	0.08	6503.76	6503.84	0.08
MW-117S	1,000.25	6503.96	6503.98	0.02	6503.77	6503.79	0.02
MW-118	1,000.03	6450.39	6450.40	0.01	6449.24	6449.26	0.01
MW-119	1,002.68	6519.48	6519.49	0.01	6519.37	6519.37	0.01
MW-120	1,000.26	6551.40	6551.45	0.05	6550.98	6551.03	0.05
MW-13	999.93	6550.97	6551.00	0.03	6550.52	6550.56	0.03
MW-5	1,000.68	6593.30	6593.33	0.03	6592.59	6592.62	0.03
OW-UT-9	1,028.40	6584.37	6584.61	0.24	6584.32	6584.56	0.24
RL-1	1,006.80	6539.53	6539.56	0.03	6539.53	6539.56	0.03
RL-3	1,006.09	6537.72	6537.77	0.05	6537.49	6537.54	0.05
RL-4	999.92	6528.09	6528.09	0.00	6527.82	6527.83	0.00
RL-5	999.78	6537.50	6537.51	0.01	6537.17	6537.17	0.01
RL-6	1,000.84	6449.80	6449.80	0.00	6448.28	6448.28	0.00
UW-1	1,000.03	6551.11	6551.12	0.01	6550.78	6550.79	0.01

[a] g/l = grams per liter

[b] ft msl = feet above mean sea level

MONTGOMERY
& ASSOCIATES

TABLE RTC-2. ESTIMATED HYDRAULIC CONDUCTIVITY VALUES FROM SLUG TESTS IN MONITOR WELLS
RIO ALGOM MINING LLC, LISBON FACILITY

WELL NAME	HSU [a]	DATE OF SLUG TESTING	CASING RADIUS (feet)	WELL RADIUS (feet)	ANALYSIS METHOD	TEST IDENTIFIER	INITIAL WATER LEVEL DISPLACEMENT (feet)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=1) (feet per day)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=.1) (feet per day)	ESTIMATED HYDRAULIC CONDUCTIVITY (Percent Increase for Kz/Kh = .1)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=1) (feet per day)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=.1) (feet per day)
BURRO CANYON AQUIFER (BCA) WELLS												
MW-13	BCA	8/26/2012	0.17	0.33	Butler Inertial [b]	Slug A Falling Head	0.44	236	261	11	421	524
						Slug A Rising Head	0.44	337	425	26		
						Slug B1 Falling Head	0.44	289	345	19		
						Slug B1 Rising Head	0.42	294	360	22		
						Slug B2 Falling Head	0.57	563	660	17		
						Slug B2 Rising Head	0.45	806	1092	35		
MW-115M	BCA	10/11/2013	0.17	0.42	Butler Inertial	Slug L Falling Head	1.05	153	171	12	167	196
						Slug L Rising Head	0.75	191	229	20		
						Slug C Falling Head	0.89	143	171	20		
						Slug C Rising Head	0.56	182	205	13		
						Slug F Falling Head	0.66	152	182	20		
						Slug F Rising Head	0.49	182	218	20		
EF-3A	BCA	8/28/2012	0.25	0.46	Bouwer-Rice	Slug C Falling Head	0.39	38	41	8	37	47
						Slug C Rising Head	0.48	29	46	59		
						Slug E Falling Head	1.48	42	47	13		
						Slug E Rising Head	1.38	24	32	33		
						Slug B Falling Head	0.38	47	61	30		
						Slug B Rising Head	0.36	42	54	30		
RL-6	BCA	8/25/2012	0.21	0.36	Bouwer-Rice	Slug A Falling Head	0.06	11	11	0	13.7	13.7
						Slug A Rising Head	0.12	26	26	0		
						Slug B Falling Head	0.08	8.5	8.5	0		
						Slug B Rising Head	0.35	9.2	9.2	0		
MW-117S	BCA	10/12/2013	0.17	0.42	Bouwer-Rice	Slug K Falling Head	1.20	Not Used [c]	Not Used [c]	---	9.3	9.3
						Slug K Rising Head	0.93	12	12	0		
						Slug L Falling Head	1.14	8.4	8.4	0		
						Slug L Rising Head	0.87	8.2	8.2	0		
						Slug D Falling Head	0.89	6.2	6.2	0		
						Slug D Rising Head	1.08	12	12	0		
MW-120	BCA	10/3/2013	0.17	0.33	Bouwer-Rice	Slug C Falling Head	1.05	Not Used [c]	Not Used [c]	---	6.4	6.4
						Slug C Rising Head	0.77	7.4	7.4	0		
						Slug F Falling Head	0.89	Not Used [c]	Not Used [c]	---		
						Slug F Rising Head	0.54	6.3	6.3	0		
						Slug L Falling Head	1.10	Not Used [c]	Not Used [c]	---		
						Slug L Rising Head	0.97	5.6	5.6	0		

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RIO ALGOM MINING LLC, LISBON FACILITY

WELL NAME	HSU [a]	DATE OF SLUG TESTING	CASING RADIUS (feet)	WELL RADIUS (feet)	ANALYSIS METHOD	TEST IDENTIFIER	INITIAL WATER LEVEL DISPLACEMENT (feet)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=1) (feet per day)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=.1) (feet per day)	ESTIMATED HYDRAULIC CONDUCTIVITY (Percent Increase for Kz/Kh = .1)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=1) (feet per day)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=.1) (feet per day)
MW-118	BCA	10/1/2013	0.17	0.33	Bouwer-Rice	Slug F Falling Head	0.89	4.7	4.7	0	4.5	4.5
						Slug F Rising Head	0.89	5.3	5.3	0		
						Slug C Falling Head	0.67	2.8	2.8	0		
						Slug C Rising Head	0.76	3.5	3.5	0		
						Slug I Falling Head	0.83	4.6	4.6	0		
						Slug I Rising Head	0.97	6.2	6.2	0		
MW-115S	BCA	10/2/2013	0.17	0.33	Bouwer-Rice	Slug J Falling Head	0.26	4.2	4.2	0	4.2	4.2
						Slug J Rising Head	0.20	2.4	2.4	0		
						Slug L Falling Head	0.43	4.6	4.6	0		
						Slug L Rising Head	Interrupted [d]	---	---	---		
						Slug K Falling Head	0.60	5.7	5.7	0		
						Slug K Rising Head	Interrupted [d]	---	---	---		
RL-5	BCA	8/25/2012	0.21	0.36	Bouwer-Rice	Slug B Falling Head	0.71	3.5	3.5	0	3.3	3.3
						Slug B Rising Head	0.59	3.7	3.7	0		
						Slug C Falling Head	0.50	2.8	2.8	0		
						Slug C Rising Head	0.68	3.6	3.6	0		
						Slug D Falling Head	0.91	3.3	3.3	0		
						Slug D Rising Head	0.81	3.2	3.2	0		
LW-1	BCA	8/27/2012	0.16	0.33	Bouwer-Rice	Slug B Falling Head	1.15	3.1	3.6	15	2.8	3.5
						Slug B Rising Head	0.77	2.6	3.6	38		
						Slug C Falling Head	1.63	3.2	4.1	31		
						Slug C Rising Head	0.96	2.6	3.5	33		
						Slug D Falling Head	1.14	2.5	2.7	10		
						Slug D Rising Head	1.24	2.8	3.4	22		
MW-107S	BCA	10/1/2013	0.17	0.33	Bouwer-Rice	Slug F Falling Head	0.60	2.0	2.0	0	2.5	2.5
						Slug F Rising Head	0.89	2.673	2.7	0		
						Slug B Falling Head	0.79	2.573	2.6	0		
						Slug B Rising Head	0.78	2.8	2.8	0		
						Slug A Falling Head	0.37	1.9	1.9	0		
						Slug A Rising Head	0.51	3.061	3.1	0		
MW-117M	BCA	10/3/2013	0.17	0.42	Bouwer-Rice	Slug K Falling Head	1.51	1.9	2.4	27	2.3	2.9
						Slug K Rising Head	Interrupted [d]	---	---	---		
						Slug D Falling Head	1.84	1.8	2.4	32		
						Slug D Rising Head	1.55	2.7	3.3	24		
						Slug J Falling Head	1.74	2	2.6	31		
						Slug J Rising Head	1.72	2.9	3.6	23		

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RIO ALGOM MINING LLC, LISBON FACILITY

WELL NAME	HSU [a]	DATE OF SLUG TESTING	CASING RADIUS (feet)	WELL RADIUS (feet)	ANALYSIS METHOD	TEST IDENTIFIER	INITIAL WATER LEVEL DISPLACEMENT (feet)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=1) (feet per day)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=.1) (feet per day)	ESTIMATED HYDRAULIC CONDUCTIVITY (Percent Increase for Kz/Kh = .1)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=1) (feet per day)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=.1) (feet per day)
MW-113	BCA	10/2/2013	0.17	0.33	Bouwer-Rice	Slug C Falling Head	0.87	2.8	2.8	0	1.9	1.9
						Slug C Rising Head	1.05	1.9	1.9	0		
						Slug F Falling Head	0.89	2.8	2.8	0		
						Slug F Rising Head	0.89	1.9	1.9	0		
						Slug I Falling Head	0.70	2.8	2.8	0		
						Slug I Rising Head	0.89	1.9	1.9	0		
ML-1	BCA	8/26/2012	0.17	0.33	Bouwer-Rice	Slug C Falling Head	1.31	1.8	2.3	31	1.8	2.3
						Slug C Rising Head	1.18	1.8	2.3	27		
						Slug B Falling Head	1.29	1.7	2.3	32		
						Slug B Rising Head	0.89	1.8	2.3	29		
						Slug D Falling Head	1.76	1.8	2.2	22		
						Slug D Rising Head	1.71	1.7	2.3	38		
H-63	BCA	8/26/2012	0.17	0.33	Bouwer-Rice	Slug B Falling Head	1.11	1.6	2.1	32	1.6	2.1
						Slug B Rising Head	0.63	1.7	2.2	32		
						Slug C Falling Head	0.87	1.5	2.0	31		
						Slug C Rising Head	0.79	1.6	2.1	33		
						Slug D Falling Head	1.24	1.6	2.1	33		
						Slug D Rising Head	1.04	1.6	2.1	33		
EF-8	BCA	8/27/2012	0.17	0.33	Bouwer-Rice	Slug A Falling Head	0.86	1.5	1.9	25	1.4	1.8
						Slug A Rising Head	0.61	1.6	1.8	15		
						Slug D Falling Head	2.20	1.3	1.8	36		
						Slug D Rising Head	0.86	1.4	1.9	31		
						Slug B Falling Head	1.02	1.4	1.8	26		
						Slug B Rising Head	0.98	1.4	1.7	25		
MW-107D	BCA	10/1/2013	0.17	0.33	Bouwer-Rice	Slug B Falling Head	0.78	1.7	2.1	25	1.4	1.8
						Slug B Rising Head	0.78	1.3	1.5	18		
						Slug F Falling Head	0.89	1.4	1.8	31		
						Slug F Rising Head	0.89	1.4	1.6	17		
						Slug C Falling Head	0.91	1.3	1.7	27		
						Slug C Rising Head	0.98	1.4	1.7	24		
MW-108	BCA	10/1/2013	0.17	0.33	Bouwer-Rice	Slug B Falling Head	0.78	1.3	1.7	29	1.3	1.7
						Slug B Rising Head	0.78	1.5	1.7	15		
						Slug D Falling Head	1.41	1.3	1.5	19		
						Slug D Rising Head	Interrupted [d]	---	---	---		
						Slug J Falling Head	1.16	1.3	1.7	33		
						Slug J Rising Head	1.03	1.3	1.6	23		

TABLE RTC-2. ESTIMATED HYDRAULIC CONDUCTIVITY VALUES FROM SLUG TESTS IN MONITOR WELLS
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WELL NAME	HSU [a]	DATE OF SLUG TESTING	CASING RADIUS (feet)	WELL RADIUS (feet)	ANALYSIS METHOD	TEST IDENTIFIER	INITIAL WATER LEVEL DISPLACEMENT (feet)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=1) (feet per day)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=.1) (feet per day)	ESTIMATED HYDRAULIC CONDUCTIVITY (Percent Increase for Kz/Kh = .1)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=1) (feet per day)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=.1) (feet per day)
OW-UT-9	BCA	8/29/2012	0.25	0.41	Bouwer-Rice	Slug C Falling Head	0.98	1.2	1.2	0	1.2	1.2
						Slug C Rising Head	0.47	1.5	1.5	0		
						Slug B Falling Head	0.22	1.0	1.0	0		
						Slug B Rising Head	0.38	1.1	1.1	0		
						Slug D Falling Head	0.38	1.1	1.1	0		
						Slug D Rising Head	0.67	1.3	1.3	0		
RL-3	BCA	11/2/2012	0.21	0.36	Bouwer-Rice	Slug A Falling Head	0.41	1.3	1.3	0	1.2	1.2
						Slug A Rising Head	0.36	1.1	1.1	0		
						Slug B Falling Head	0.49	1.2	1.2	0		
						Slug B Rising Head	0.57	1.4	1.4	0		
						Slug G Falling Head	0.31	1.2	1.2	0		
						Slug G Rising Head	0.42	1.3	1.3	0		
MW-101	BCA	11/4/2012	0.17	0.33	Bouwer-Rice	Slug A Falling Head	0.32	0.6	0.6	0	0.8	0.8
						Slug A Rising Head	0.54	1.0	1.0	0		
						Slug G Falling Head	0.49	0.7	0.7	0		
						Slug G Rising Head	0.75	0.9	0.9	0		
MW-100	BCA	11/3/2012	0.17	0.33	Bouwer-Rice	Slug F Falling Head	0.34	0.6	0.6	0	0.7	0.7
						Slug F Rising Head	2.03	Not Used [c]	Not Used [c]	---		
						Slug C Falling Head	0.42	0.6	0.6	0		
						Slug C Rising Head	1.65	Not Used [c]	Not Used [c]	---		
						Slug B Falling Head	0.49	0.8	0.8	0		
						Slug B Rising Head	1.00	Not Used [c]	Not Used [c]	---		
RL-1	BCA	8/28/2012	0.21	0.37	Bouwer-Rice	Slug A Falling Head	0.21	0.7	0.7	0	0.6	0.6
						Slug A Rising Head	0.32	0.6	0.6	0		
						Slug B Falling Head	0.36	0.5	0.5	0		
						Slug B Rising Head	0.52	0.6	0.6	0		
RL-4	BCA	8/26/2012	0.21	0.36	Bouwer-Rice	Slug C Falling Head	1.42	0.7	0.7	0	0.6	0.6
						Slug C Rising Head	0.70	0.7	0.7	0		
						Slug D Falling Head	0.70	0.7	0.7	0		
						Slug D Rising Head	0.79	0.6	0.6	0		
						Slug B Falling Head	0.32	0.5	0.5	0		
						Slug B Rising Head	0.82	0.7	0.7	0		
EF-6	BCA	8/27/2012	0.17	0.33	Bouwer-Rice	Slug A Falling Head	0.57	0.5	0.7	39	0.5	0.7
						Slug A Rising Head	0.61	0.5	0.7	32		
						Slug B Falling Head	0.98	0.5	0.7	24		
						Slug B Rising Head	0.96	0.6	0.7	32		
						Slug C Falling Head	1.32	0.5	0.7	24		
						Slug C Rising Head	1.15	0.5	0.7	46		

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WELL NAME	HSU [a]	DATE OF SLUG TESTING	CASING RADIUS (feet)	WELL RADIUS (feet)	ANALYSIS METHOD	TEST IDENTIFIER	INITIAL WATER LEVEL DISPLACEMENT (feet)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=1) (feet per day)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=.1) (feet per day)	ESTIMATED HYDRAULIC CONDUCTIVITY (Percent Increase for Kz/Kh = .1)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=1) (feet per day)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=.1) (feet per day)
UW-1	BCA	11/4/2012	0.17	0.33	Bouwer-Rice	Slug C Falling Head	0.70	0.5	0.5	0	0.4	0.4
						Slug C Rising Head	0.72	0.5	0.5	0		
						Slug G Falling Head	0.47	0.5	0.5	0		
						Slug G Rising Head	0.38	0.4	0.4	0		
						Slug C&G Falling Head	1.18	0.4	0.4	0		
						Slug C&G Rising Head	1.15	0.4	0.4	0		
MW-116	BCA	10/2/2013	0.17	0.33	Bouwer-Rice	Slug I Falling Head	0.83	0.4	0.5	24	0.4	0.5
						Slug I Rising Head	0.97	0.4	0.5	27		
						Slug A Falling Head	0.51	0.4	0.5	24		
						Slug A Rising Head	0.51	0.4	0.4	10		
						Slug G Falling Head	0.62	0.4	0.5	22		
						Slug G Rising Head	0.71	0.4	0.5	21		
MW-112	BCA	10/2/2013	0.17	0.33	Bouwer-Rice	Slug K Falling Head	0.97	0.3	0.3	0	0.4	0.4
						Slug K Rising Head	1.24	0.4	0.4	0		
						Slug C Falling Head	0.82	0.3	0.3	0		
						Slug C Rising Head	1.05	0.4	0.4	0		
						Slug F Falling Head	0.72	0.3	0.3	0		
						Slug F Rising Head	0.89	0.4	0.4	0		
MW-114	BCA	10/2/2013	0.17	0.33	Bouwer-Rice	Slug J Falling Head	0.60	0.4	0.4	0	0.3	0.3
						Slug J Rising Head	0.25	0.3	0.3	0		
						Slug L Falling Head	0.37	0.3	0.3	0		
						Slug L Rising Head	0.39	0.4	0.4	0		
						Slug D Falling Head	0.49	0.3	0.3	0		
						Slug D Rising Head	Interrupted [d]	---	---	---		
MW-102	BCA	11/3/2012	0.17	0.33	Bouwer-Rice	Slug F Falling Head	1.37	0.3	0.3	0	0.3	0.3
						Slug F Rising Head	1.79	0.3	0.3	0		
						Slug A Falling Head	0.79	0.3	0.3	0		
						Slug A Rising Head	0.85	0.4	0.4	0		
MW-119	BCA	10/2/2013	0.17	0.33	Bouwer-Rice	Slug G Falling Head	0.66	0.1	0.1	0	0.1	0.1
						Slug G Rising Head	1.02	0.1	0.1	0		
						Slug H Falling Head	0.37	0.2	0.2	0		
						Slug H Rising Head	0.33	0.1	0.1	0		

TABLE RTC-2. ESTIMATED HYDRAULIC CONDUCTIVITY VALUES FROM SLUG TESTS IN MONITOR WELLS
RIO ALGOM MINING LLC, LISBON FACILITY

WELL NAME	HSU [a]	DATE OF SLUG TESTING	CASING RADIUS (feet)	WELL RADIUS (feet)	ANALYSIS METHOD	TEST IDENTIFIER	INITIAL WATER LEVEL DISPLACEMENT (feet)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=1) (feet per day)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=.1) (feet per day)	ESTIMATED HYDRAULIC CONDUCTIVITY (Percent Increase for Kz/Kh = .1)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=1) (feet per day)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=.1) (feet per day)
MW-109	BCA	10/1/2013	0.17	0.33	Bouwer-Rice	Slug A Falling Head	0.51	0.06	0.06	0	0.06	0.06
						Slug A Rising Head	0.51	0.05	0.05	0		
						Slug G Falling Head	0.62	0.06	0.06	0		
						Slug G Rising Head	0.62	0.08	0.08	0		
						Slug H Falling Head	0.33	Not Used [c]	Not Used [c]	---		
MW-5	BCA	8/27/2012	0.17	0.33	Bouwer-Rice	Slug E Falling Head	3.48	0.03	0.03	0	0.03	0.03
						Slug E Rising Head	1.69	0.02	0.02	0		
						Slug D Falling Head	1.47	0.02	0.02	0		
						Slug D Rising Head	0.71	0.03	0.03	0		
MW-104	BCA	8/27/2013	0.17	0.33	Bouwer-Rice	Slug B Falling Head	0.44	0.03	0.03	0	0.02	0.02
						Slug B Rising Head	0.59	0.01	0.01	0		
						Slug A Falling Head	0.31	0.01	0.01	0		
						Slug A Rising Head	0.30	0.02	0.02	0		
MW-105	BCA	11/4/2012	0.17	0.33	---	Slug C Falling Head	0.66	Not Analyzed [e]	Not Analyzed [e]	---	---	---
						Slug C Rising Head	0.19	Not Analyzed [e]	Not Analyzed [e]	---		
						Slug F&C Falling Head	0.42	Not Analyzed [e]	Not Analyzed [e]	---		
						Slug F&C Rising Head	1.04	Not Analyzed [e]	Not Analyzed [e]	---		
MW-122	BCA	---	0.17	0.33	y; no testing conducted							
MORRISON FORMATION, BRUSHY BASIN MEMBER (BBM) WELLS												
MW-102DB	BBM	11/3/2012	0.17	0.33	Bouwer-Rice	Slug A Falling Head	0.72	0.6	0.8	32	0.7	0.9
						Slug A Rising Head	0.64	0.6	0.8	26		
						Slug B Falling Head	1.16	0.8	0.9	24		
						Slug B Rising Head	1.00	0.6	0.8	32		
						Slug G Falling Head	0.71	0.6	0.7	20		
						Slug G Rising Head	1.26	0.9	1.1	21		
MW-103	BBM	11/4/2012	0.17	0.33	Bouwer-Rice	Slug A Falling Head	0.61	0.05	0.05	0	0.04	0.04
						Slug A Rising Head	0.63	0.05	0.05	0		
						Slug F Falling Head	0.52	0.02	0.02	0		
						Slug F Rising Head	1.56	0.05	0.05	0		
MW-106	BBM	8/19/2013	0.17	0.33	Bouwer-Rice	Slug F Falling Head	0.84	0.0014	0.0014	0	0.0007	0.0007
						Slug F Rising Head	0.83	0.0007	0.0007	0		
						Slug H Falling Head	0.33	0.0005	0.0005	0		
						Slug H Rising Head	Interrupted [d]	---	---	---		
MW-110	BBM	---	0.17	0.33	Well recovering after installation activities; no testing conducted							
MW-111	BBM	---	0.17	0.33	Well recovering after installation activities; no testing conducted							
CHINLE FORMATION WELL												

TABLE RTC-2. ESTIMATED HYDRAULIC CONDUCTIVITY VALUES FROM SLUG TESTS IN MONITOR WELLS
RIO ALGOM MINING LLC, LISBON FACILITY

WELL NAME	HSU [a]	DATE OF SLUG TESTING	CASING RADIUS (feet)	WELL RADIUS (feet)	ANALYSIS METHOD	TEST IDENTIFIER	INITIAL WATER LEVEL DISPLACEMENT (feet)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=1) (feet per day)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (Kz/Kh=.1) (feet per day)	ESTIMATED HYDRAULIC CONDUCTIVITY (Percent Increase for Kz/Kh = .1)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=1) (feet per day)	MEAN OF ESTIMATED HYDRAULIC CONDUCTIVITY VALUES (Kz/Kh=.1) (feet per day)
MW-121	CHINLE	---	0.17	0.33	Well dry; no testing conducted							

Notes:

--- = Not applicable

[a] Hydrostratigraphic Unit

BCA = Burro Canyon Aquifer
BBM = Brushy Basin Member of the Morrison Formation
CHINLE = Chinle Formation

[b] Slug testing data re-analyzed during second phase of work.

[c] Anomalous water level response observed, <u>or</u> data is outside of the normalized head range for matching results to type curve solutions.

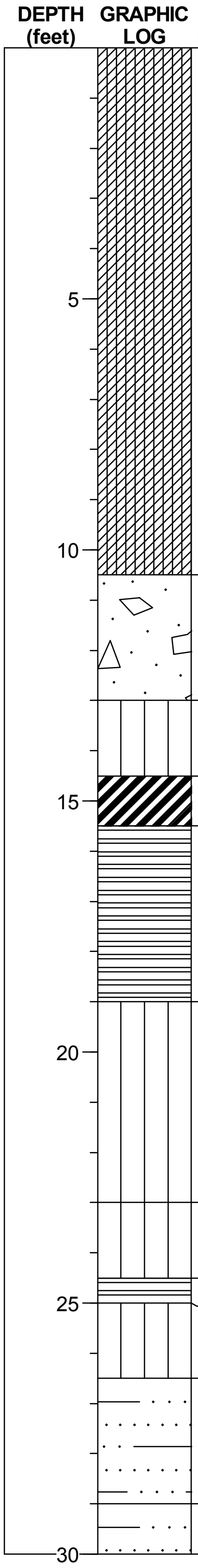
[d] Water level measurement was interrupted during test and data not analyzed; transducer was inadvertently moved during slug deployment or retrieval.

[e] Water level recovery to static condition near instantaneous; response is too fast to analyze.

ILLUSTRATIONS

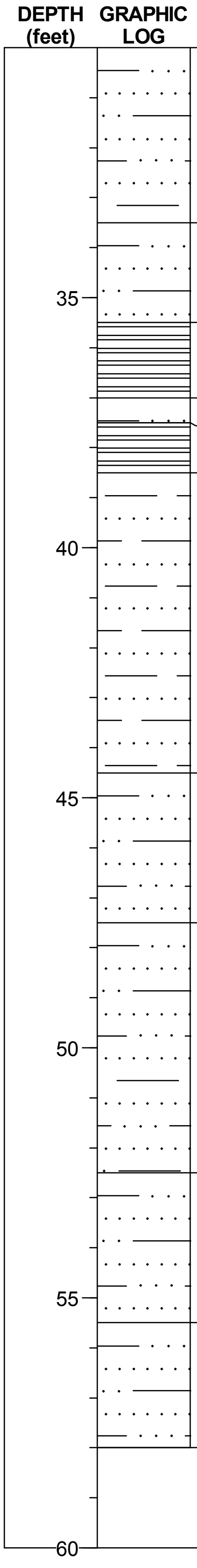
FIGURE RTC-1. GRAPHIC LOG FOR CORE SAMPLES FROM EXPLORATION BOREHOLE MW-116C RIO ALGOM MINE LISBON LA SAL, UTAH

DRILLING METHOD / COMPANY: Core / National EWP	LOGGED BY: M. Shelley
DEPTH DRILLED: 58.0 feet	DATE DRILLED: Aug. 13, 2013
NAD27 : 589209.93 N / 2632593.25 E	BOREHOLE DIAMETER: 5 inches



FORMATION	ROCK TYPE	DESCRIPTION	SECONDARY FEATURES
Qea	**SILT AND CLAY**	reddish brown; non-lithified to weakly lithified; silt and clay with few lithic clasts of sandstone and limestone; low plastisticity; reaction to acid: very strong	
Kbc	**BRECCIATED SANDSTONE**	reddish brown; weakly to moderately lithified; brecciated sandstone with few lithic fragments of sandstone and limestone; non-plastic; clasts up to 2 cm; reaction to acid: none to weak	
Kbc	**SANDY SILTSTONE**	gray; moderately to well lithified; sandy siltstone; non-plastic; reaction to acid: none to weak	fractured at 13.5 feet
Kbc	**CLAY**	purplish gray; weakly to moderately lithified; clay; high plasticity; reaction to acid: none	
Kbc	**SHALE**	purplish gray; moderately lithified; mudstone/shale; low plasticity; reaction to acid: none	
Kbc	**SILTSTONE**	whitish gray and yellow; well lithified; siltstone; reaction to acid: none	
Kbc	**SILTSTONE**	purplish gray and yellow; moderately lithified; siltstone; reaction to acid: none	
Kbc	**SHALE**	white; weakly to moderately lithified; mudstone/shale; reaction to acid: none	
Kbc	**SILTSTONE**	light purple; moderately to well lithified; siltstone; reaction to acid: none	
Kbc	**SANDSTONE**	light purple; well lithified; fine grained sandstone; reaction to acid: none	
Kbc	**SANDSTONE**	light purplish pink; well lithified; medium grained arkosic sandstone; reaction to acid: none	

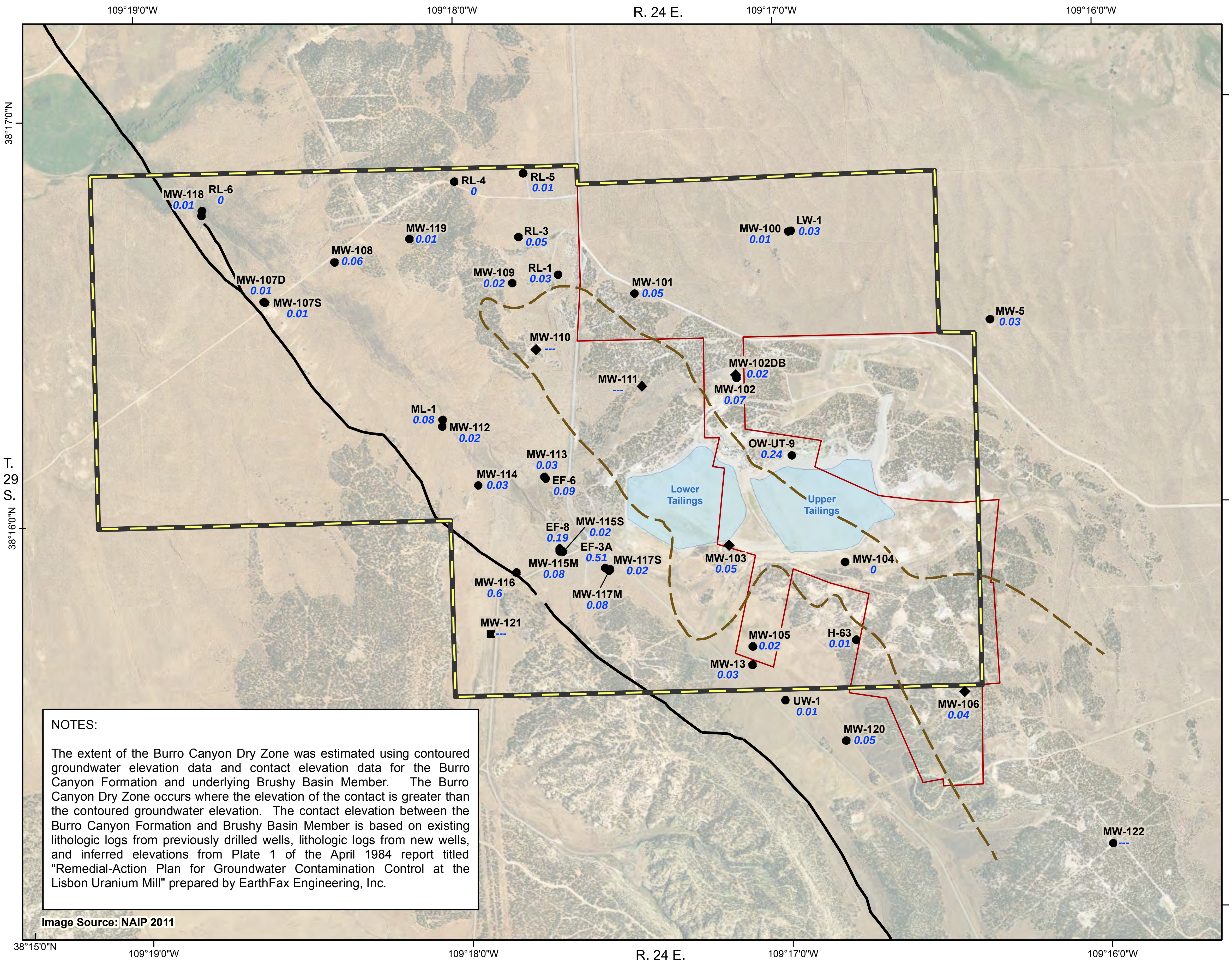
FIGURE RTC-1. GRAPHIC LOG FOR CORE SAMPLES FROM EXPLORATION BOREHOLE MW-116C
RIO ALGOM MINE LISBON
LA SAL, UTAH



FORMATION	ROCK TYPE	DESCRIPTION	SECONDARY FEATURES
	SANDSTONE *continued from previous page*		
Kbc	**SANDSTONE**	light purplish pink; well lithified; arkosic sandstone transitioning into dark gray and black mudstone/shale; reaction to acid: none	
Kbc	**SHALE**	dark gray and black; well lithified; mudstone/shale; reaction to acid: none	fractured; gypsum in fractures
Kbc	**SANDSTONE**	grayish pink; well lithified; medium grained sandstone; reaction to acid: none	
Kbc	**SHALE**	black; well lithified; mudstone/shale; reaction to acid: none	
Kbc	**SHALE AND SANDSTONE**	black and grayish pink; well lithified; mudstone/shale with interbedded sandstone; reaction to acid: none	
Kbc	**SANDSTONE**	yellowish gray; well lithified; medium grained sandstone; carbonified wood; reaction to acid: none	fractured with iron oxide staining at 45.5 feet
Kbc	**SANDSTONE**	dark grayish tan; moderately to well lithified; medium grained sandstone with few lithic clasts; carbonified wood; reaction to acid: none	
Kbc	**SANDSTONE**	gray; weakly lithified; medium grained sandstone; trace carbonified wood	
Kbc	**SANDSTONE**	dark gray and brown; weakly to well lithified; fine grained sandstone; thin black organic layers	

TD: 58.0 feet

MONTGOMERY & ASSOCIATES

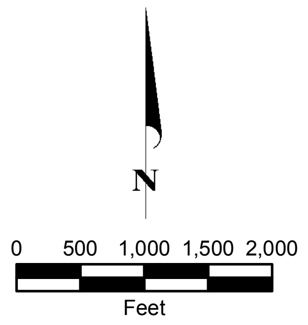


NOTES:

The extent of the Burro Canyon Dry Zone was estimated using contoured groundwater elevation data and contact elevation data for the Burro Canyon Formation and underlying Brushy Basin Member. The Burro Canyon Dry Zone occurs where the elevation of the contact is greater than the contoured groundwater elevation. The contact elevation between the Burro Canyon Formation and Brushy Basin Member is based on existing lithologic logs from previously drilled wells, lithologic logs from new wells, and inferred elevations from Plate 1 of the April 1984 report titled "Remedial-Action Plan for Groundwater Contamination Control at the Lisbon Uranium Mill" prepared by EarthFax Engineering, Inc.

EXPLANATION

● **MW-100** *0.01*	Well screened in Burro Canyon Aquifer (BCA) Head added by equivalent freshwater head adjustment (feet); measured in April 2014. --- Water level not stable at time of measurement.
◆ **MW-103**	Well screened in Brushy Basin Member of the Morrison Formation (BBM)
■ **MW-121**	Well screened in the Chinle Formation
— —	Burro Canyon dry zone
▭	Long Term Surveillance and Maintenance Boundary
▭	Rio Algom Mining LLC property boundary
—	Lisbon Fault



RIO ALGOM MINING LLC
LISBON FACILITY

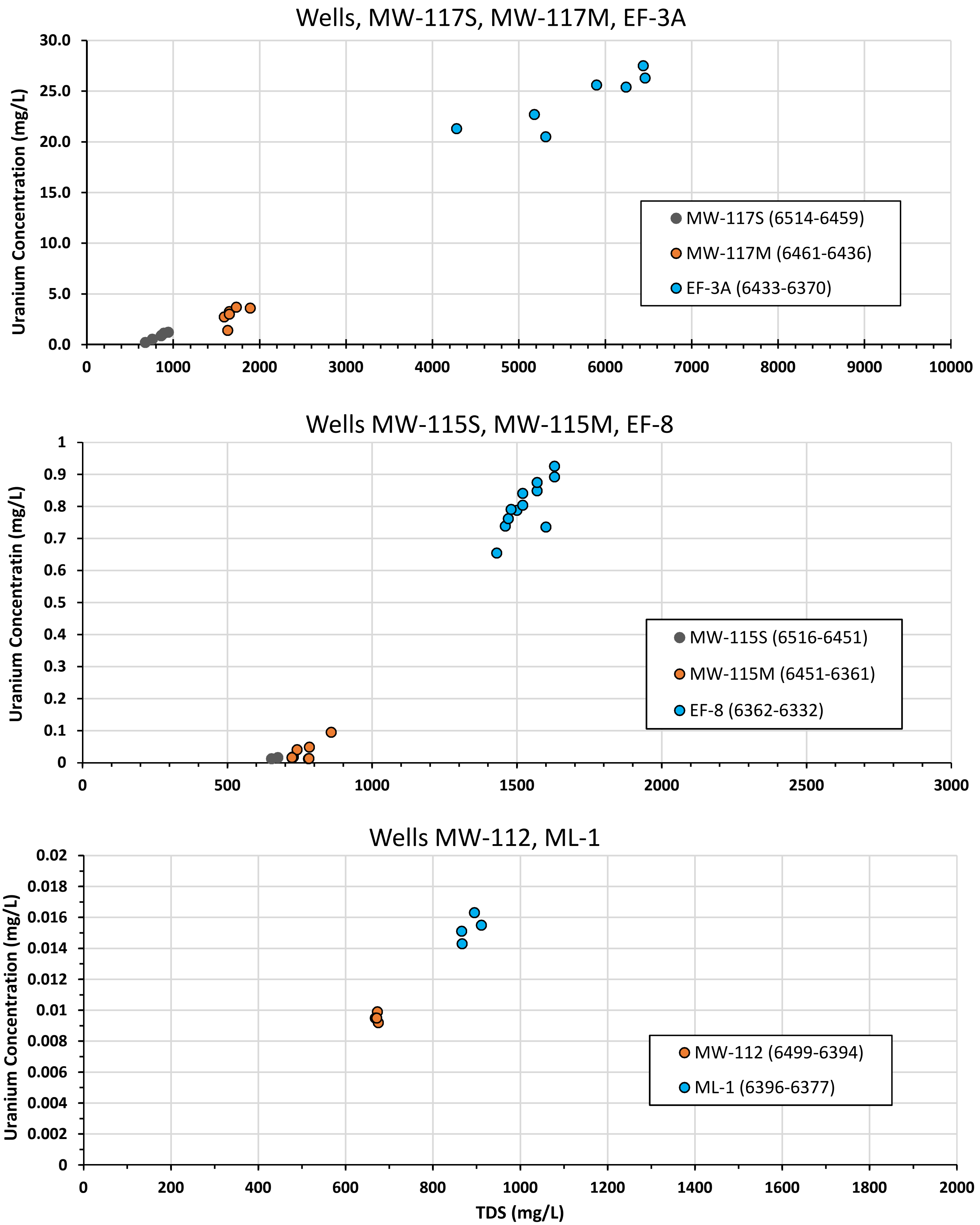
EQUIVALENT FRESHWATER HEAD ADJUSTMENTS APRIL 2014

MONTGOMERY & ASSOCIATES
Water Resource Consultants

2015

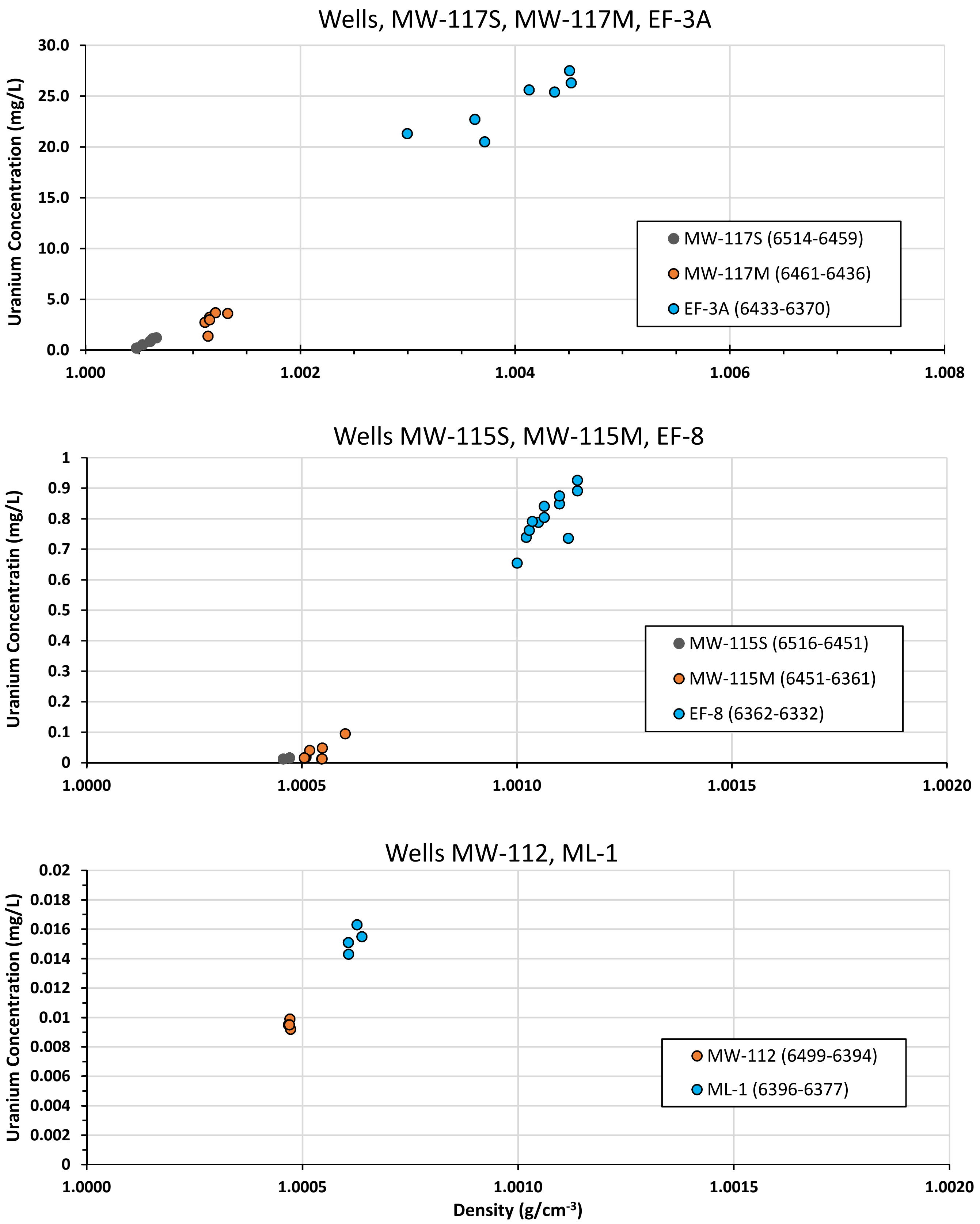
FIGURE RTC-2

GIS\1350.54\Eq_Fw_Head_4_14_diff.mxd\23Feb2015 NAD27_SP_Utah_So.



Note: Numbers in parentheses in legend are top and bottom screen elevation in feet.

Figure RTC-3a
Uranium vs TDS for selected well clusters at the Site



Note: Numbers in parentheses in legend are top and bottom screen elevation in feet.

Figure RTC-3b

Uranium vs density for selected well clusters at the Site

S:\Projects\Rio_Lisbon_SupplmentalSiteCharacterization\Database\KAS_COPY16Dec2014databaseQuery_workingCopy.xlsx

FIGURE RTC-4. GRAPHIC LOG FOR CORE SAMPLES FROM MONITOR WELL MW-118 RIO ALGOM MINE LISBON LA SAL, UTAH

DRILLING METHOD / COMPANY: Core and Symmetrix/Conventional Air Rotary / National EWP

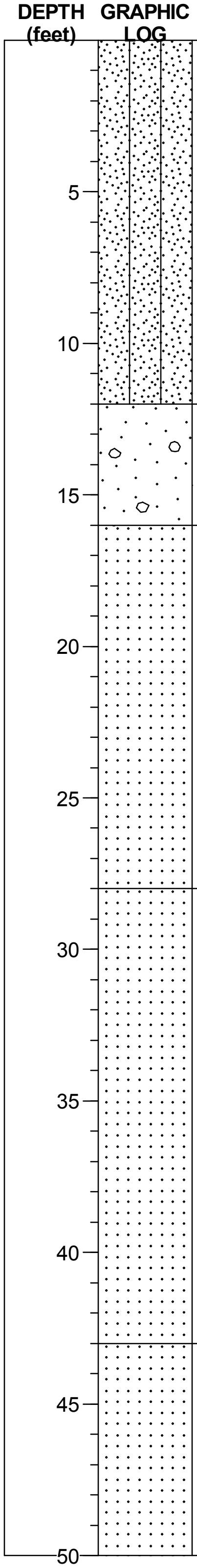
LOGGED BY: M. Shelley

DEPTH DRILLED: 78.0 feet

DATE DRILLED: Aug. 25, 2013

NAD27 : 594554.29 N / 2627874.16 E

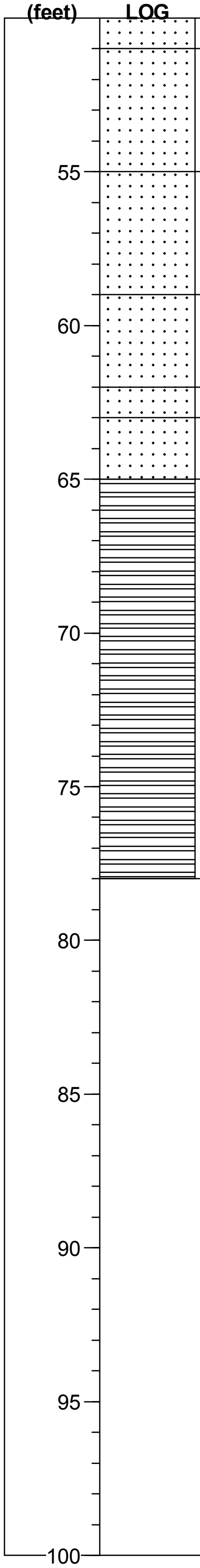
BOREHOLE DIAMETER: 8 inches



FORMATION	ROCK TYPE	DESCRIPTION	SECONDARY FEATURES
Qea	**SILTY SAND**	reddish brown; weakly lithified; loose silty sand with weakly lithified calcareous deposits (caliche); reaction to acid: strong	
Kbc	**CONGLOMERATE**	light brown; weakly lithified; conglomerate; poorly sorted; fine grained sandstone matrix with clasts of chert, limestone, sandstone and siltstone; reaction to acid: strong	
Kbc	**SANDSTONE**	light brown to gray; non-lithified to moderately lithified; fine grained sandstone; well sorted; uniform, subrounded quartz grains; reaction to acid: none	iron oxidation
Kbc	**SANDSTONE**	yellowish brown; weakly to well lithified; fine grained sandstone; well sorted; uniform, subrounded quartz grains; reaction to acid: none	fractured
Kbc	**SANDSTONE**	light brown to gray; well lithified; fine grained sandstone; well sorted; uniform, subrounded quartz grains; reaction to acid: none	fractured with iron oxide staining

MONTGOMERY & ASSOCIATES

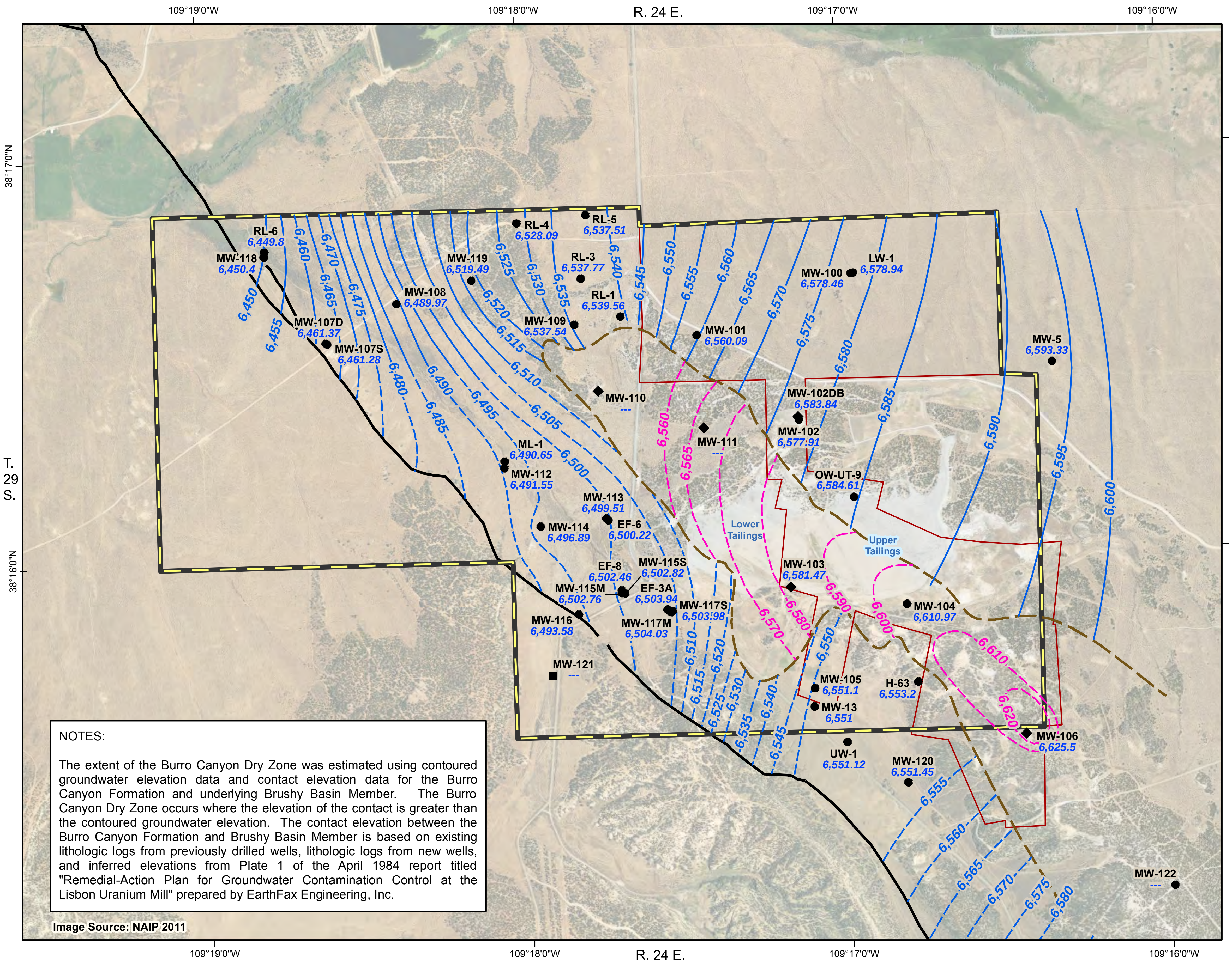
FIGURE RTC-4. GRAPHIC LOG FOR CORE SAMPLES FROM MONITOR WELL MW-118 RIO ALGOM MINE LISBON LA SAL, UTAH



FORMATION	ROCK TYPE	DESCRIPTION	SECONDARY FEATURES
	SANDSTONE *continued from previous page*		
Kbc	**SANDSTONE**	light brown to gray; weakly lithified; fine grained sandstone; well sorted; uniform, subrounded quartz grains; reaction to acid: none	
Kbc	**SANDSTONE**	light brown to gray; weakly to moderately lithified; fine grained sandstone; well sorted; uniform, subrounded quartz grains; reaction to acid: none	
Kbc	**SANDSTONE**	light brown to gray; moderately to well lithified; fine to medium grained sandstone; poorly sorted; gravels up to 1 cm; reaction to acid: none	
Kbc	**SANDSTONE**	light brown to gray; moderately to well lithified; fine to medium grained sandstone; poorly sorted; gravels up to 1 cm; reaction to acid: none	
Kbc	**SANDSTONE**	light brown to gray; well lithified; fine grained sandstone; well sorted; uniform, subrounded quartz grains; reaction to acid: none	
Jmb	**SHALE**	bluish gray; moderately to very well lithified; mudstone/shale; reaction to acid: none	fractured

TD: 78.0 feet

MONTGOMERY & ASSOCIATES

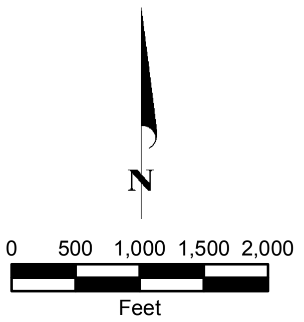


NOTES:

The extent of the Burro Canyon Dry Zone was estimated using contoured groundwater elevation data and contact elevation data for the Burro Canyon Formation and underlying Brushy Basin Member. The Burro Canyon Dry Zone occurs where the elevation of the contact is greater than the contoured groundwater elevation. The contact elevation between the Burro Canyon Formation and Brushy Basin Member is based on existing lithologic logs from previously drilled wells, lithologic logs from new wells, and inferred elevations from Plate 1 of the April 1984 report titled "Remedial-Action Plan for Groundwater Contamination Control at the Lisbon Uranium Mill" prepared by EarthFax Engineering, Inc.

EXPLANATION

● **MW-100** *6,578.46*	Well screened in Burro Canyon Aquifer (BCA)
	Water level elevation, in feet above mean sea level (feet msl) adjusted to equivalent freshwater head; measured in April 2014. --- Water level not stable at time of measurement.
◆ **MW-103**	Well screened in Brushy Basin Member of the Morrison Formation (BBM)
■ **MW-121**	Well screened in the Chinle Formation
6,500 — —	Water level elevation in the BCA (feet msl); dashed where inferred
6,600 - - -	Water level elevation in the BBM (feet msl); dashed where inferred
— —	Burro Canyon dry zone
▭	Long Term Surveillance and Maintenance Boundary
▭	Rio Algom Mining LLC property boundary
—	Lisbon Fault



RIO ALGOM MINING LLC
LISBON FACILITY

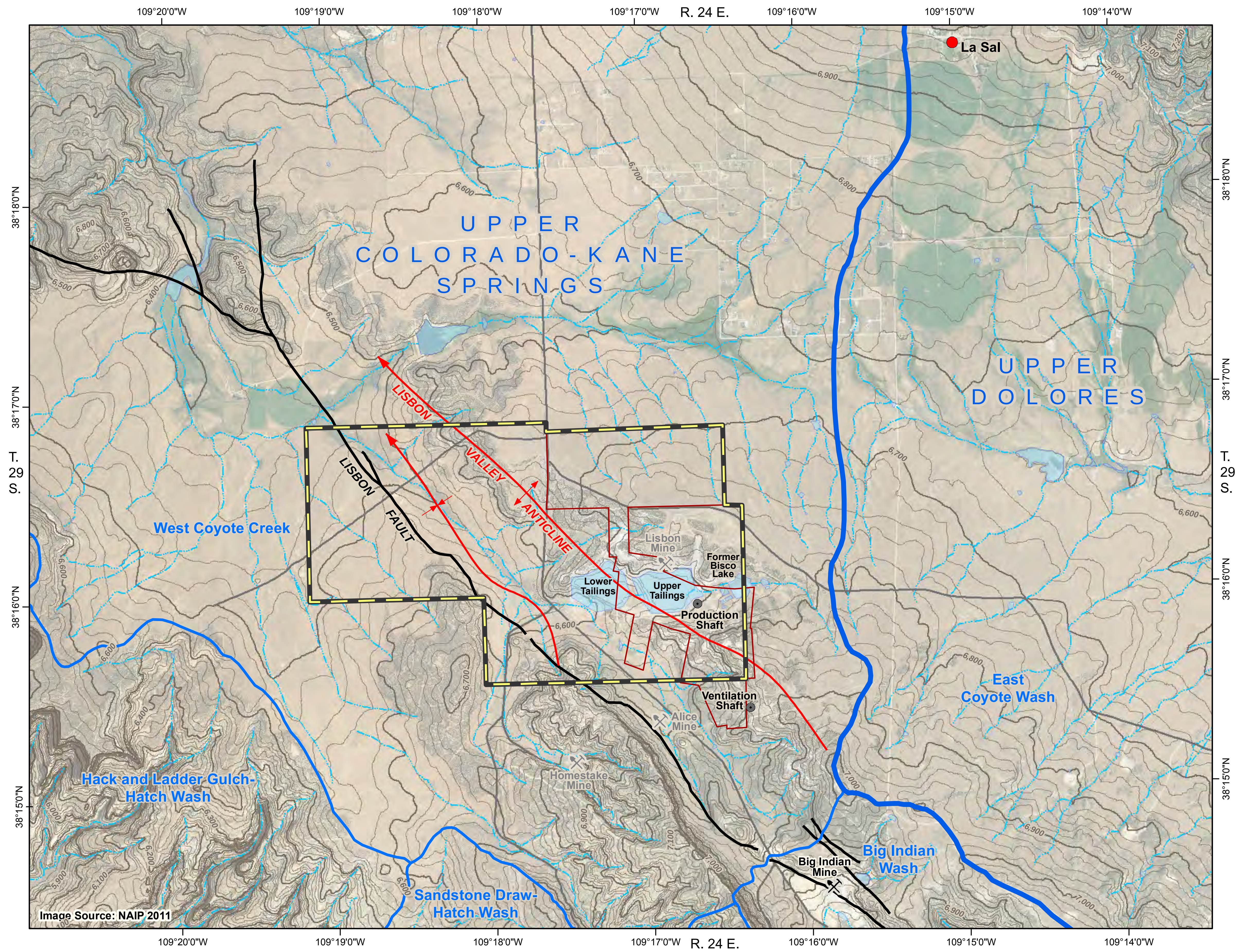
ADJUSTED GROUNDWATER ELEVATIONS APRIL 2014

MONTGOMERY & ASSOCIATES
Water Resource Consultants

2015

FIGURE RTC-5

GIS\1350.54\Eq_Fw_Head_4_14\23Feb2015 NAD27_SP_Utah_So.



EXPLANATION

⚒ Active mine

⚒ Inactive/former mine

● Former mine shaft

— 6,800 — Topography contour, in feet above mean sea level (feet amsl); contour interval 20 feet

— Lisbon Fault

Anticline fold axis; arrow shows direction of plunge

Syncline fold axis; arrow shows direction of plunge

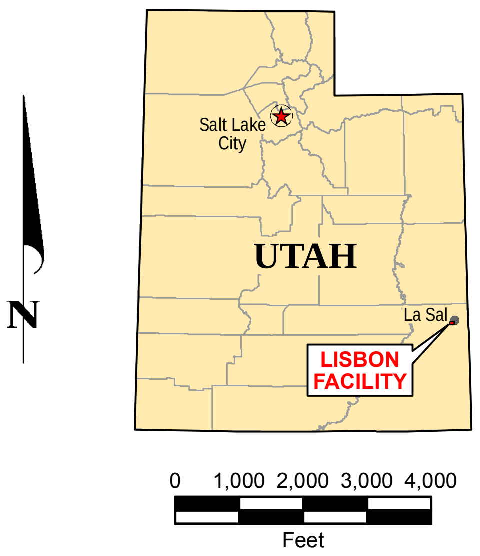
Long Term Surveillance and Maintenance Boundary

Rio Algom Mining LLC property boundary

— Road

Sub-basin divide

Sub-watershed divide



RIO ALGOM MINING LLC
LISBON FACILITY

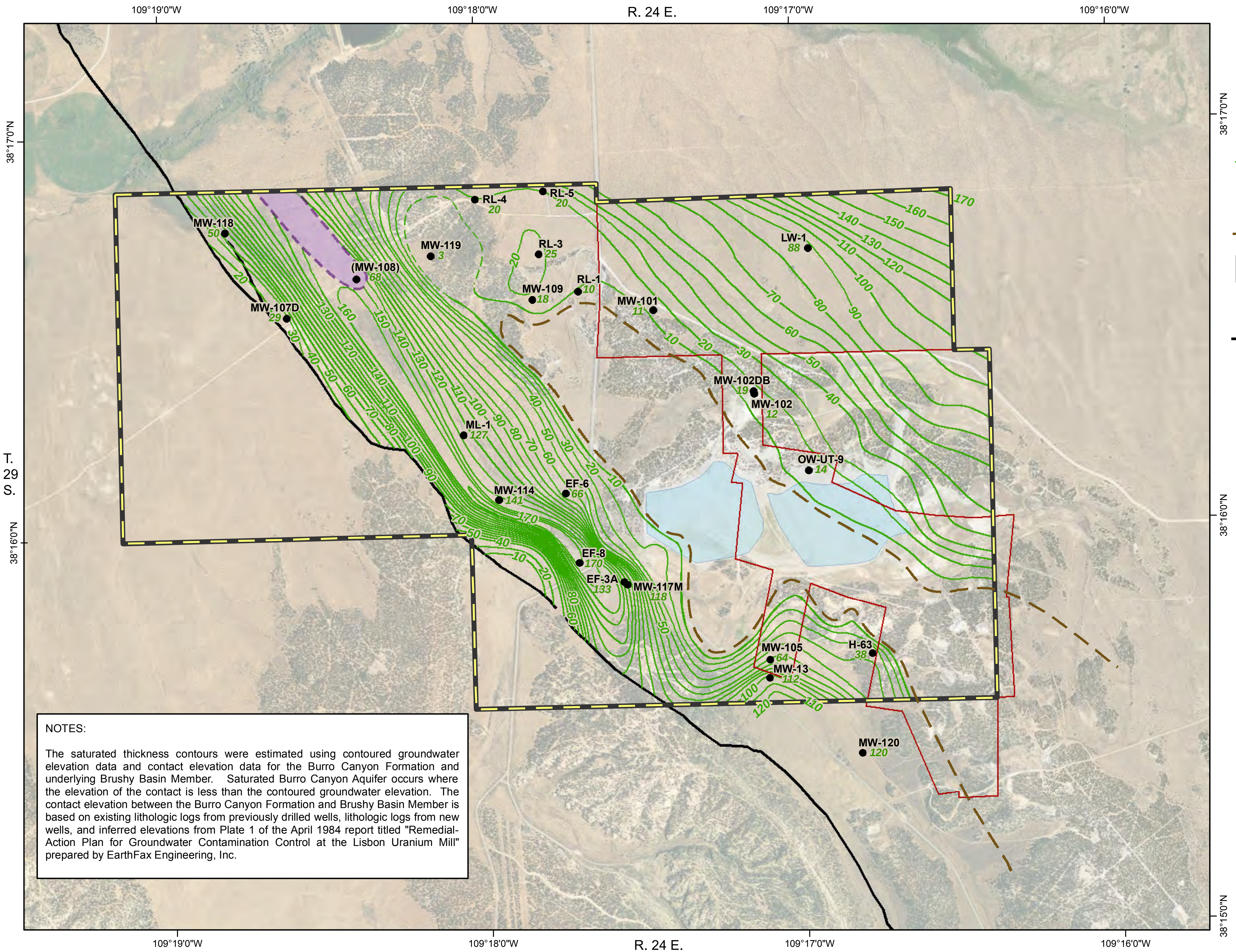
SURFACE WATER DRAINAGES

MONTGOMERY & ASSOCIATES
Water Resource Consultants

2015

FIGURE RTC-6

GIS\1350.54\RegionalSite_LocMap_watersheds.mxd\23Feb2015 NAD27_SP_Utah_So.



NOTES:

The saturated thickness contours were estimated using contoured groundwater elevation data and contact elevation data for the Burro Canyon Formation and underlying Brushy Basin Member. Saturated Burro Canyon Aquifer occurs where the elevation of the contact is less than the contoured groundwater elevation. The contact elevation between the Burro Canyon Formation and Brushy Basin Member is based on existing lithologic logs from previously drilled wells, lithologic logs from new wells, and inferred elevations from Plate 1 of the April 1984 report titled "Remedial-Action Plan for Groundwater Contamination Control at the Lisbon Uranium Mill" prepared by EarthFax Engineering, Inc.

EXPLANATION

● MW-102 12	Well screened in Burro Canyon Aquifer (BCA) Well identifier in parentheses **(MW-108)** indicates: Well screened in confined Burro Canyon Aquifer Saturated thickness (feet) based on water levels measured in April 2014
160 — —	Saturated thickness in the BCA (feet); dashed where inferred
🟪	Inferred zone of confinement
— —	Burro Canyon dry zone
▭	Long Term Surveillance and Maintenance Boundary
▭	Rio Algom Mining LLC property boundary
—	Lisbon Fault

N

0 500 1,000 1,500 2,000
Feet

RIO ALGOM MINING LLC
LISBON FACILITY

SATURATED THICKNESS IN THE BURRO CANYON AQUIFER APRIL 2014

MONTGOMERY & ASSOCIATES
Water Resource Consultants

2015

FIGURE RTC-7

GIS\1350.54\Phase2_Report\SaturatedThickness_R2.mxd\23Feb2015 NAD27_SP_Utah_So.

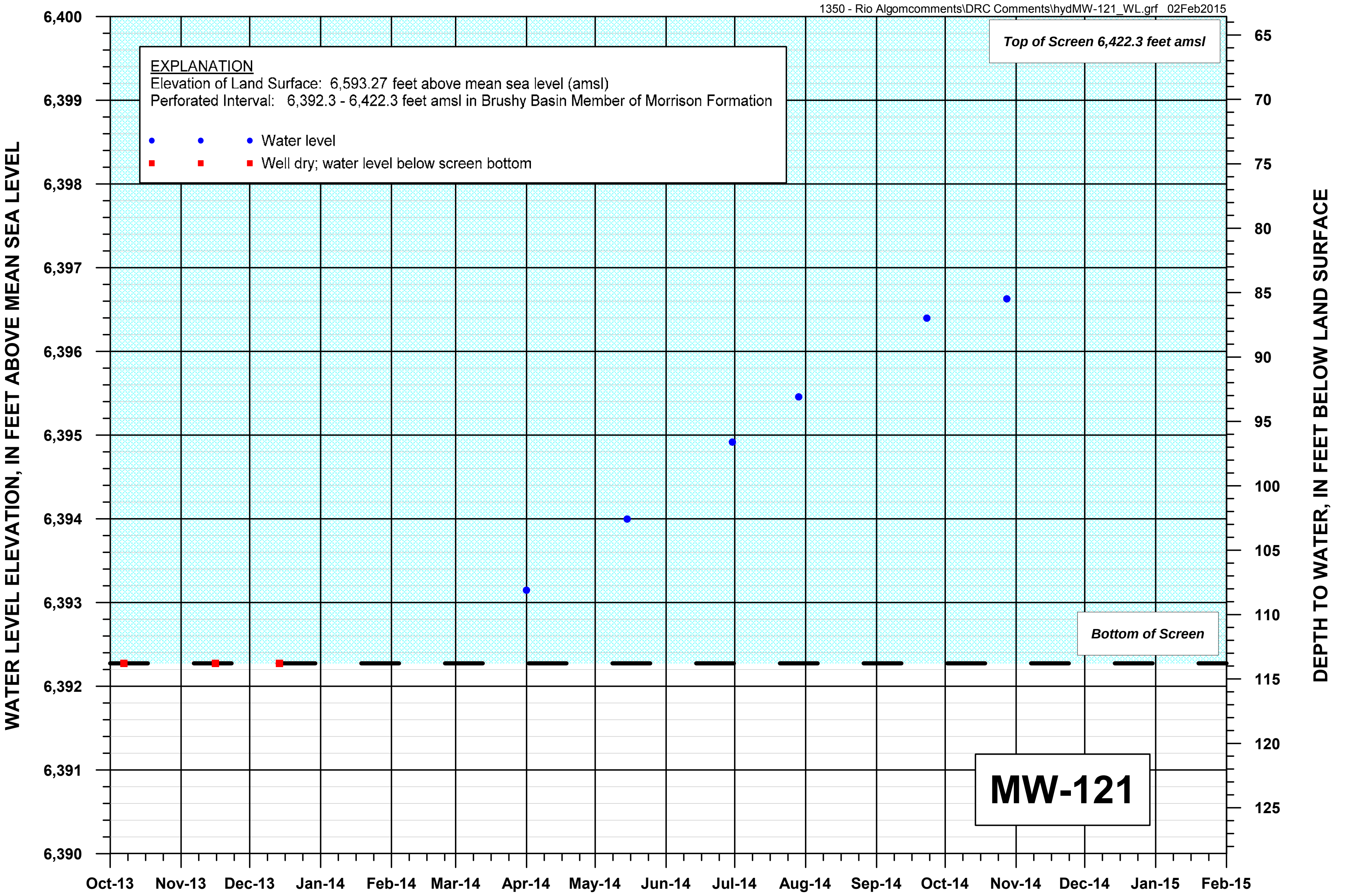
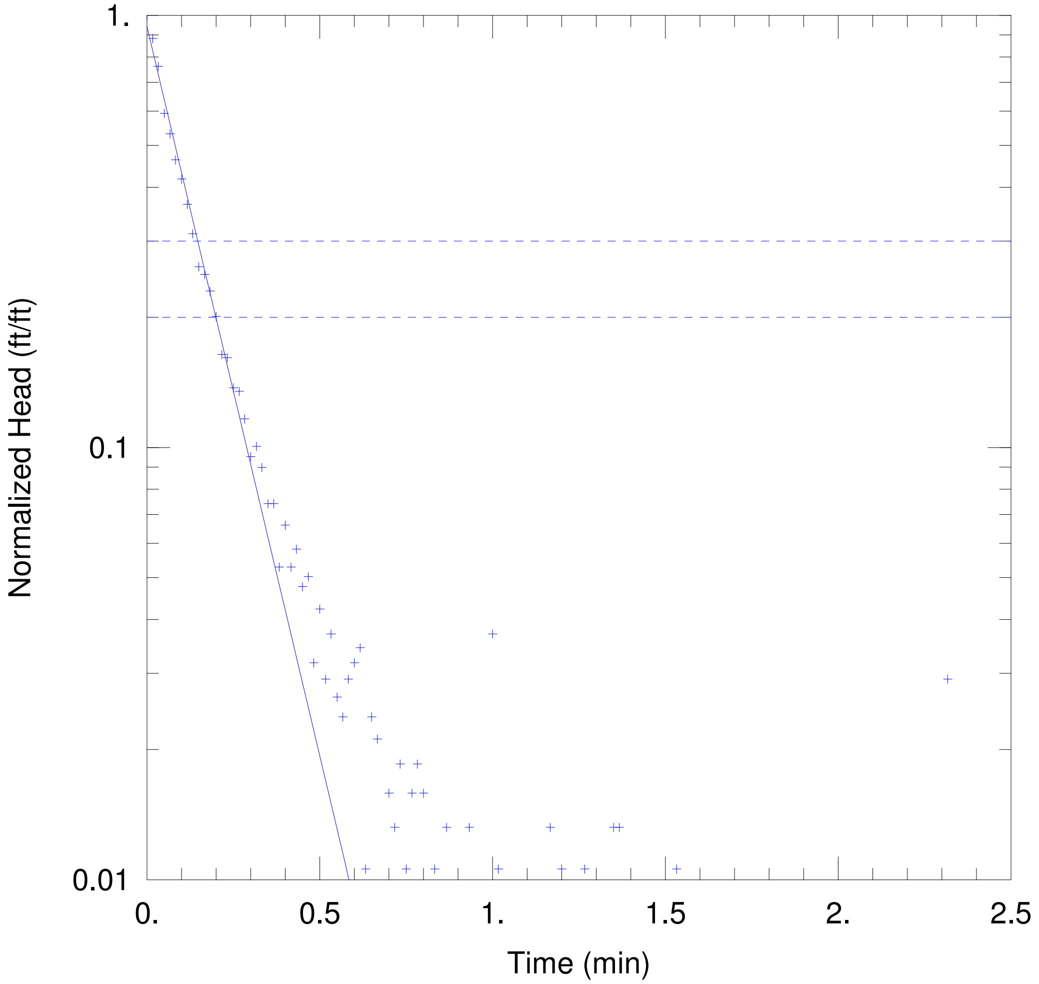


FIGURE RTC-8. WATER LEVEL HYDROGRAPH FOR MONITOR WELL MW-121, RIO ALGOM MINING LLC, LISBON FACILITY

MONTGOMERY & ASSOCIATES

APPENDIX RTC-A

Revised Slug Test Analyses



WELL TEST ANALYSIS

Data Set: S:\...\EF-3A_SlugBFallingHead_Kz.aqt
Date: 01/12/15 Time: 10:23:44

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-3A
Test Date: 28 Aug 2012

AQUIFER DATA

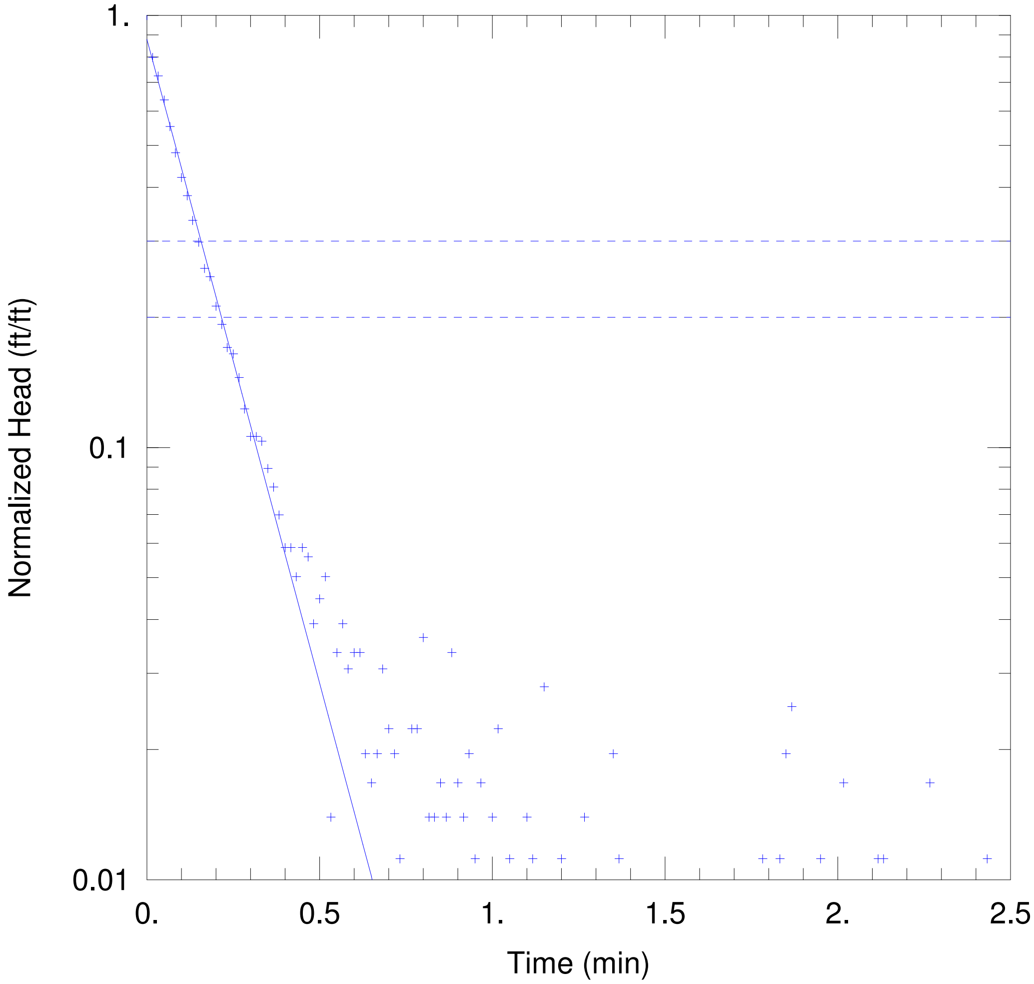
Saturated Thickness: 121.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (EF-3A Slug B Falling Head)

Initial Displacement: 0.378 ft
Static Water Column Height: 121.8 ft
Total Well Penetration Depth: 121.8 ft
Screen Length: 30. ft
Casing Radius: 0.25 ft
Well Radius: 0.458 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 61.39 ft/day
y0 = 0.3555 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-3A_SlugBRisingHead_Kz.aqt
Date: 01/12/15 Time: 10:26:18

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-3A
Test Date: 28 Aug 2012

AQUIFER DATA

Saturated Thickness: 121.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

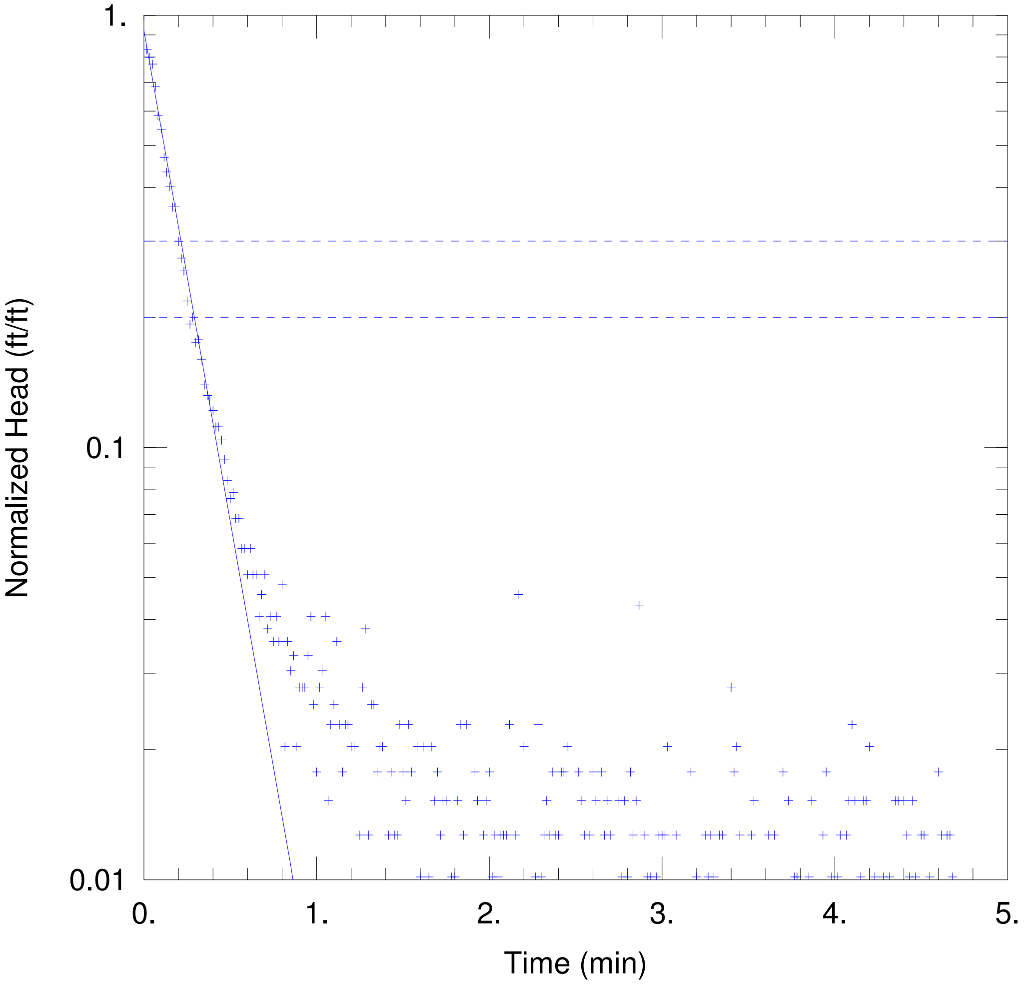
WELL DATA (EF-3A Slug B Rising Head)

Initial Displacement: 0.358 ft
Total Well Penetration Depth: 121.8 ft
Casing Radius: 0.25 ft
Static Water Column Height: 121.8 ft
Screen Length: 30. ft
Well Radius: 0.458 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 54.21 ft/day
y0 = 0.3149 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-3A_SlugCFallingHead_Kz.aqt
Date: 01/12/15 Time: 10:27:55

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-3A
Test Date: 28 Aug 2012

AQUIFER DATA

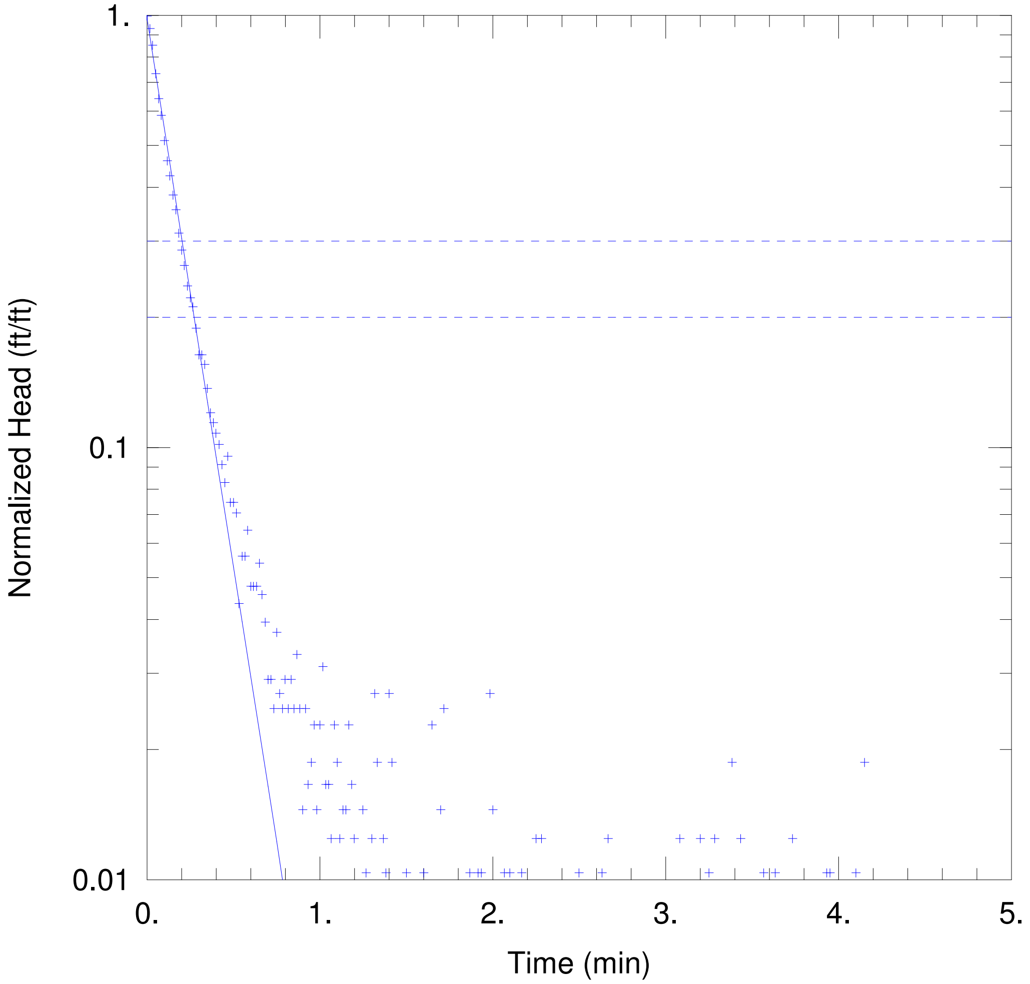
Saturated Thickness: 121.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (EF-3A Slug C Falling Head)

Initial Displacement: 0.394 ft
Static Water Column Height: 121.8 ft
Total Well Penetration Depth: 121.8 ft
Screen Length: 30. ft
Casing Radius: 0.25 ft
Well Radius: 0.458 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 41.36 ft/day
y0 = 0.3636 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-3A_SlugCRisingHead_Kz.aqt
Date: 01/12/15 Time: 10:30:12

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-3A
Test Date: 28 Aug 2012

AQUIFER DATA

Saturated Thickness: 121.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

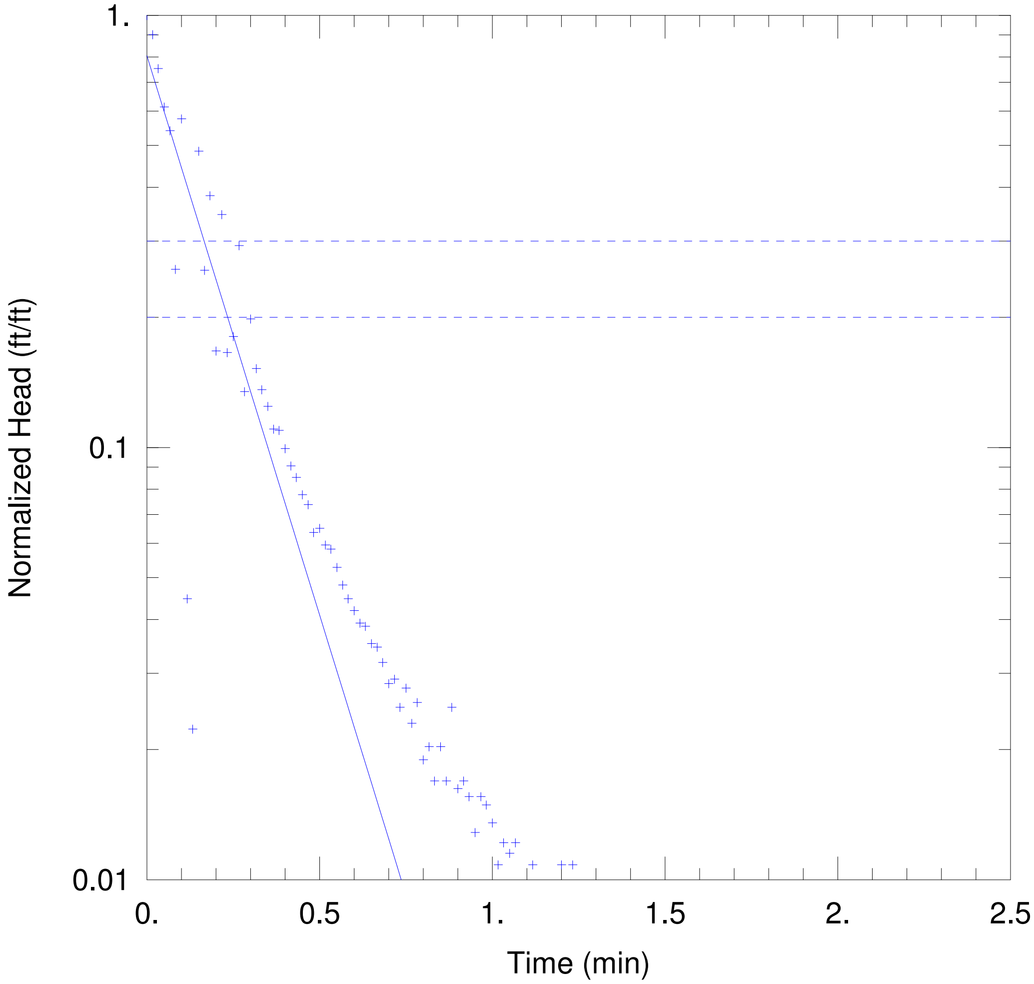
WELL DATA (EF-3A Slug C Rising Head)

Initial Displacement: 0.482 ft
Static Water Column Height: 121.8 ft
Total Well Penetration Depth: 121.8 ft
Screen Length: 30. ft
Casing Radius: 0.25 ft
Well Radius: 0.458 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 46.16 ft/day
y0 = 0.4731 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-3A_SlugEFallingHead_Kz.aqt
Date: 01/12/15 Time: 10:31:10

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-3A
Test Date: 28 Aug 2012

AQUIFER DATA

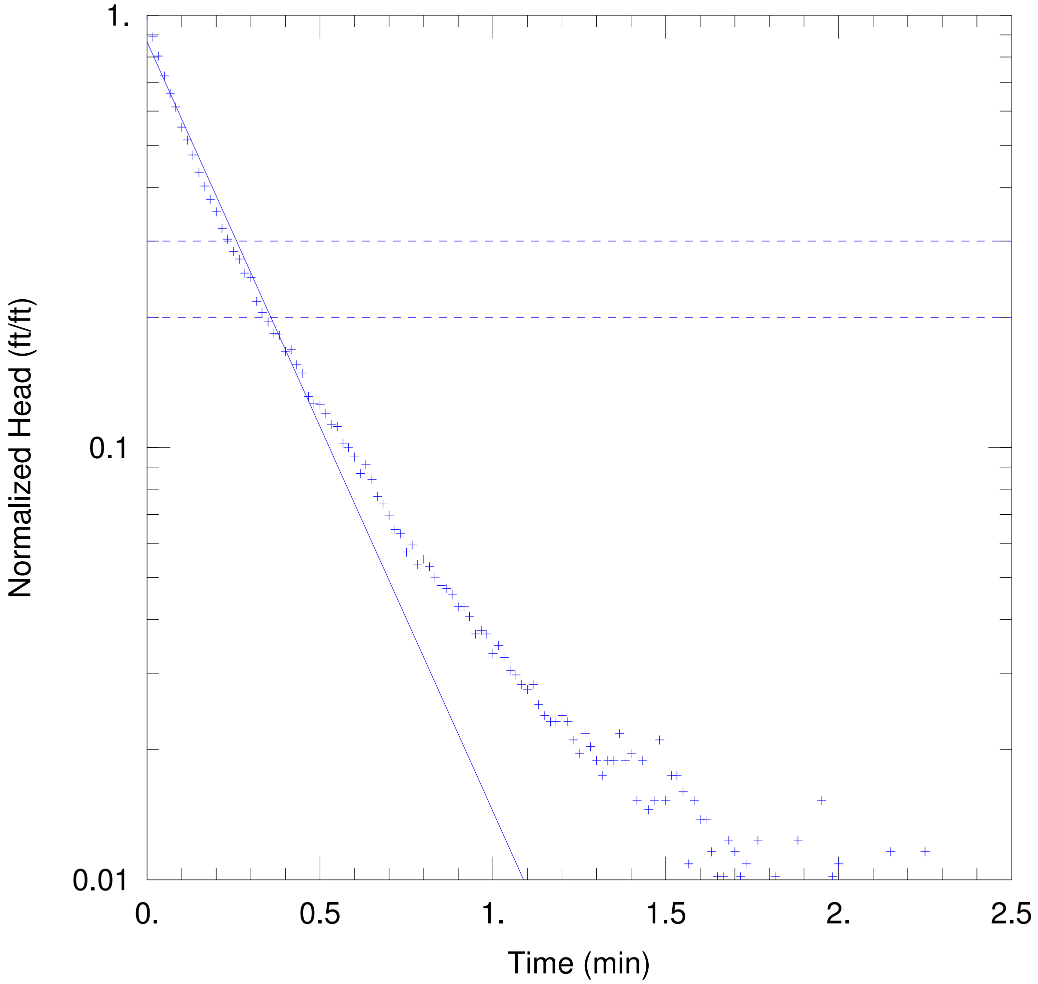
Saturated Thickness: 121.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (EF-3A Slug E Falling Head)

Initial Displacement: 1.478 ft
Static Water Column Height: 121.8 ft
Total Well Penetration Depth: 121.8 ft
Screen Length: 30. ft
Casing Radius: 0.25 ft
Well Radius: 0.458 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 47.09 ft/day
y0 = 1.191 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-3A_SlugERisingHead_Kz.aqt
Date: 01/12/15 Time: 10:32:25

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-3A
Test Date: 28 Aug 2012

AQUIFER DATA

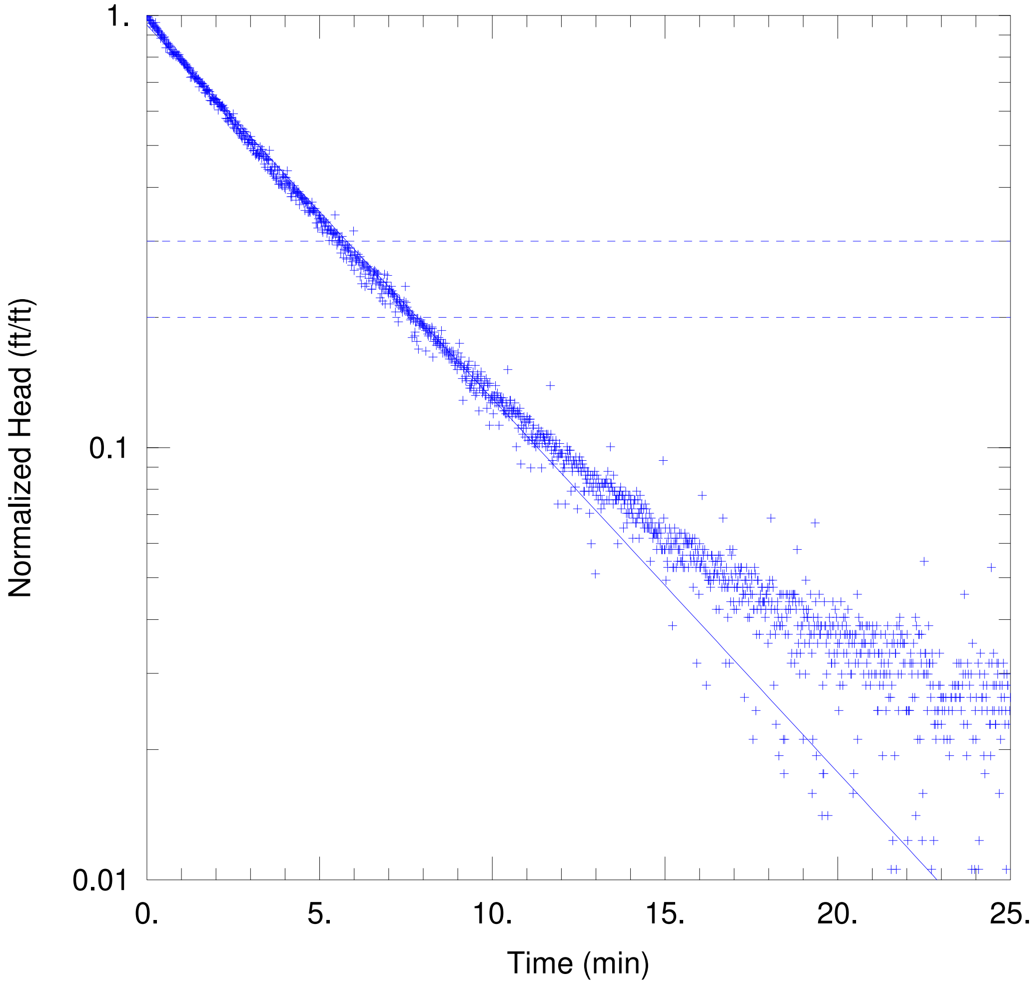
Saturated Thickness: 121.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (EF-3A Slug E Rising Head)

Initial Displacement: 1.378 ft
Total Well Penetration Depth: 121.8 ft
Casing Radius: 0.25 ft
Static Water Column Height: 121.8 ft
Screen Length: 30. ft
Well Radius: 0.458 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 32.37 ft/day
y0 = 1.194 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-6_SlugAFallingHead_Kz.aqt
Date: 01/12/15 Time: 10:36:22

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-6
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 65.36 ft
Anisotropy Ratio (Kz/Kr): 0.1

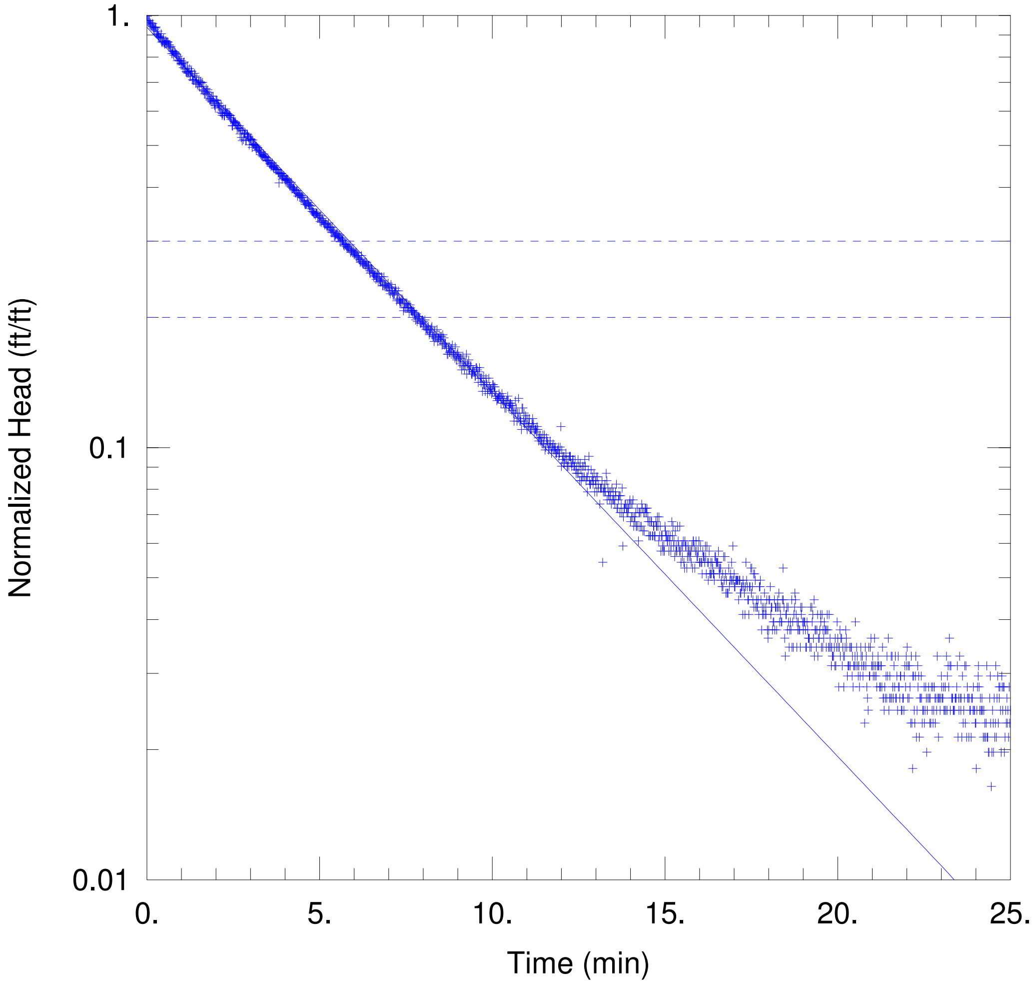
WELL DATA (EF-6 Slug A Falling Head)

Initial Displacement: 0.568 ft
Total Well Penetration Depth: 65.36 ft
Casing Radius: 0.167 ft
Static Water Column Height: 65.36 ft
Screen Length: 30. ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.6666 ft/day
y0 = 0.5395 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-6_SlugARisingHead_Kz.aqt
Date: 01/12/15 Time: 10:37:56

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-6
Test Date: 27 Aug 2012

AQUIFER DATA

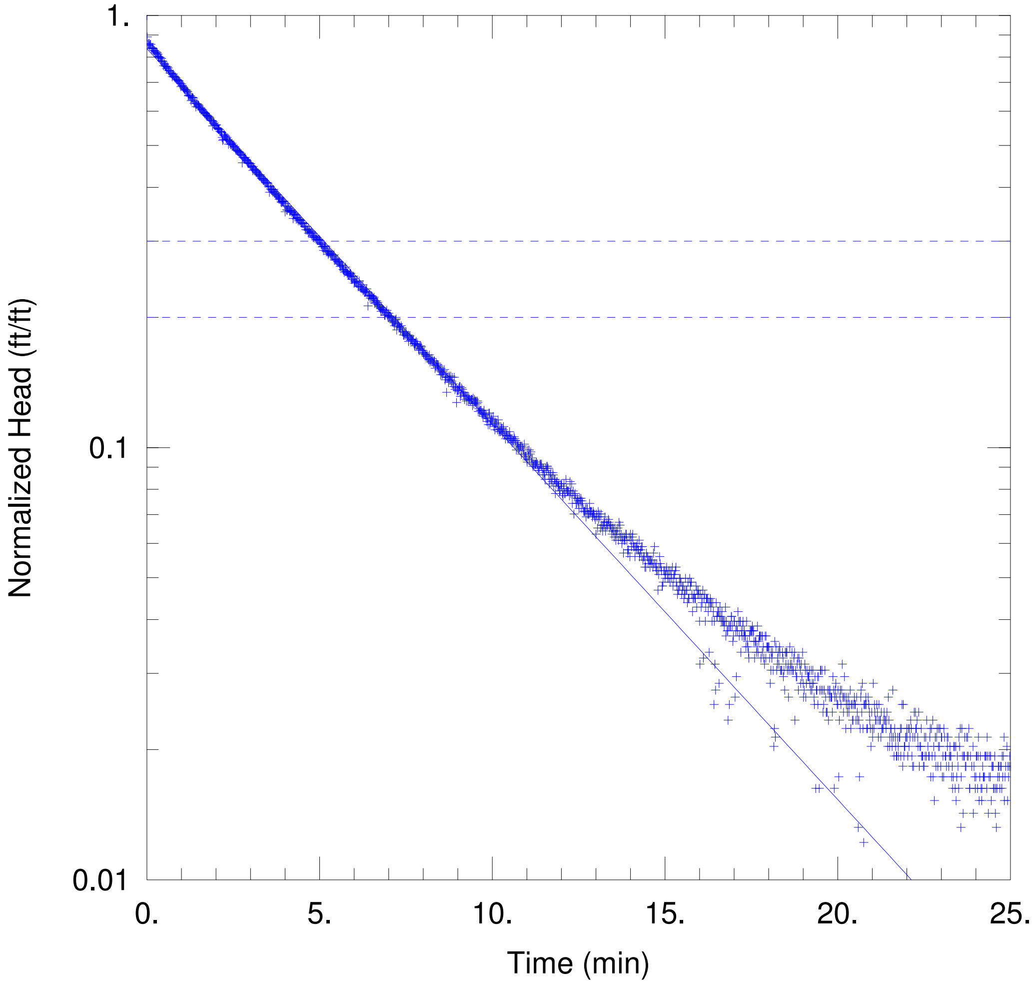
Saturated Thickness: 65.36 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (EF-6 Slug A Rising Head)

Initial Displacement: 0.608 ft
Static Water Column Height: 65.36 ft
Total Well Penetration Depth: 65.36 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.6503 ft/day
y0 = 0.5699 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-6_SlugBFallingHead_Kz.aqt
Date: 01/12/15 Time: 10:39:12

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-6
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 65.36 ft
Anisotropy Ratio (Kz/Kr): 0.1

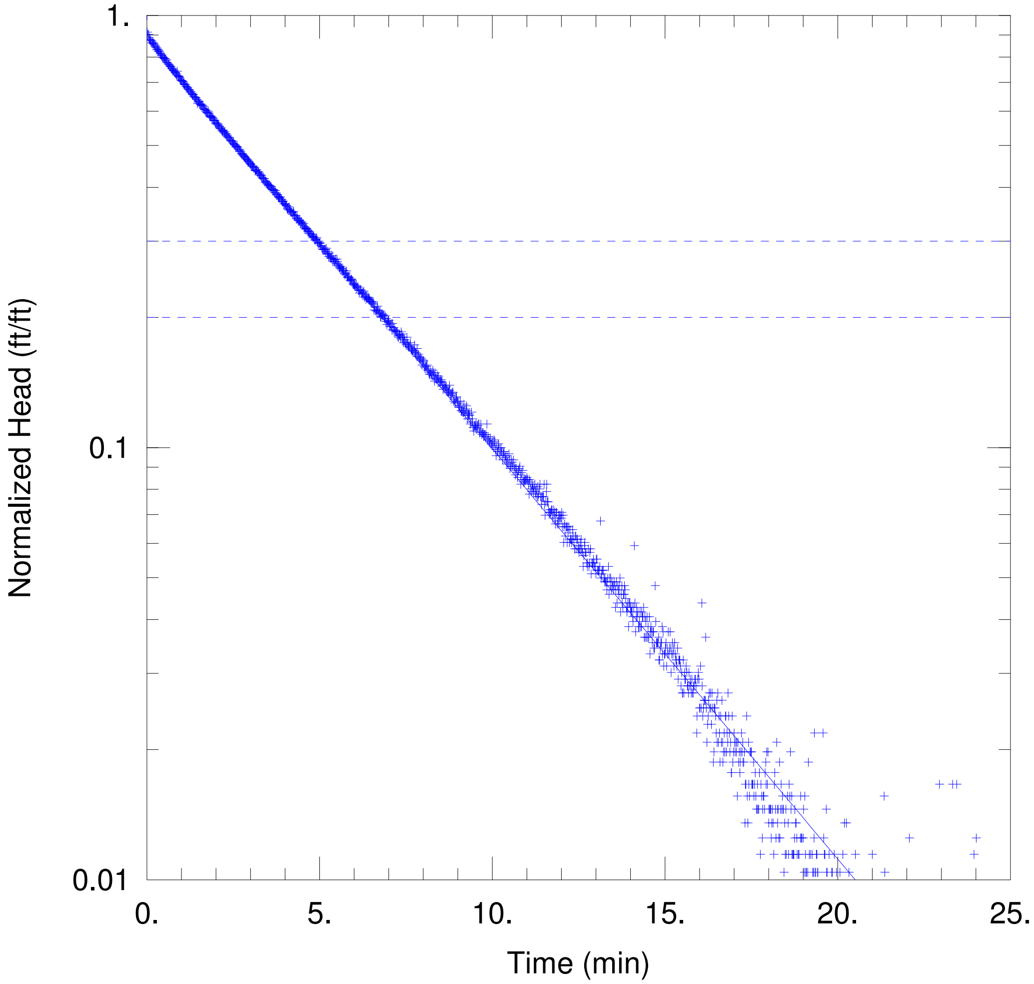
WELL DATA (EF-6 Slug B Falling Head)

Initial Displacement: 0.983 ft
Static Water Column Height: 65.36 ft
Total Well Penetration Depth: 65.36 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.6698 ft/day
y0 = 0.8226 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-6_SlugBRisingHead_Kz.aqt
Date: 01/12/15 Time: 10:40:54

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-6
Test Date: 27 Aug 2012

AQUIFER DATA

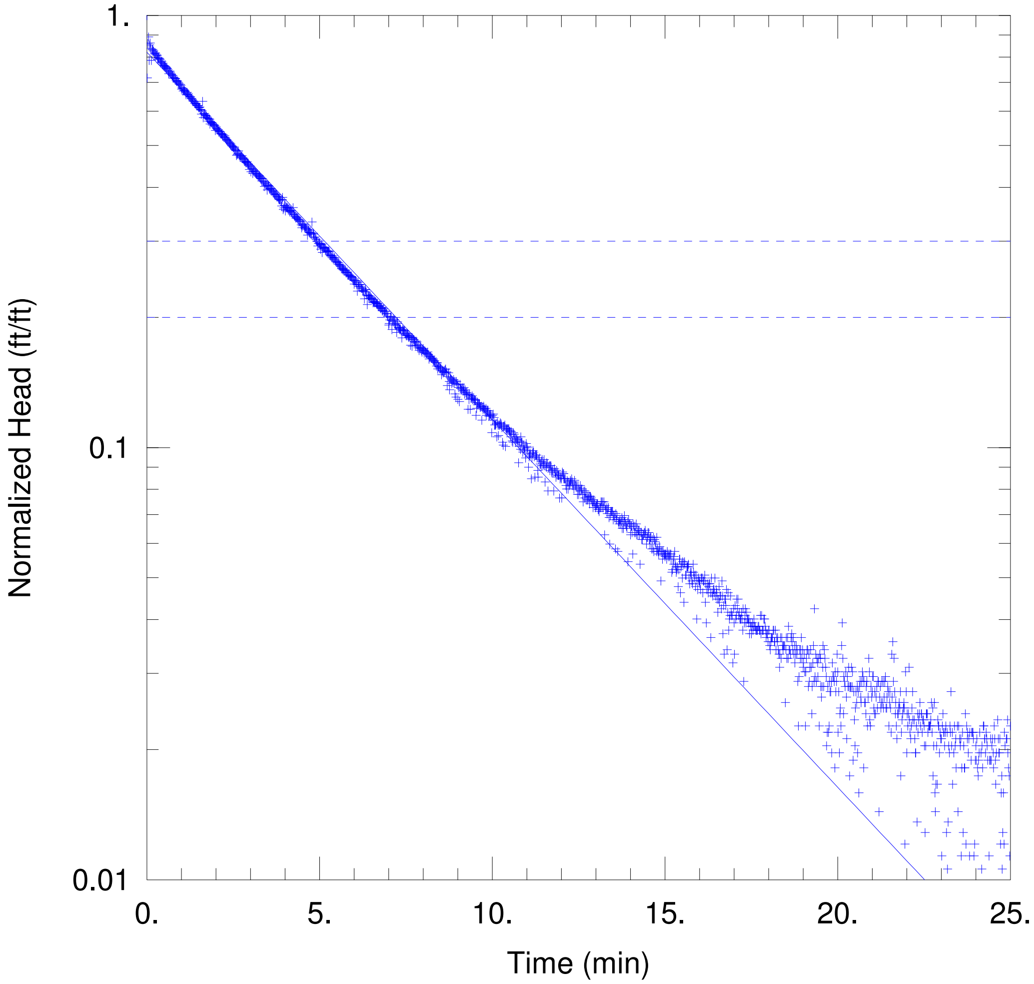
Saturated Thickness: 65.36 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (EF-6 Slug B Rising Head)

Initial Displacement: 0.961 ft
Static Water Column Height: 65.36 ft
Total Well Penetration Depth: 65.36 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.7318 ft/day
y0 = 0.849 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-6_SlugCFallingHead_Kz.aqt
Date: 01/12/15 Time: 10:43:23

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-6
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 65.36 ft
Anisotropy Ratio (Kz/Kr): 0.1

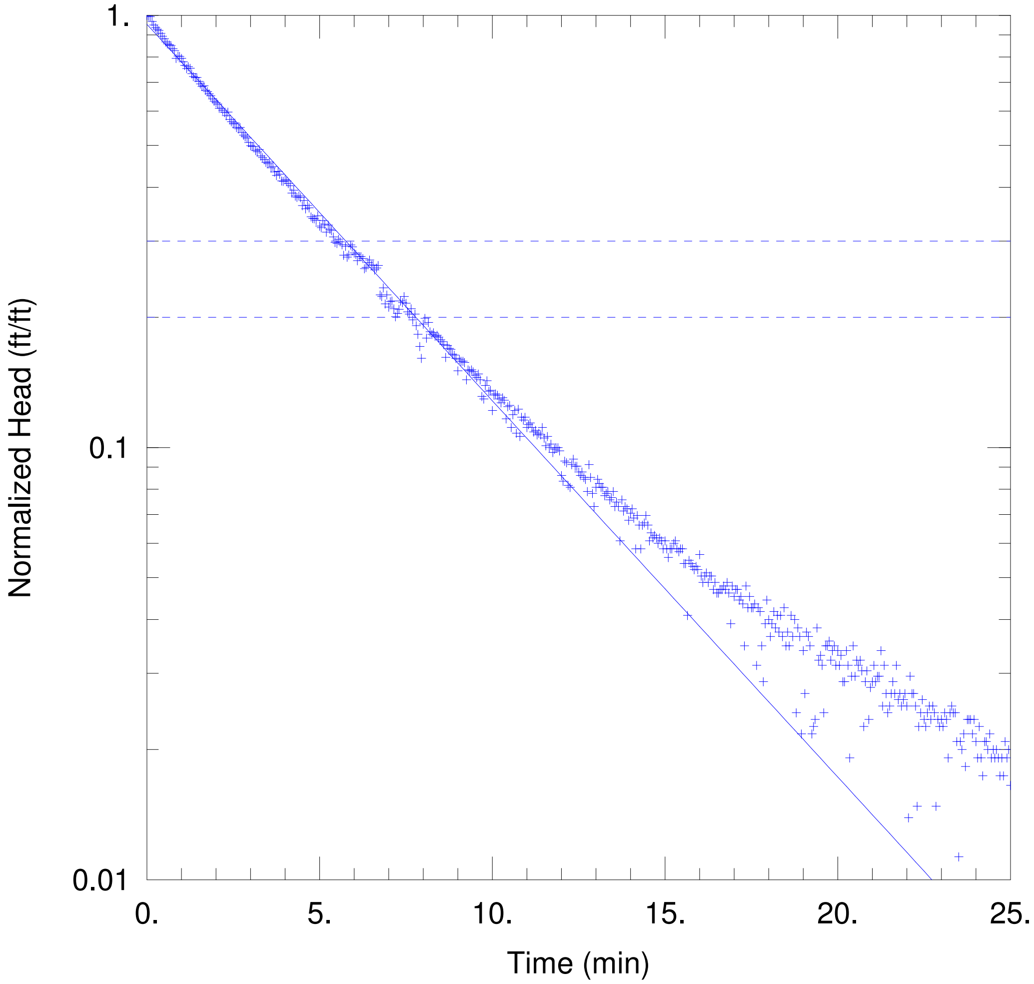
WELL DATA (EF-6 Slug C Falling Head)

Initial Displacement: 1.322 ft
Static Water Column Height: 65.36 ft
Total Well Penetration Depth: 65.36 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.6558 ft/day
y0 = 1.087 ft



EF-6 SLUG C RISING HEAD

Data Set: S:\...\EF-6_SlugCRisingHead_Kz.aqt
Date: 01/12/15 Time: 10:44:46

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-6
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 65.36 ft
Anisotropy Ratio (Kz/Kr): 0.1

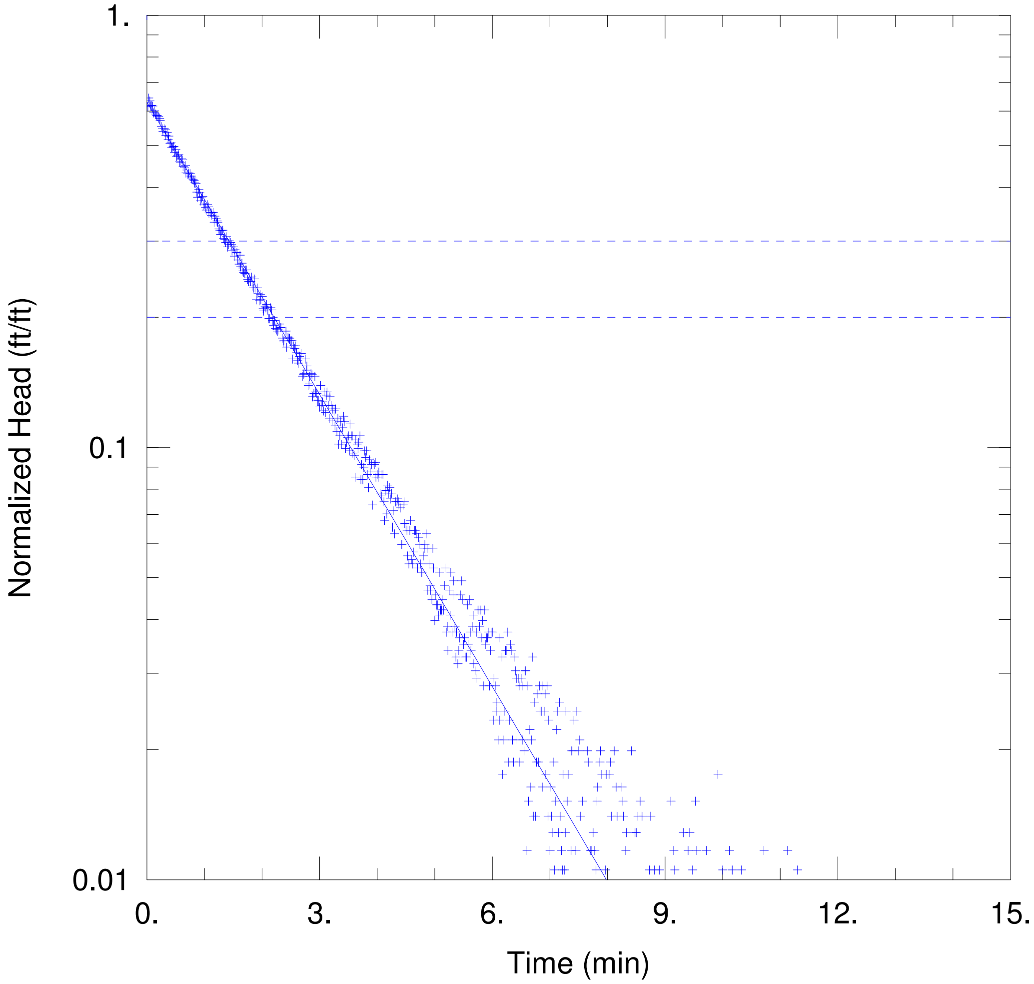
WELL DATA (EF-6 Slug C Rising Head)

Initial Displacement: 1.15 ft
Total Well Penetration Depth: 65.36 ft
Casing Radius: 0.167 ft
Static Water Column Height: 65.36 ft
Screen Length: 30. ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.6714 ft/day
y0 = 1.095 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-8_SlugAFallingHead_Kz.aqt
Date: 01/12/15 Time: 10:47:14

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-8
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 121. ft
Anisotropy Ratio (Kz/Kr): 0.1

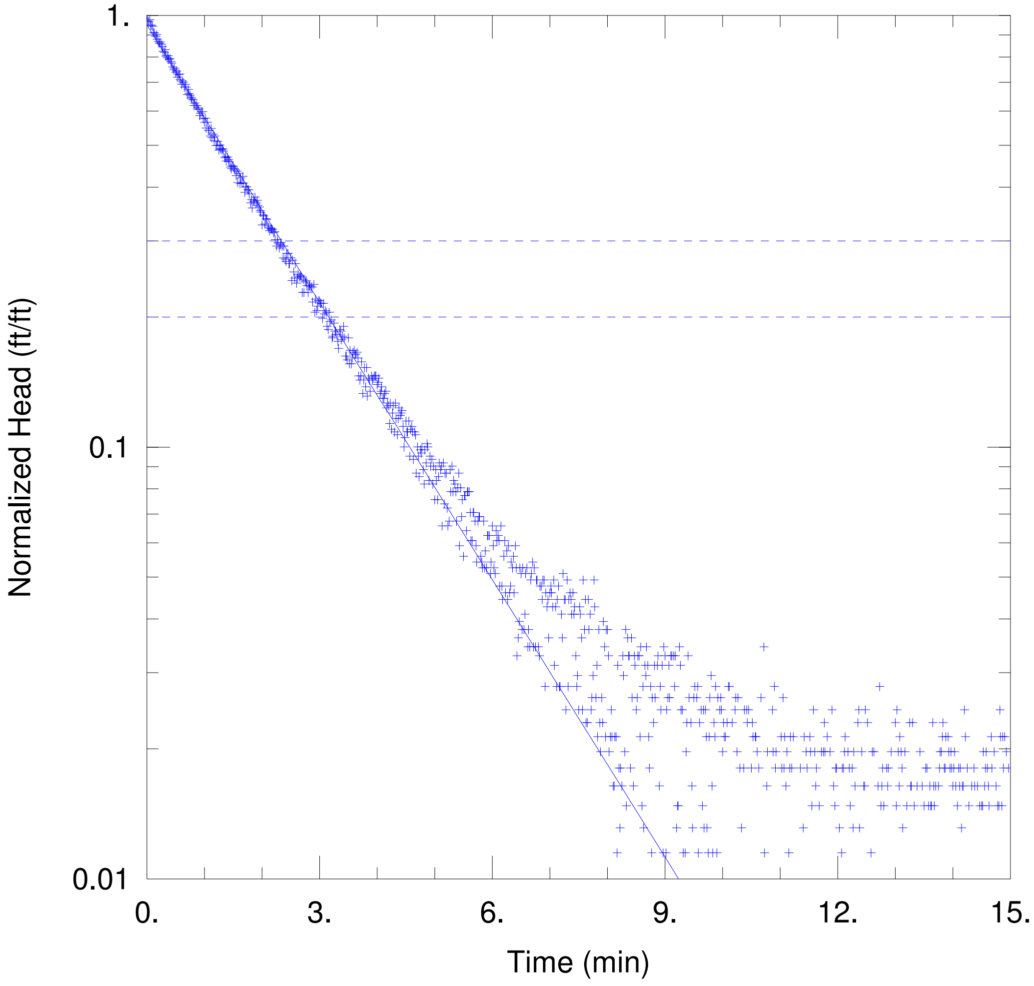
WELL DATA (EF-8 Slug A Falling Head)

Initial Displacement: 0.855 ft
Static Water Column Height: 169. ft
Total Well Penetration Depth: 121. ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.878 ft/day
y0 = 0.5382 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-8_SlugARisingHead_Kz.aqt
Date: 01/12/15 Time: 10:48:30

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-8
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 121. ft
Anisotropy Ratio (Kz/Kr): 0.1

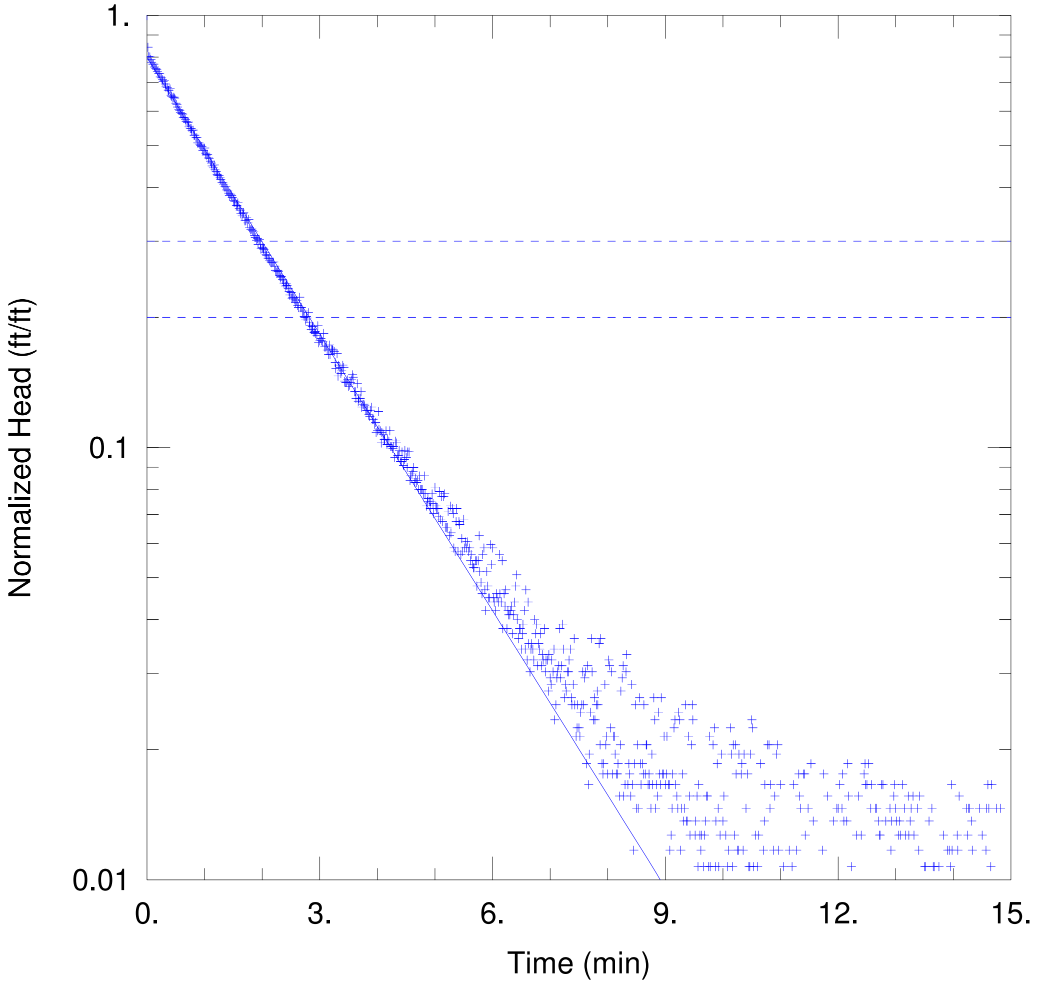
WELL DATA (EF-8 Slug A Rising Head)

Initial Displacement: 0.609 ft
Total Well Penetration Depth: 121. ft
Casing Radius: 0.167 ft
Static Water Column Height: 169. ft
Screen Length: 30. ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.783 ft/day
y0 = 0.578 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-8_SlugBFallingHead_Kz.aqt
Date: 01/12/15 Time: 10:49:55

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-8
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 121. ft
Anisotropy Ratio (Kz/Kr): 0.1

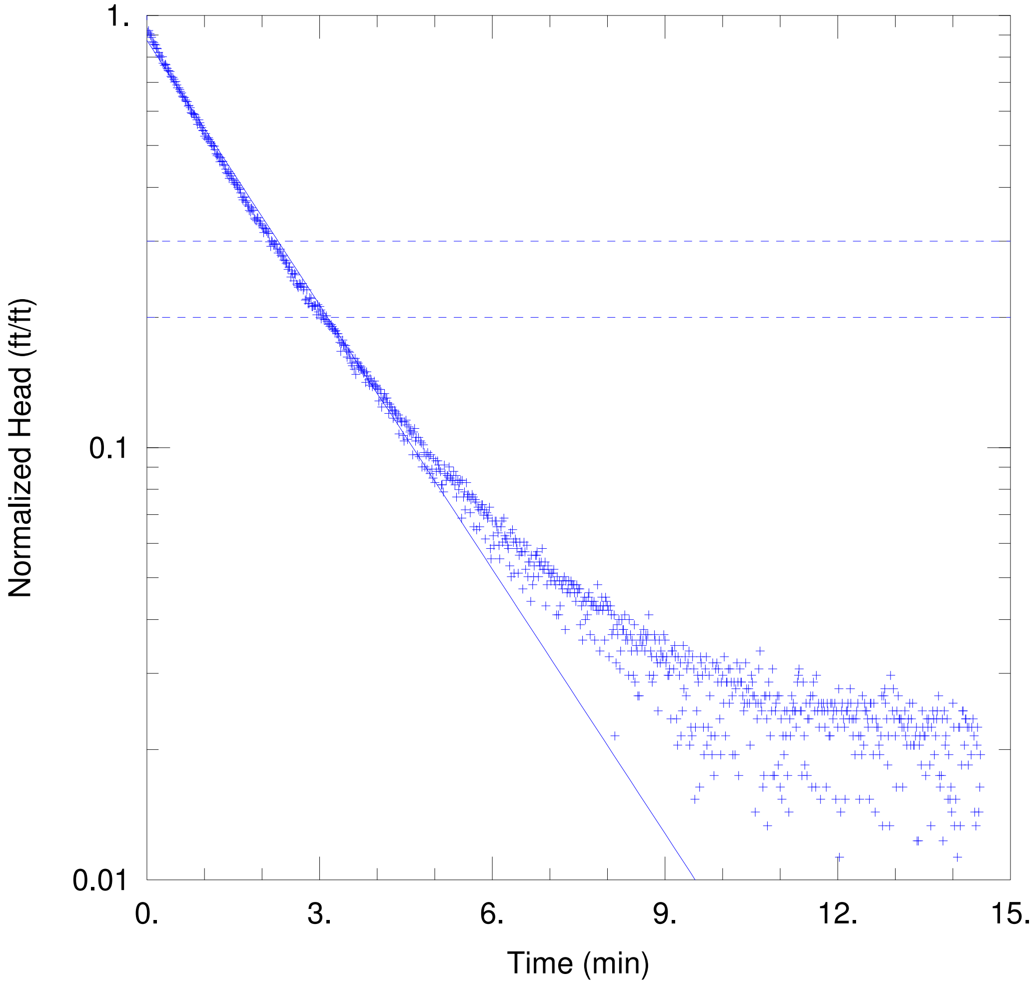
WELL DATA (EF-8 Slug B Falling Head)

Initial Displacement: 1.024 ft
Static Water Column Height: 169. ft
Total Well Penetration Depth: 121. ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.778 ft/day
y0 = 0.8187 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-8_SlugBRisingHead_Kz.aqt
Date: 01/12/15 Time: 10:51:18

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-8
Test Date: 27 Aug 2012

AQUIFER DATA

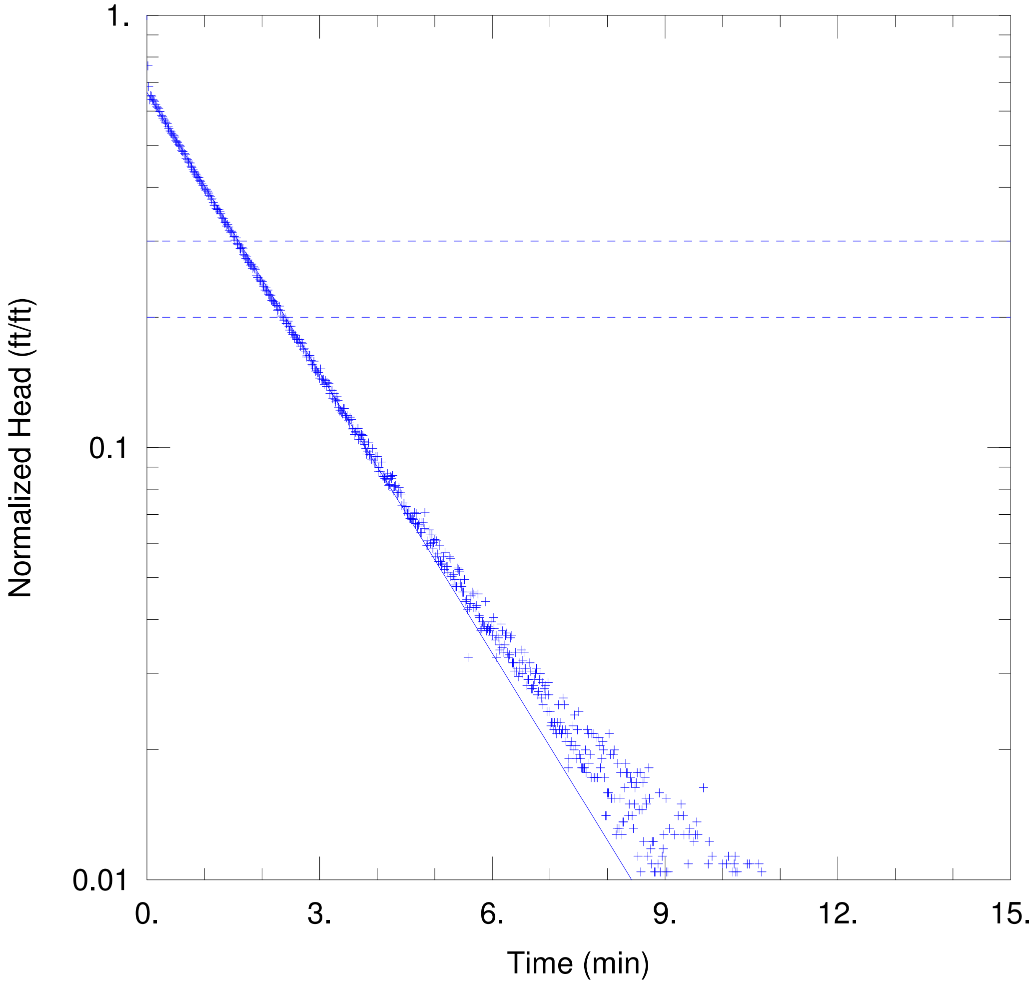
Saturated Thickness: 121. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (EF-8 Slug B Rising Head)

Initial Displacement: 0.976 ft
Total Well Penetration Depth: 121. ft
Casing Radius: 0.167 ft
Static Water Column Height: 169. ft
Screen Length: 30. ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.699 ft/day
y0 = 0.8536 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-8_SlugDFallingHead_Kz.aqt
Date: 01/12/15 Time: 10:52:29

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-8
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 121. ft
Anisotropy Ratio (Kz/Kr): 0.1

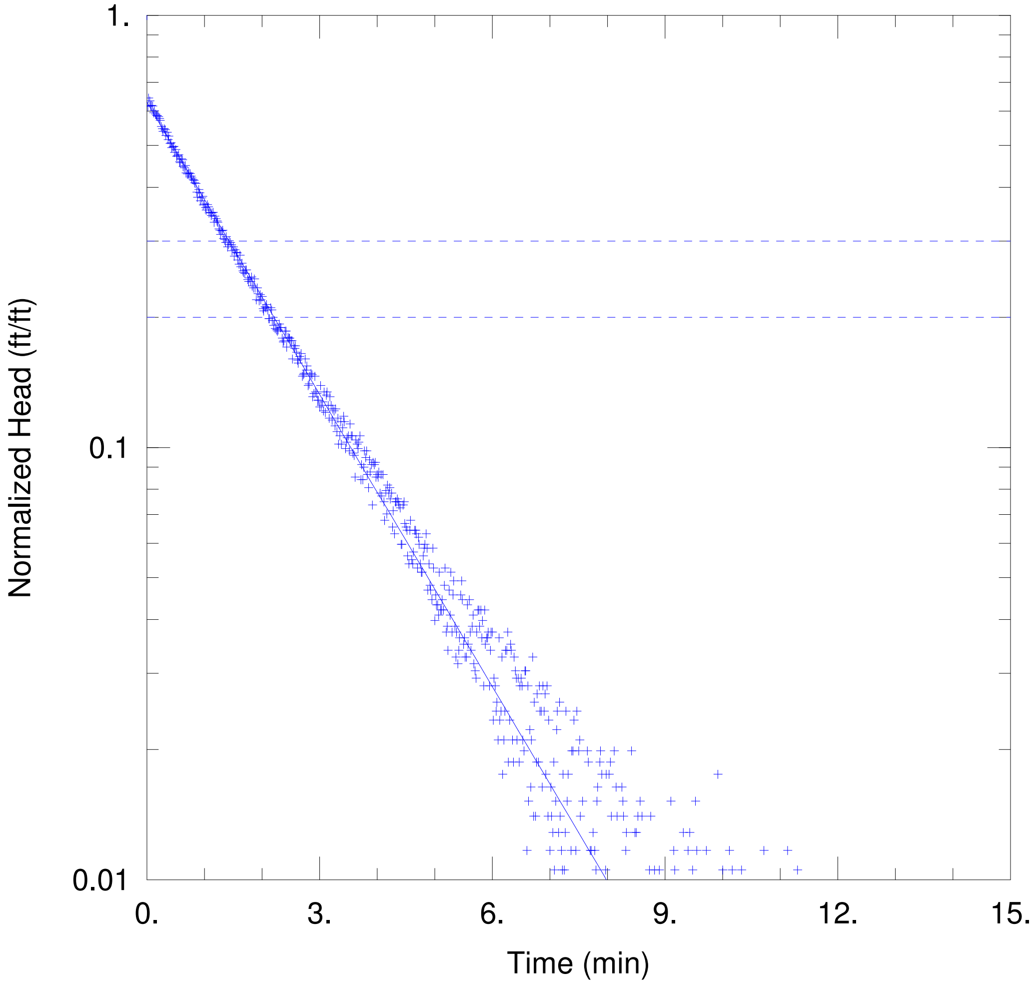
WELL DATA (EF-8 Slug D Falling Head)

Initial Displacement: 2.204 ft
Total Well Penetration Depth: 121. ft
Casing Radius: 0.167 ft
Static Water Column Height: 169. ft
Screen Length: 30. ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.802 ft/day
y0 = 1.462 ft



WELL TEST ANALYSIS

Data Set: S:\...\EF-8_SlugDRisingHead_Kz.aqt
Date: 01/12/15 Time: 10:53:56

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: EF-8
Test Date: 27 Aug 2012

AQUIFER DATA

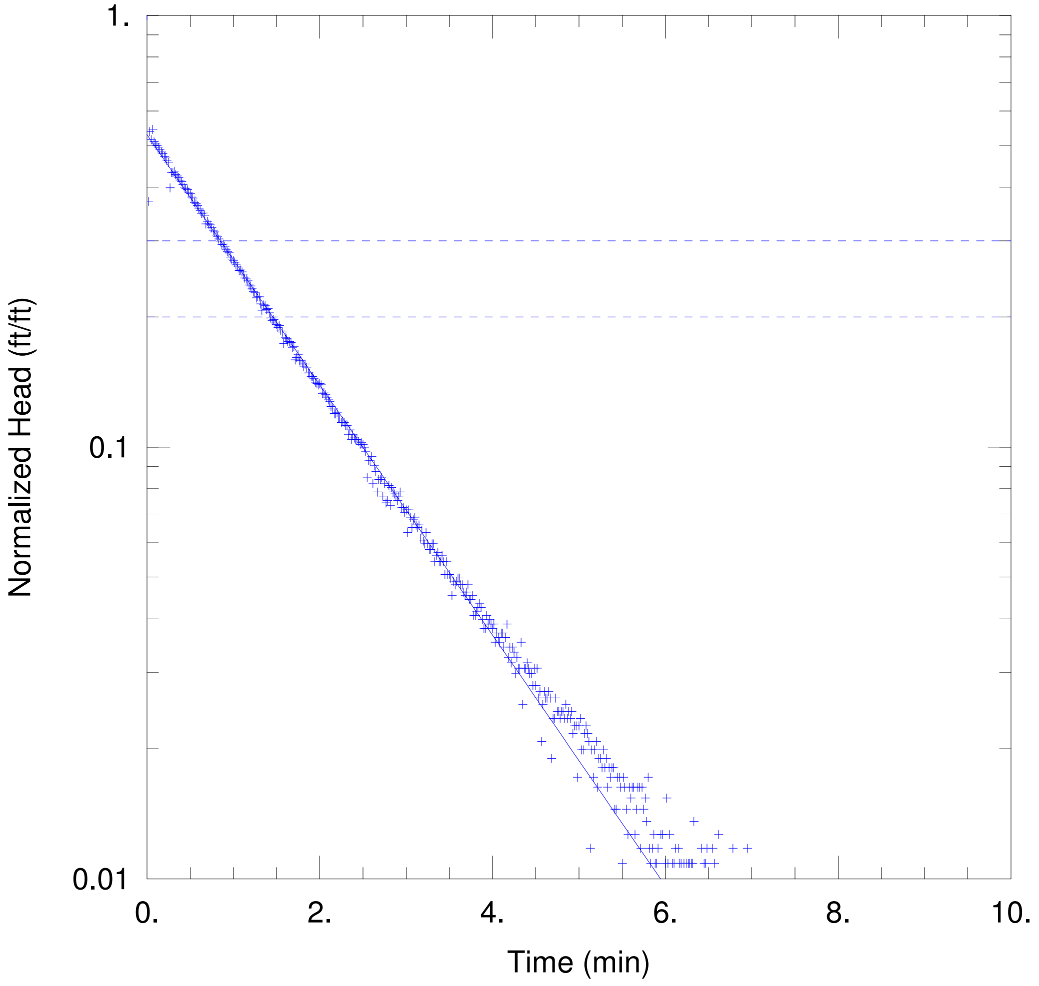
Saturated Thickness: 121. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (EF-8 Slug A Falling Head)

Initial Displacement: 0.855 ft
Static Water Column Height: 169. ft
Total Well Penetration Depth: 121. ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.878 ft/day
y0 = 0.5382 ft



WELL TEST ANALYSIS

Data Set: S:\...\H-63_SlugBFallingHead_Kz.aqt
Date: 01/12/15
Time: 11:08:20

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: H-63
Test Date: 26 Aug 2012

AQUIFER DATA

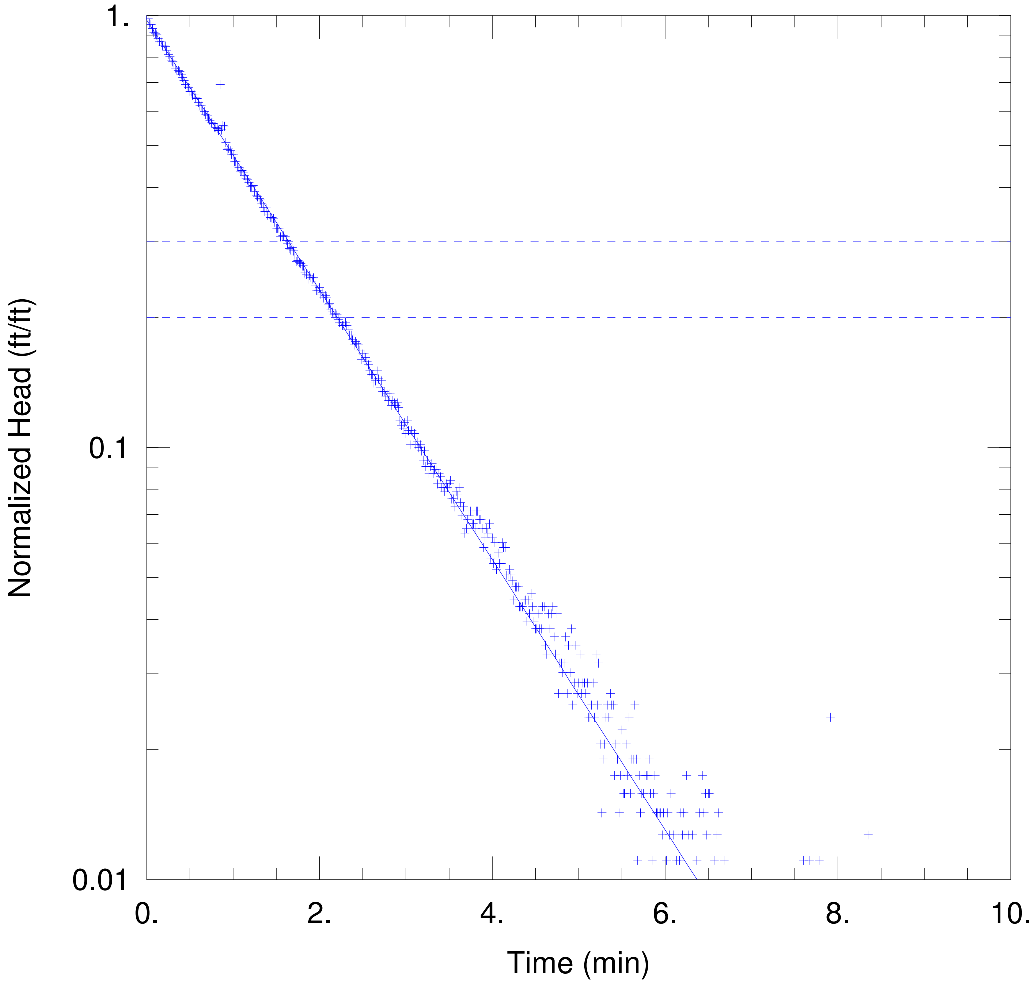
Saturated Thickness: 36.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (H-63 Slug B Falling Head)

Initial Displacement: 1.105 ft
Total Well Penetration Depth: 36.55 ft
Casing Radius: 0.167 ft
Static Water Column Height: 36.55 ft
Screen Length: 30. ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.06 ft/day
y0 = 0.584 ft



WELL TEST ANALYSIS

Data Set: S:\...\H-63_SlugBRisingHead_Kz.aqt
Date: 01/12/15 Time: 11:09:46

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: H-63
Test Date: 26 Aug 2012

AQUIFER DATA

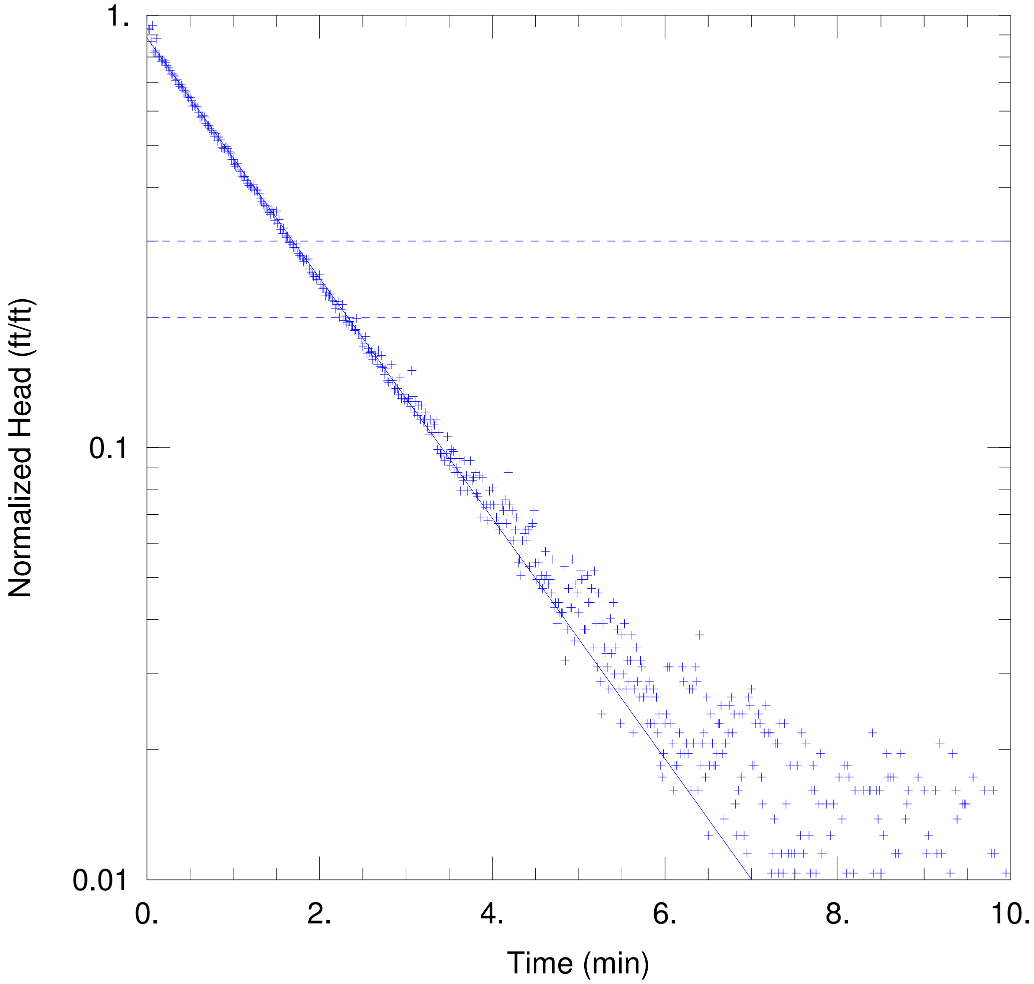
Saturated Thickness: 36.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (H-63 Slug B Rising Headd)

Initial Displacement: 0.631 ft
Static Water Column Height: 36.55 ft
Total Well Penetration Depth: 36.55 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.22 ft/day
y0 = 0.6156 ft



WELL TEST ANALYSIS

Data Set: S:\...\H-63_SlugCFallingHead_Kz.aqt
Date: 01/12/15 Time: 11:11:00

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: H-63
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 36.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

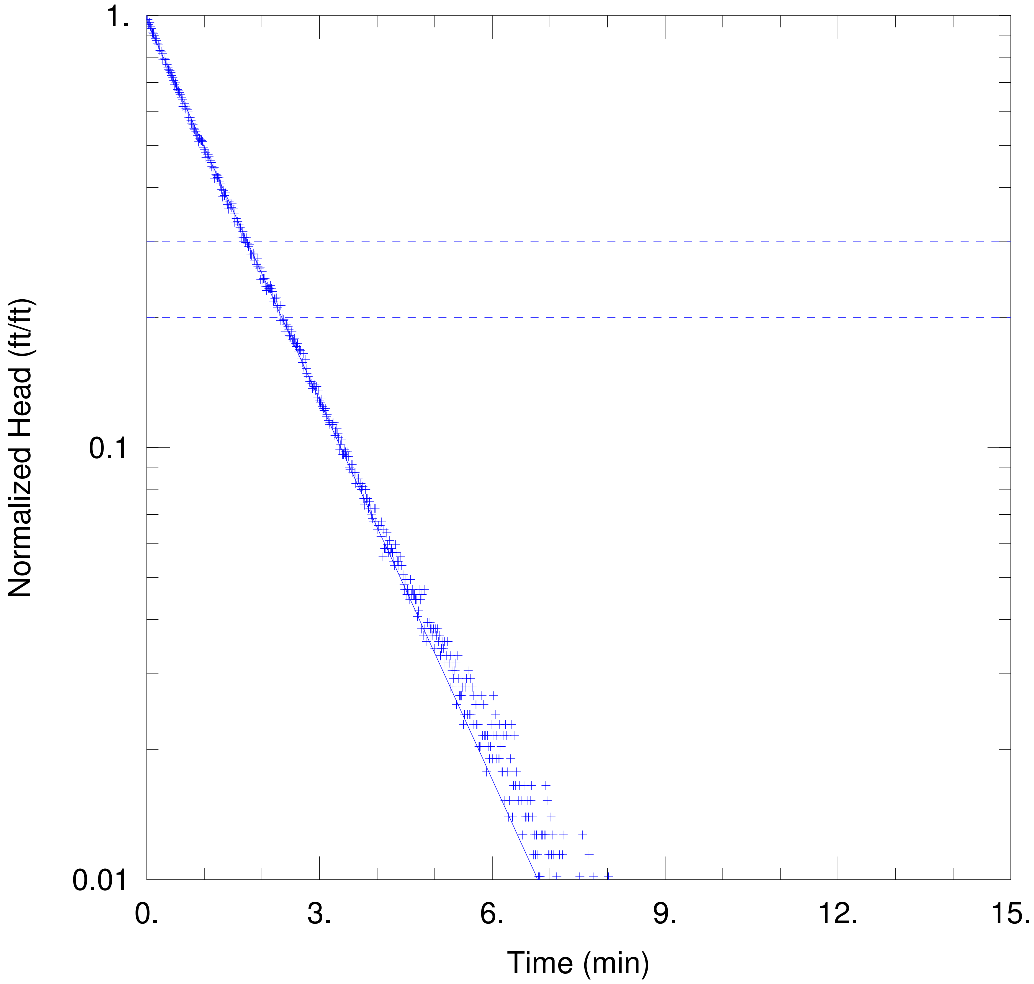
WELL DATA (H-63 Slug C Falling Head)

Initial Displacement: 0.869 ft
Static Water Column Height: 36.55 ft
Total Well Penetration Depth: 36.55 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.976 ft/day
y0 = 0.7703 ft



WELL TEST ANALYSIS

Data Set: S:\...\H-63_SlugCRisingHead_Kz.aqt
Date: 01/12/15 Time: 11:12:07

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: H-63
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 36.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

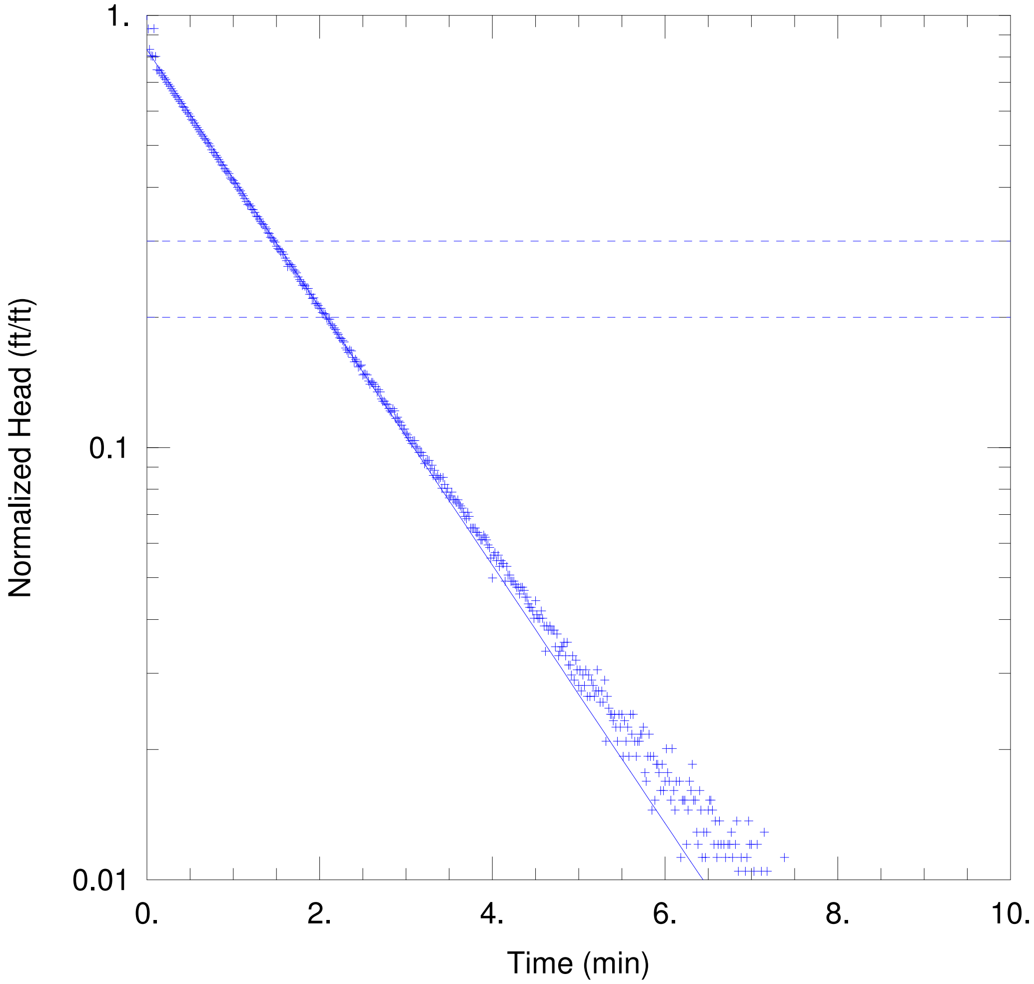
WELL DATA (H-63 Slug C Rising Head)

Initial Displacement: 0.788 ft
Total Well Penetration Depth: 36.55 ft
Casing Radius: 0.167 ft
Static Water Column Height: 36.55 ft
Screen Length: 30. ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.081 ft/day
y0 = 0.7657 ft



WELL TEST ANALYSIS

Data Set: S:\...\H-63_SlugDFallingHead_Kz.aqt
Date: 01/12/15 Time: 11:13:31

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: H-63
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 36.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

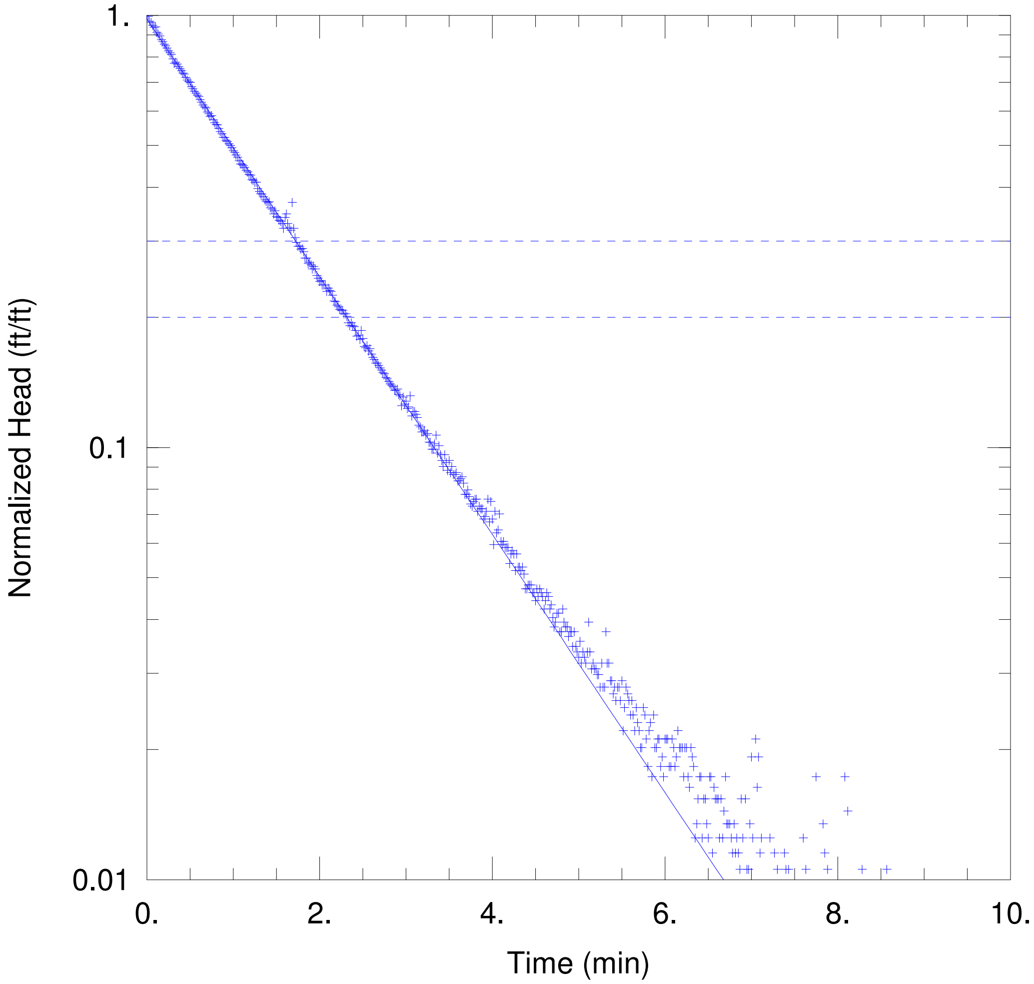
WELL DATA (H-63 Slug D Falling Head)

Initial Displacement: 1.243 ft
Total Well Penetration Depth: 36.55 ft
Casing Radius: 0.167 ft
Static Water Column Height: 36.55 ft
Screen Length: 30. ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.119 ft/day
y0 = 1.034 ft



WELL TEST ANALYSIS

Data Set: S:\...\H-63_SlugDRisingHead_Kz.aqt
Date: 01/12/15 Time: 11:14:54

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: H-63
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 36.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

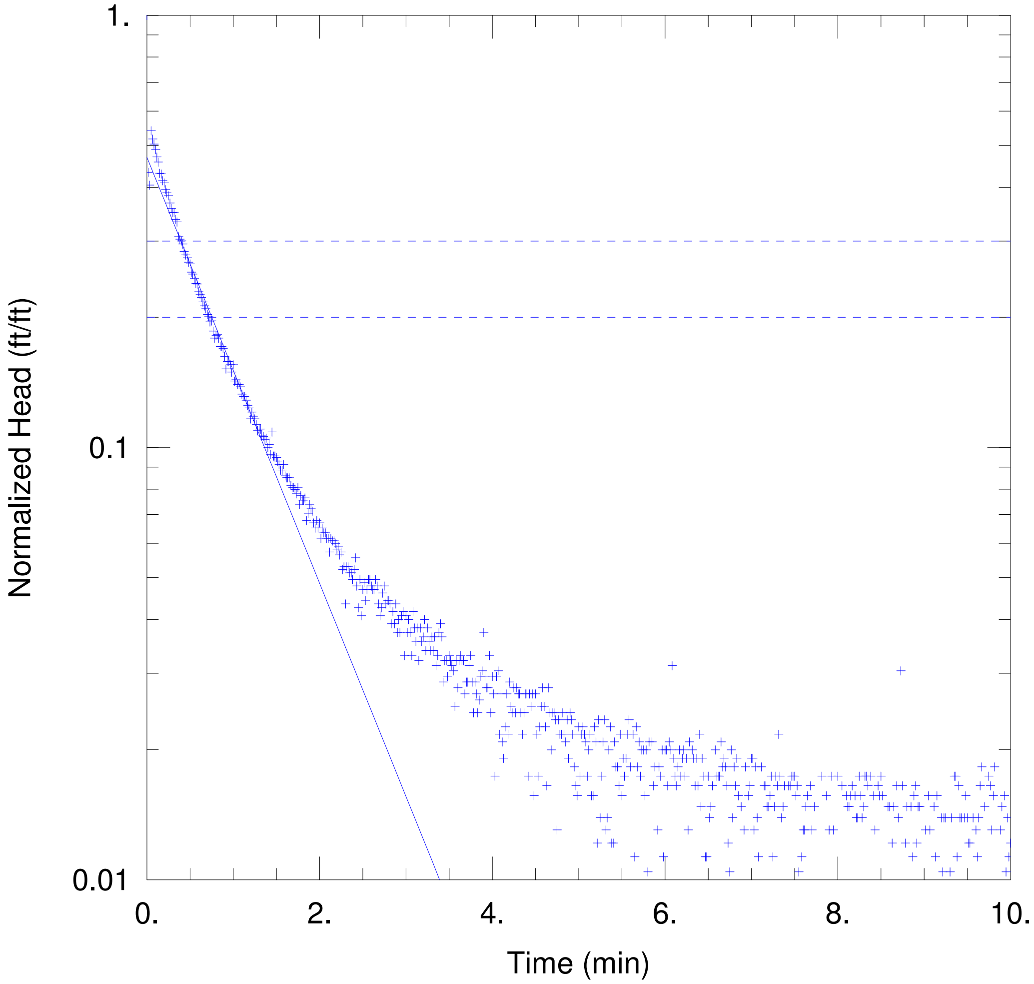
WELL DATA (H-63 Slug D Rising Head)

Initial Displacement: 1.04 ft
Static Water Column Height: 36.55 ft
Total Well Penetration Depth: 36.55 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.3281 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.12 ft/day
y0 = 1.019 ft



WELL TEST ANALYSIS

Data Set: S:\...\LW-1_SlugBFallingHead_Kz.aqt
Date: 01/13/15 Time: 12:34:36

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: LW-1
Test Date: 27 Aug 2012

AQUIFER DATA

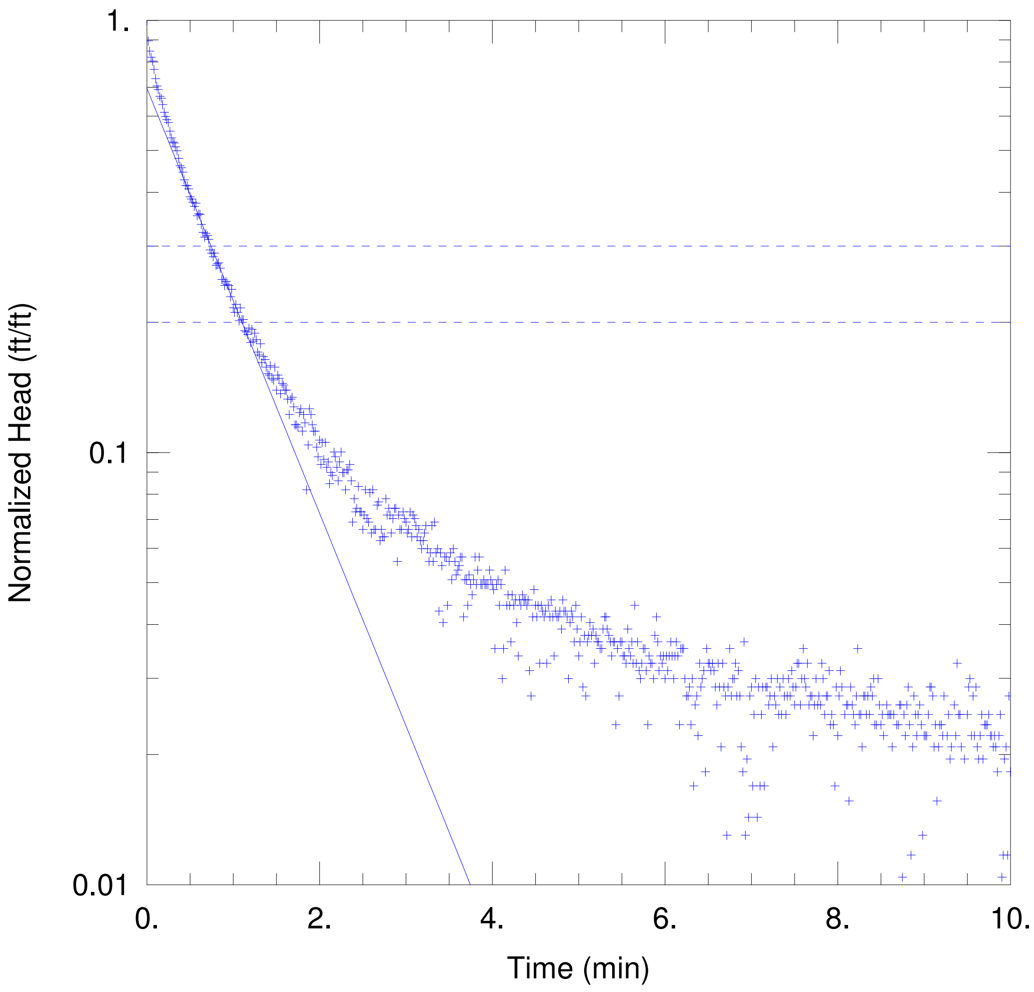
Saturated Thickness: 88.02 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (LW-1 Slug B Falling Head)

Initial Displacement: 1.151 ft
Static Water Column Height: 88.02 ft
Total Well Penetration Depth: 88.02 ft
Screen Length: 30. ft
Casing Radius: 0.159 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.57 ft/day
y0 = 0.5401 ft



WELL TEST ANALYSIS

Data Set: S:\...\LW-1_SlugBRisingHead_Kz.aqt
Date: 01/13/15 Time: 12:35:17

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: LW-1
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 88.02 ft
Anisotropy Ratio (Kz/Kr): 0.1

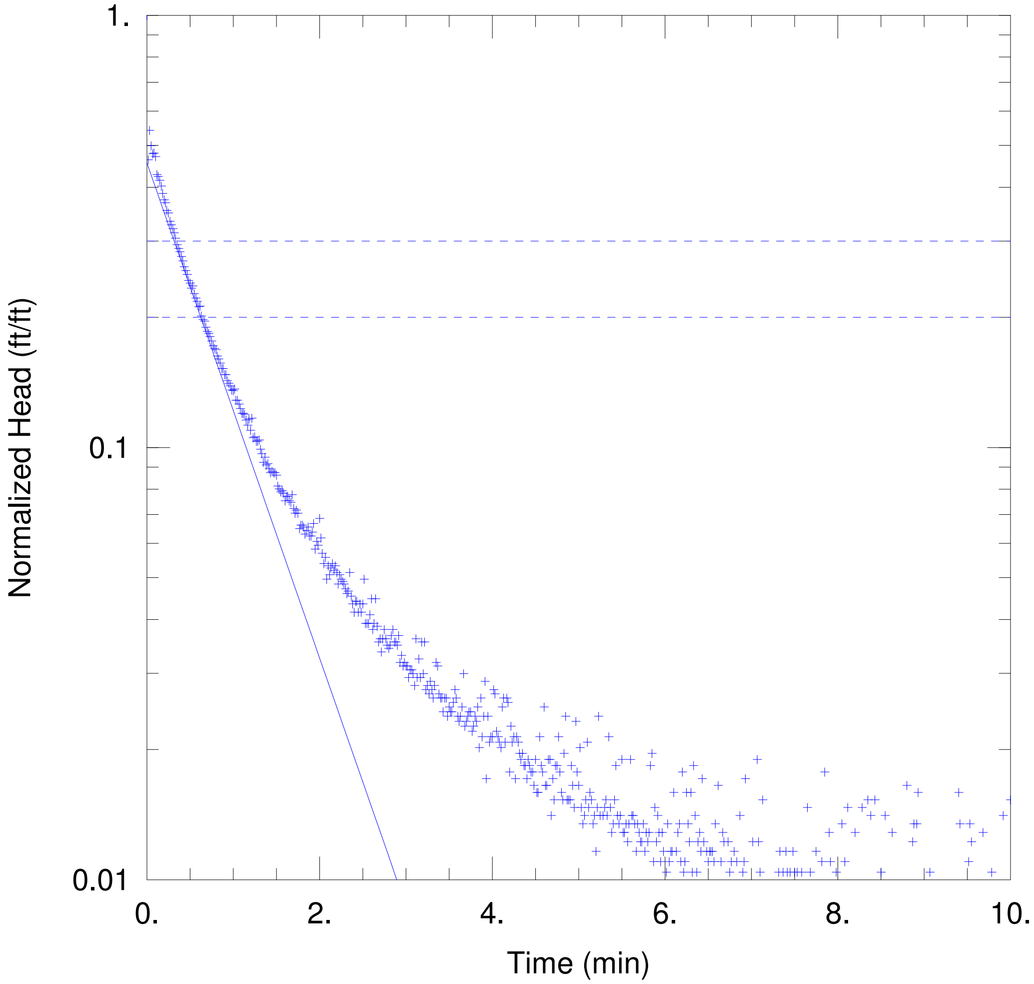
WELL DATA (LW-1 Slug B Rising Head)

Initial Displacement: 0.768 ft
Static Water Column Height: 88.02 ft
Total Well Penetration Depth: 88.02 ft
Screen Length: 30. ft
Casing Radius: 0.159 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.561 ft/day
y0 = 0.5343 ft



WELL TEST ANALYSIS

Data Set: S:\...\LW-1_SlugCFallingHead_Kz.aqt
Date: 01/13/15 Time: 12:35:49

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: LW-1
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 88.02 ft
Anisotropy Ratio (Kz/Kr): 0.1

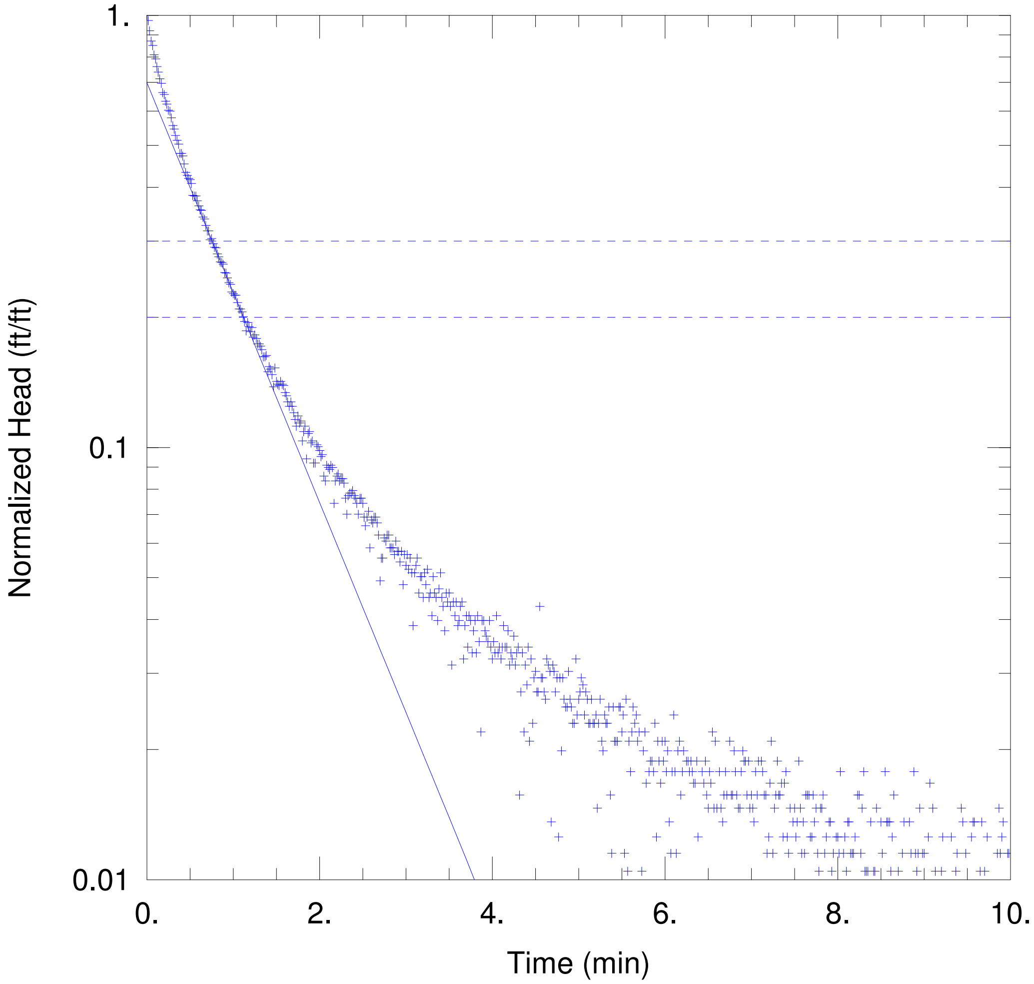
WELL DATA (LW-1 Slug C Rising Head)

Initial Displacement: 1.634 ft
Static Water Column Height: 88.02 ft
Total Well Penetration Depth: 88.02 ft
Screen Length: 30. ft
Casing Radius: 0.159 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.148 ft/day
y0 = 0.7436 ft



WELL TEST ANALYSIS

Data Set: S:\...\LW-1_SlugCRisingHead_Kz.aqt
Date: 01/13/15 Time: 12:36:26

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: LW-1
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 88.02 ft
Anisotropy Ratio (Kz/Kr): 0.1

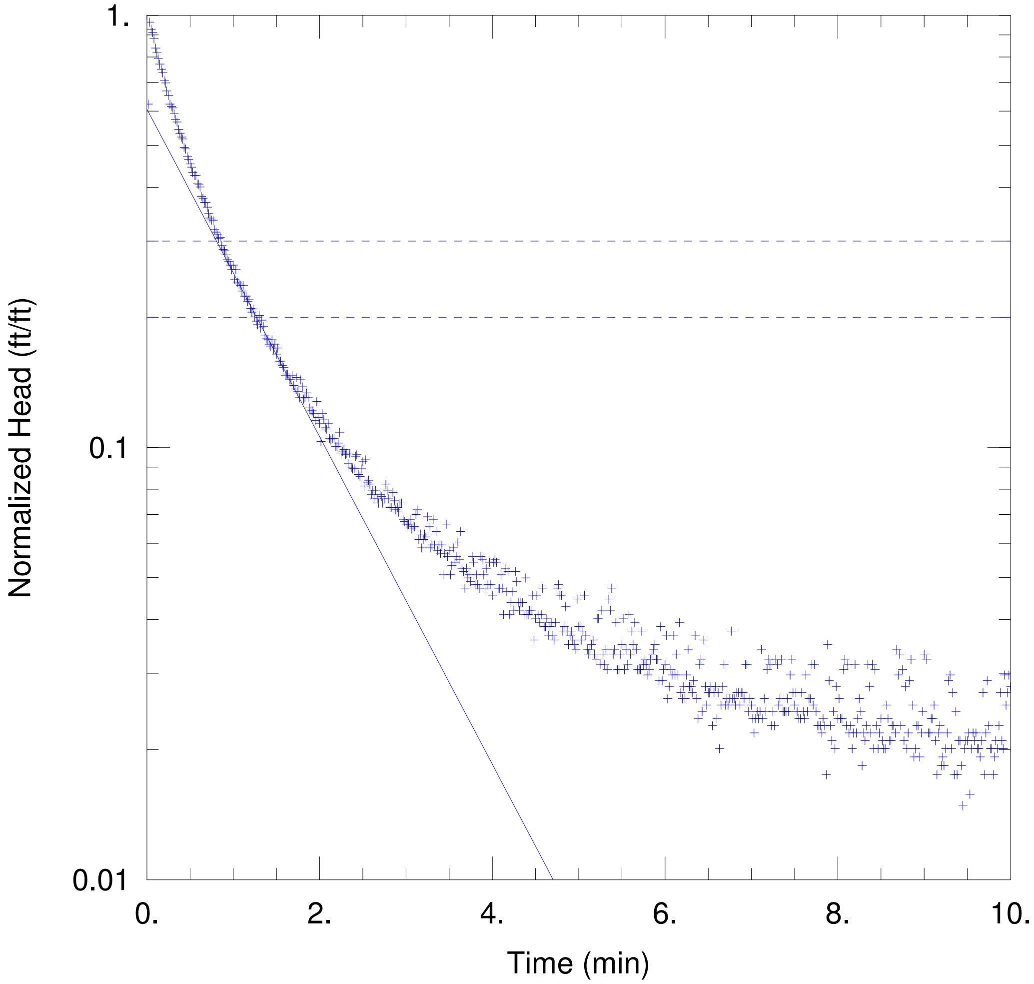
WELL DATA (LW-1 Slug C Rising Head)

Initial Displacement: 0.956 ft
Total Well Penetration Depth: 88.02 ft
Casing Radius: 0.159 ft
Static Water Column Height: 88.02 ft
Screen Length: 30. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.518 ft/day
y0 = 0.6677 ft



WELL TEST ANALYSIS

Data Set: S:\...\LW-1_SlugDFallingHead_Kz.aqt
Date: 01/13/15 Time: 12:36:57

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: LW-1
Test Date: 27 Aug 2012

AQUIFER DATA

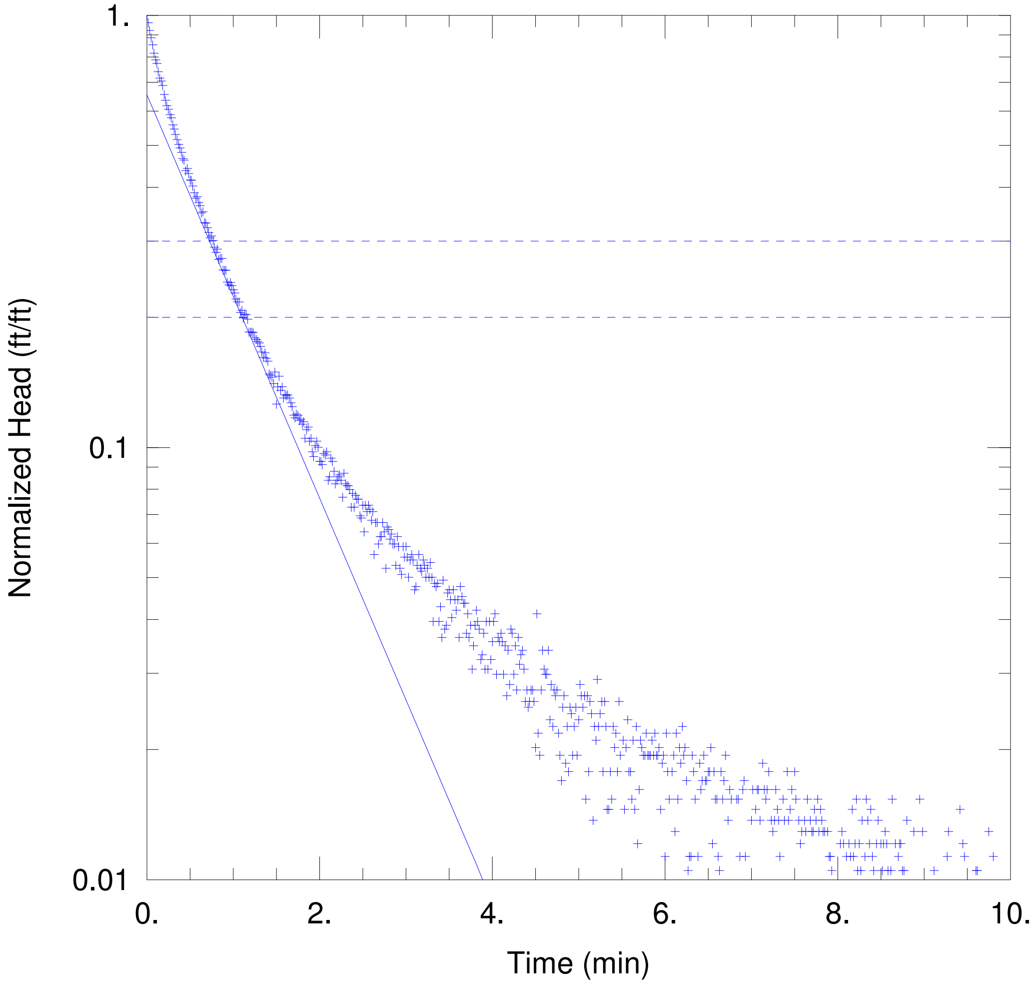
Saturated Thickness: 88.02 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (LW-1 Slug D Falling Head)

Initial Displacement: 1.143 ft
Static Water Column Height: 88.02 ft
Total Well Penetration Depth: 88.02 ft
Screen Length: 30. ft
Casing Radius: 0.159 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.745 ft/day
y0 = 0.6932 ft



WELL TEST ANALYSIS

Data Set: S:\...\LW-1_SlugDRisingHead_Kz.aqt
Date: 01/13/15
Time: 12:37:27

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: LW-1
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 88.02 ft
Anisotropy Ratio (Kz/Kr): 0.1

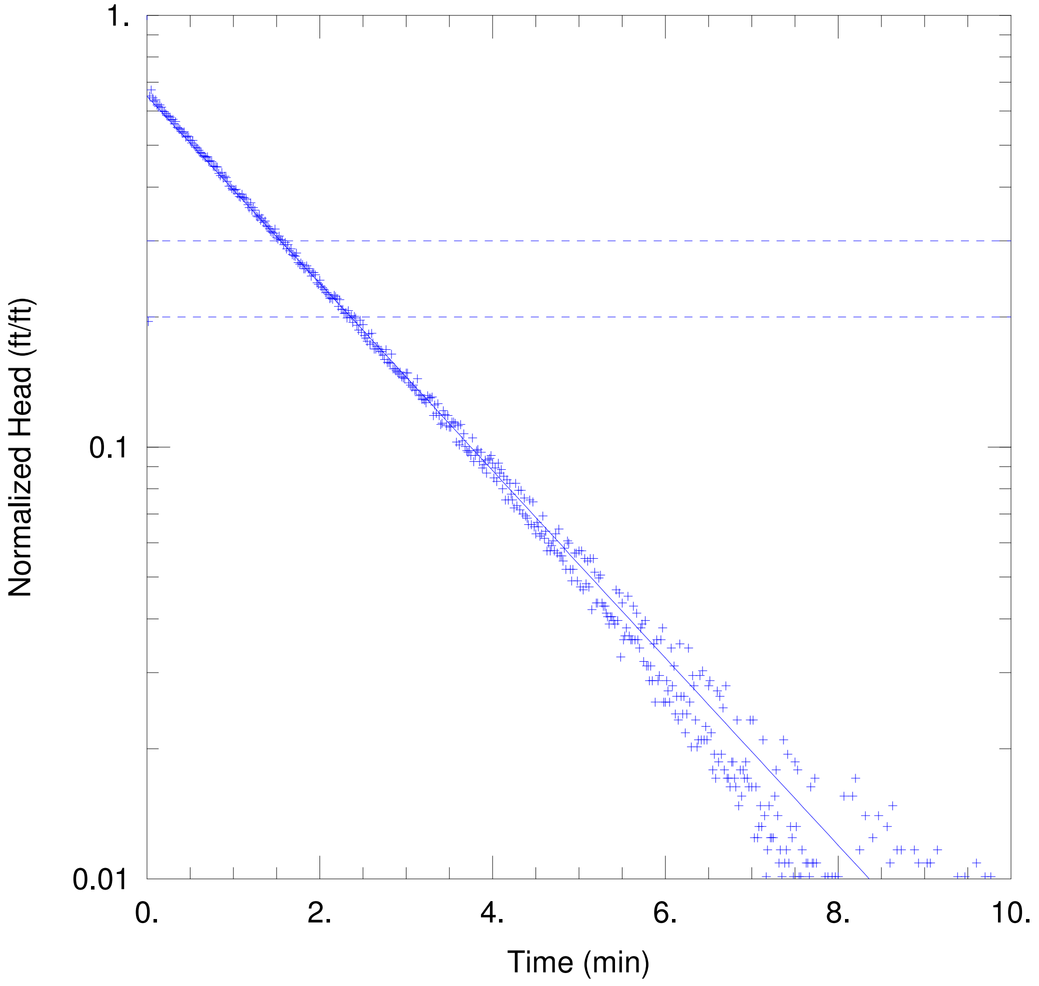
WELL DATA (LW-1 Slug D Rising Head)

Initial Displacement: 1.238 ft
Total Well Penetration Depth: 88.02 ft
Casing Radius: 0.159 ft
Static Water Column Height: 88.02 ft
Screen Length: 30. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.38 ft/day
y0 = 0.8103 ft



ML-1 SLUG B FALLING HEAD

Data Set: S:\...\ML-1SlugBFallingHead_Kz.aqt
Date: 01/12/15 Time: 11:32:52

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: ML-1
Test Date: 26 Aug 2012

AQUIFER DATA

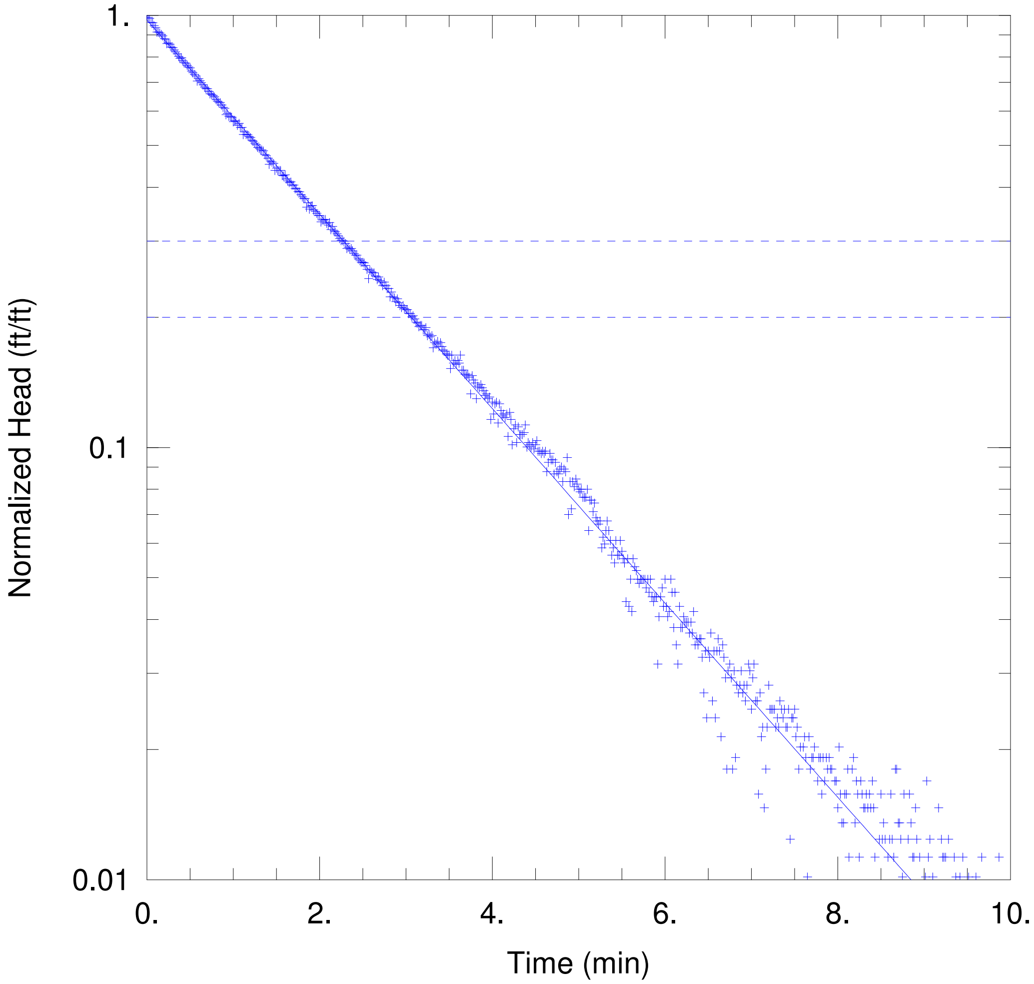
Saturated Thickness: 115.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (ML-1)

Initial Displacement: 1.286 ft
Static Water Column Height: 129.1 ft
Total Well Penetration Depth: 76.05 ft
Screen Length: 19. ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.253 ft/day
y0 = 0.8346 ft



ML-1 SLUG B RISING HEAD

Data Set: S:\...\ML-1SlugBRisingHead_Kz.aqt
Date: 01/12/15 Time: 11:33:56

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: ML-1
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 115.4 ft Anisotropy Ratio (Kz/Kr): 0.1

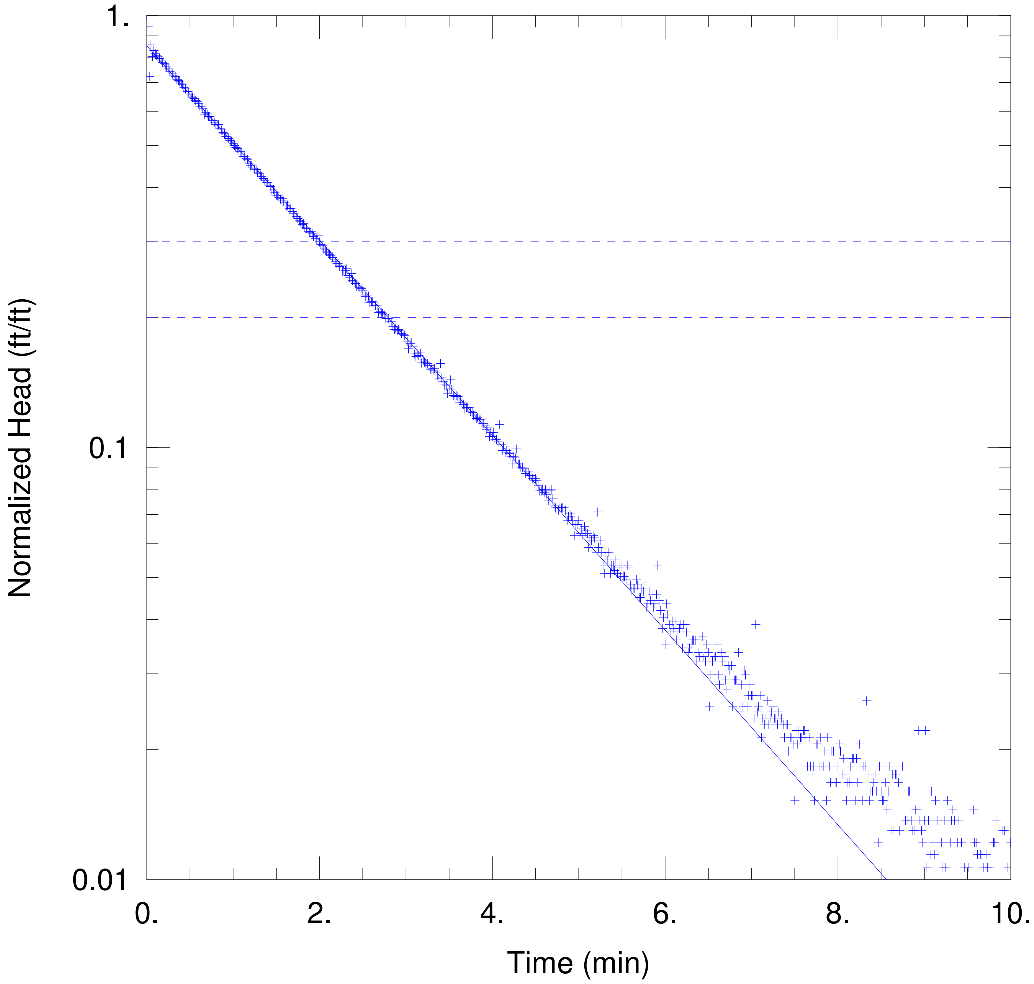
WELL DATA (ML-1)

Initial Displacement: 0.887 ft
Total Well Penetration Depth: 76.05 ft
Casing Radius: 0.167 ft
Static Water Column Height: 129.1 ft
Screen Length: 19. ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.336 ft/day y0 = 0.864 ft



ML-1 SLUG C FALLING HEAD

Data Set: S:\...\ML-1SlugCFallingHead_Kz.aqt
Date: 01/12/15 Time: 11:35:25

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: ML-1
Test Date: 26 Aug 2012

AQUIFER DATA

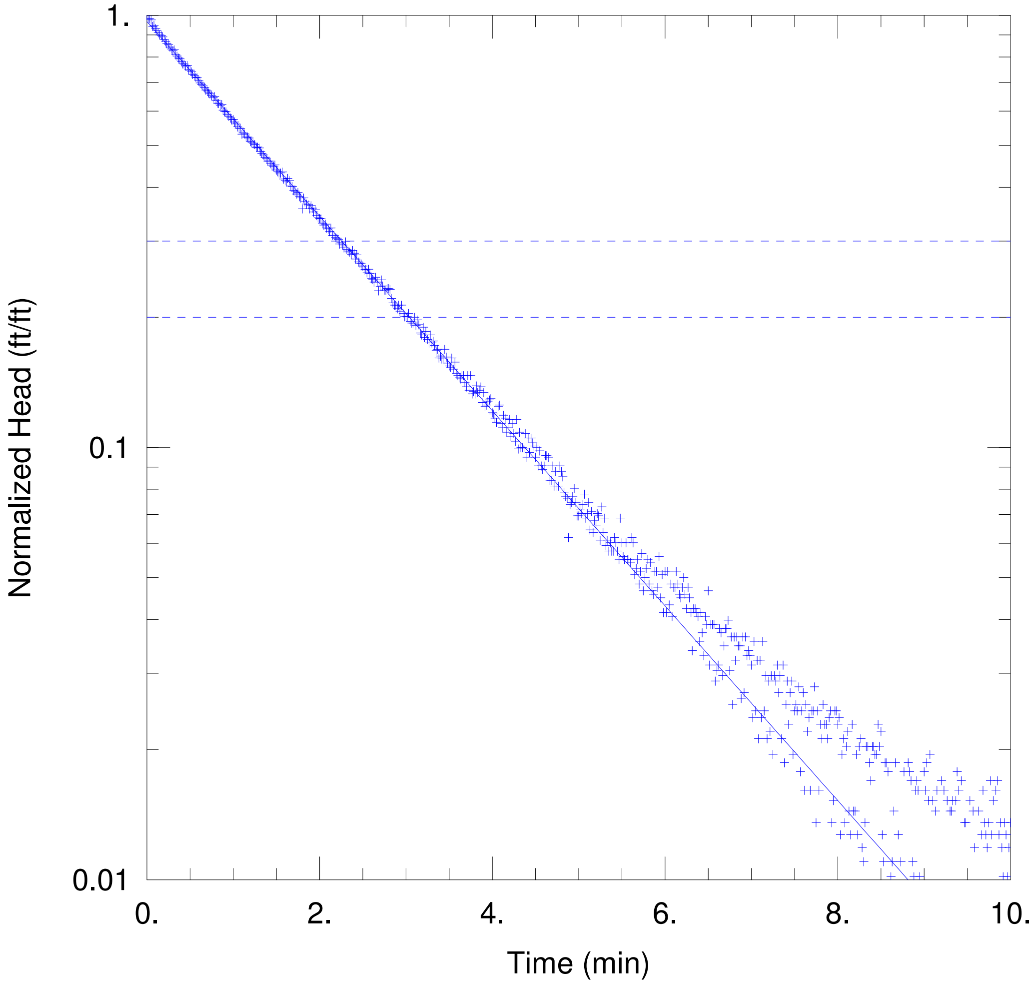
Saturated Thickness: 115.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (ML-1)

Initial Displacement: 1.311 ft
Total Well Penetration Depth: 76.05 ft
Casing Radius: 0.167 ft
Static Water Column Height: 129.1 ft
Screen Length: 19. ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.343 ft/day
y0 = 1.116 ft



ML-1 SLUG C RISING HEAD

Data Set: S:\...\ML-1SlugCRisingHead_Kz.aqt
Date: 01/12/15 Time: 11:36:39

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: ML-1
Test Date: 26 Aug 2012

AQUIFER DATA

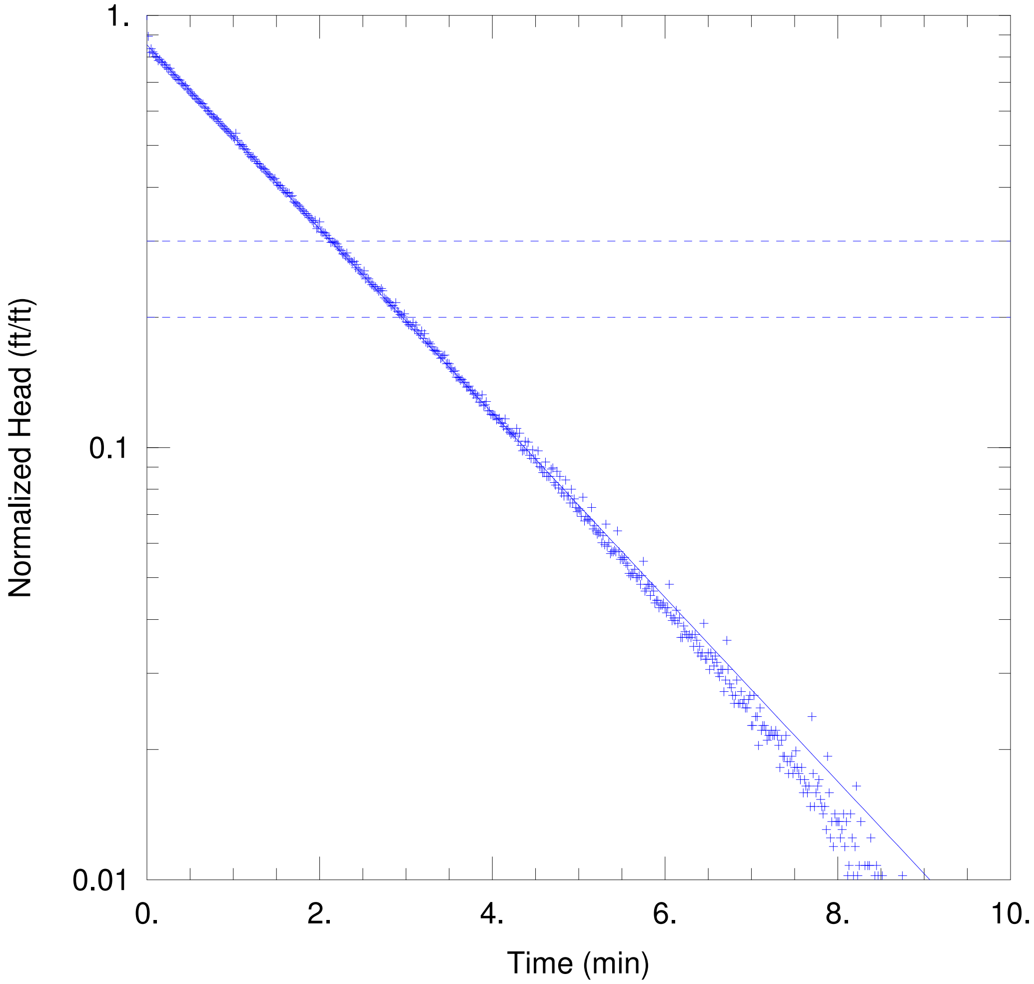
Saturated Thickness: 115.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (ML-1)

Initial Displacement: 1.18 ft
Static Water Column Height: 129.1 ft
Total Well Penetration Depth: 76.05 ft
Screen Length: 19. ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.341 ft/day
y0 = 1.141 ft



ML-1 SLUG D FALLING HEAD

Data Set: S:\...\ML-1SlugDFallingHead_Kz.aqt
Date: 01/12/15 Time: 11:37:51

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: ML-1
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 115.4 ft Anisotropy Ratio (Kz/Kr): 0.1

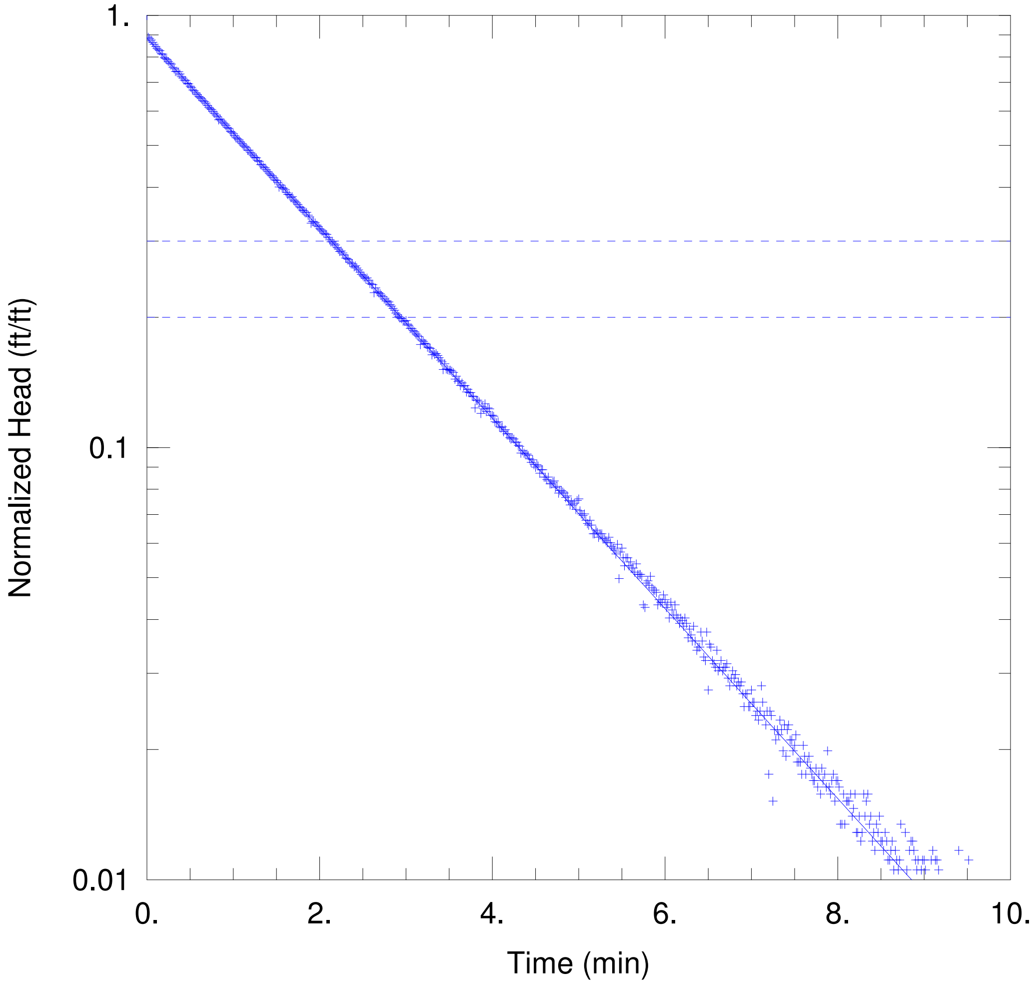
WELL DATA (ML-1)

Initial Displacement: 1.761 ft
Total Well Penetration Depth: 76.05 ft
Casing Radius: 0.167 ft
Static Water Column Height: 129.1 ft
Screen Length: 19. ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.214 ft/day y0 = 1.503 ft



ML-1 SLUG D RISING HEAD

Data Set: S:\...\ML-1SlugDRisingHead_Kz.aqt
Date: 01/12/15 Time: 11:39:02

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: ML-1
Test Date: 26 Aug 2012

AQUIFER DATA

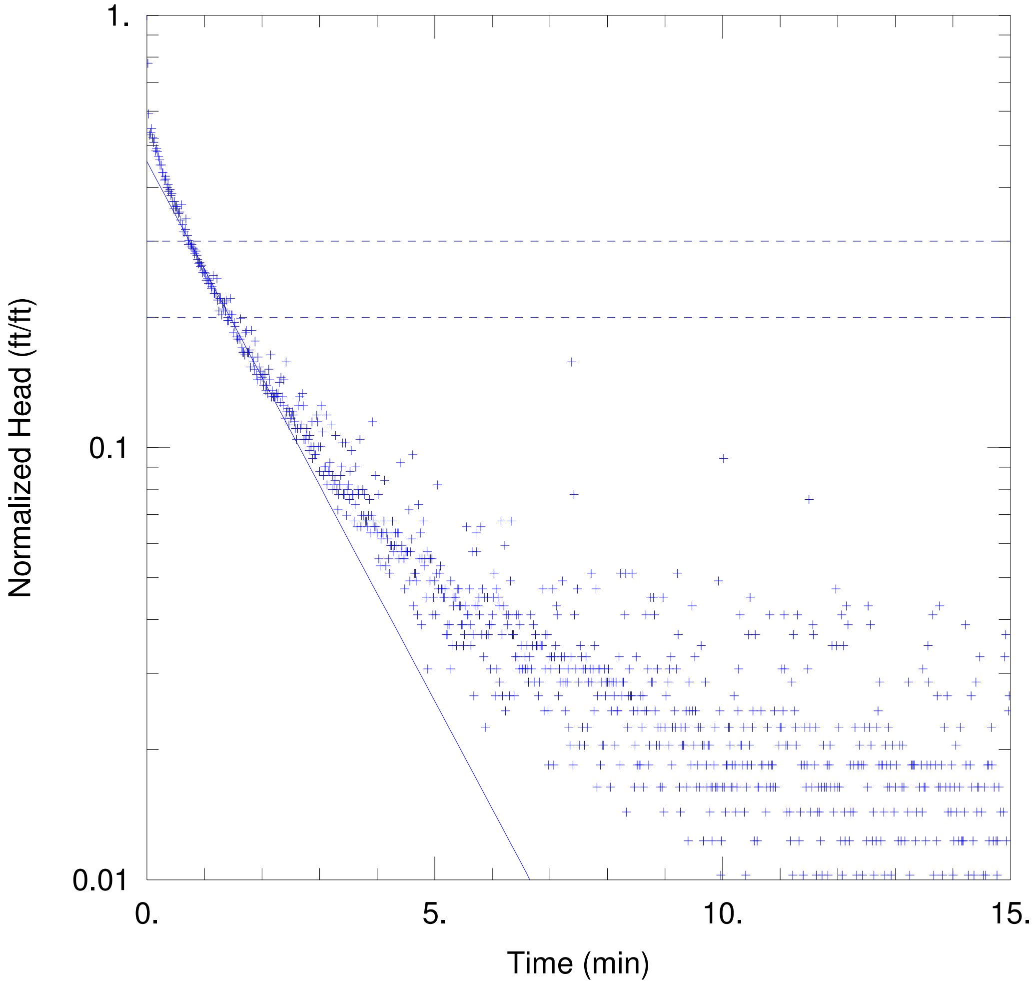
Saturated Thickness: 115.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (ML-1)

Initial Displacement: 1.71 ft
Static Water Column Height: 129.1 ft
Total Well Penetration Depth: 76.05 ft
Screen Length: 19. ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.286 ft/day
y0 = 1.515 ft



MW-100 SLUG B FALLING HEAD

Data Set: S:\...\MW-100_SlugBFallingHead_Kz.aqt
Date: 01/13/15
Time: 08:14:33

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-100
Test Date: 3 Nov 2012

AQUIFER DATA

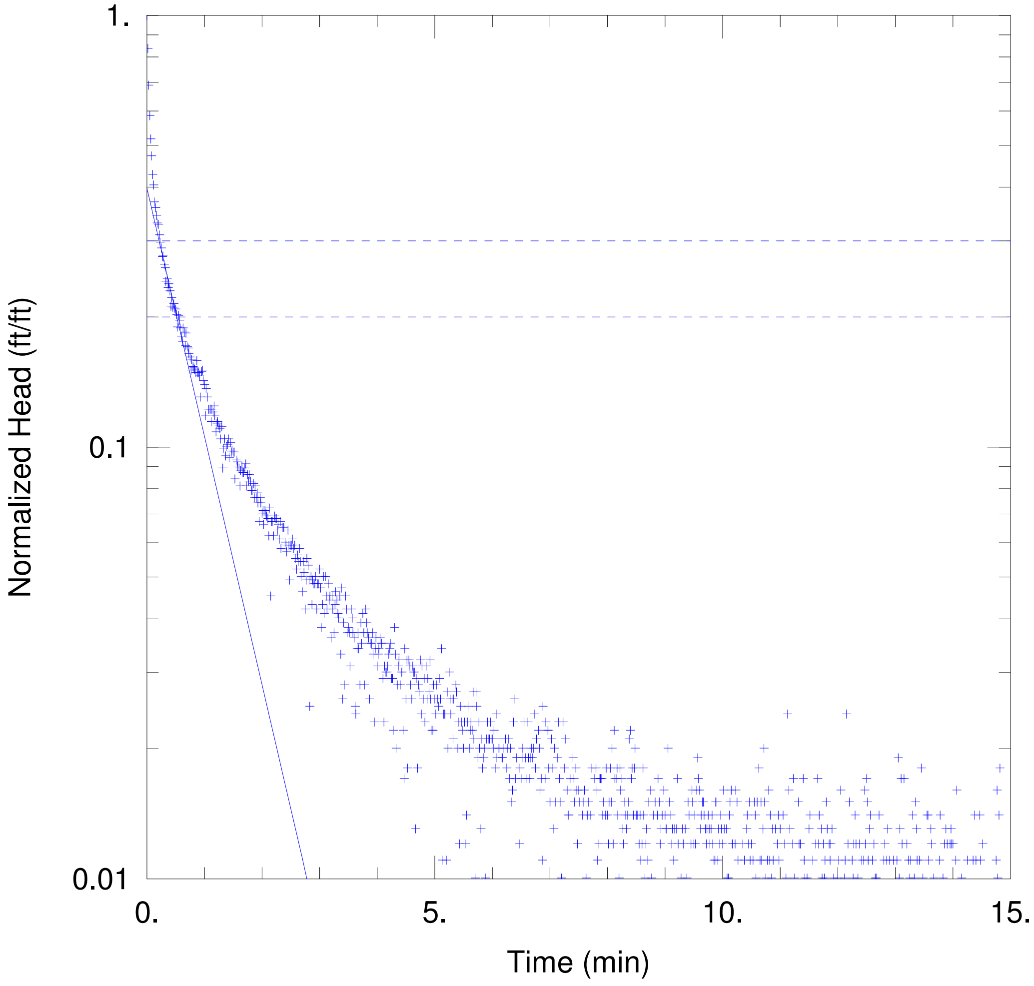
Saturated Thickness: 57.23 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-100)

Initial Displacement: 0.488 ft
Total Well Penetration Depth: 57.23 ft
Casing Radius: 0.167 ft
Static Water Column Height: 57.23 ft
Screen Length: 57.23 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.806 ft/day
y0 = 0.224 ft



MW-100 SLUG B RISING HEAD

Data Set: S:\...\MW-100_SlugBRisingHead_Kz.aqt
Date: 01/13/15 Time: 08:15:02

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-100
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 57.23 ft
Anisotropy Ratio (Kz/Kr): 0.1

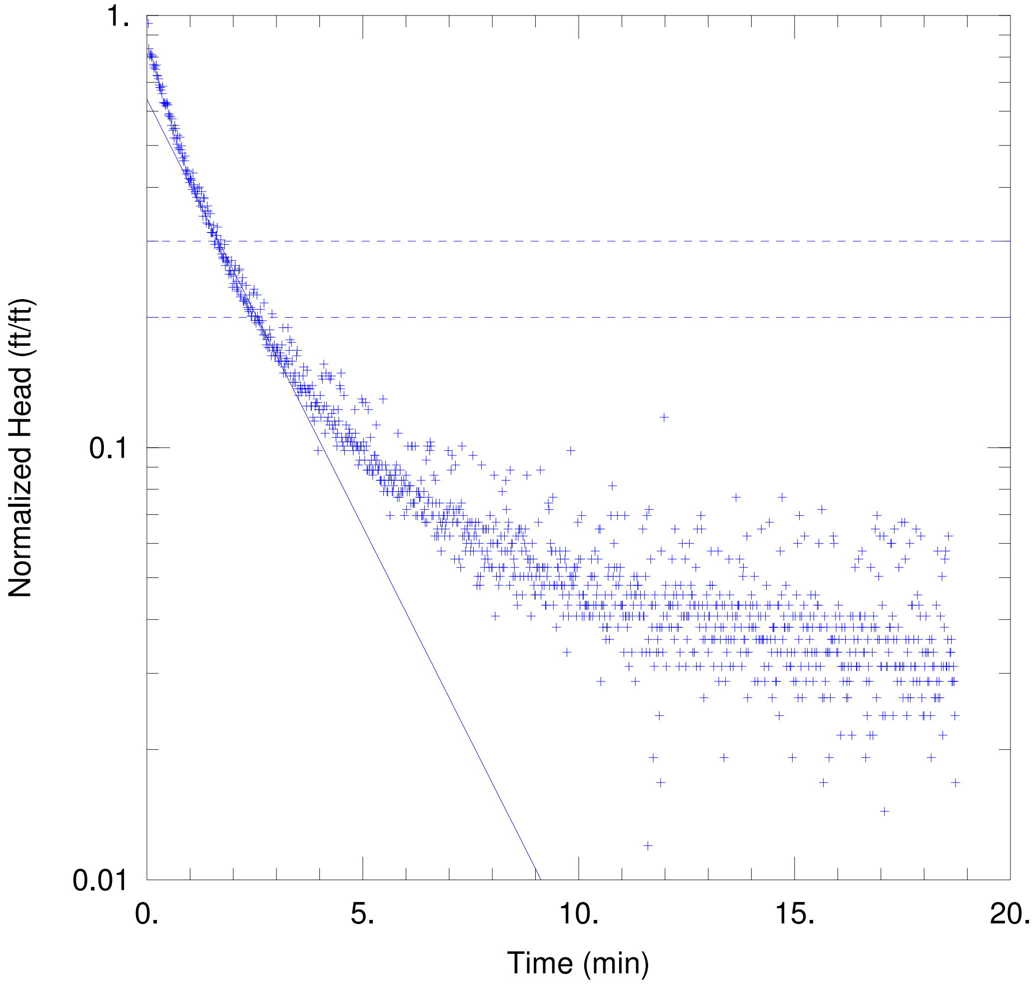
WELL DATA (MW-100)

Initial Displacement: 0.996 ft
Total Well Penetration Depth: 57.23 ft
Casing Radius: 0.167 ft
Static Water Column Height: 57.23 ft
Screen Length: 57.23 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.856 ft/day
y0 = 0.396 ft



MW-100 SLUG C FALLING HEAD

Data Set: S:\...\MW-100_SlugCFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:08:49

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-100
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 57.23 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-100)

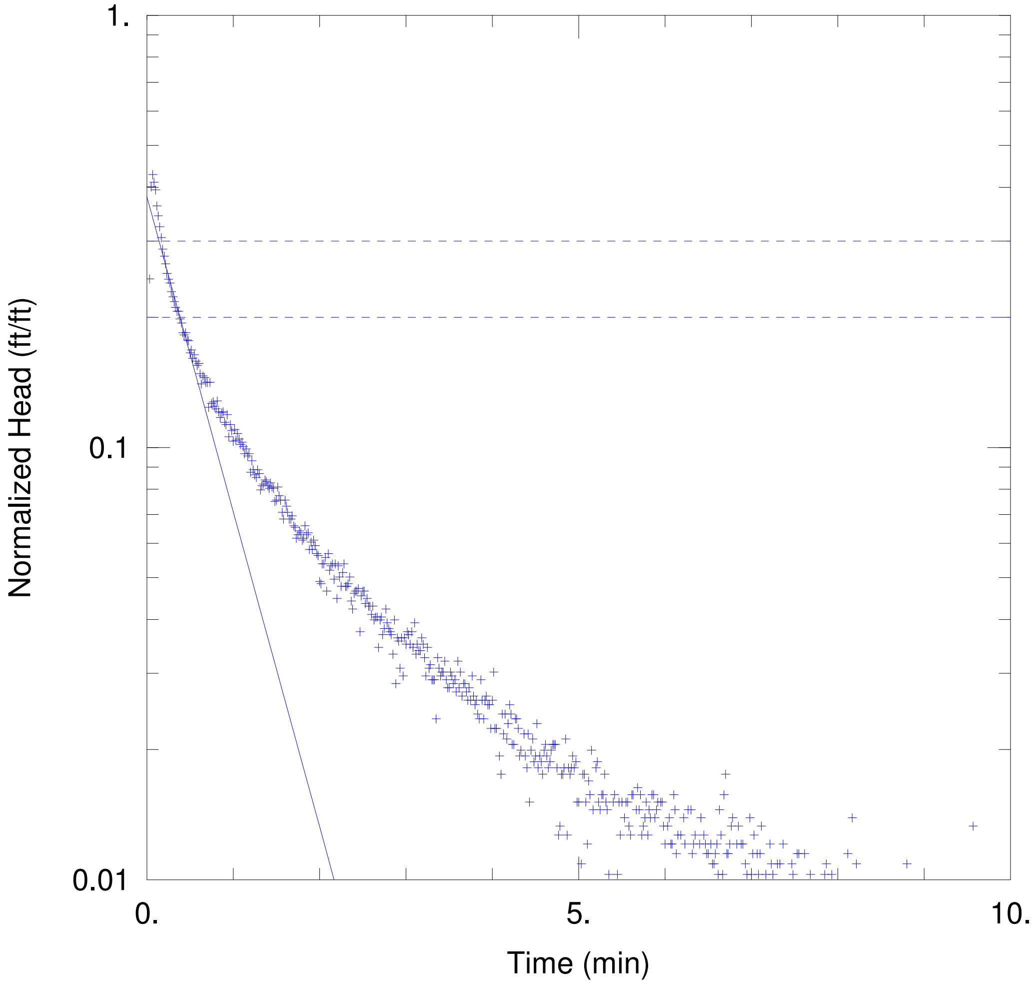
Initial Displacement: 0.417 ft
Total Well Penetration Depth: 57.23 ft
Casing Radius: 0.167 ft

Static Water Column Height: 57.23 ft
Screen Length: 57.23 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.6385 ft/day y0 = 0.2666 ft



MW-100 SLUG C RISING HEAD

Data Set: S:\...\MW-100_SlugCRisingHead_Kz.aqt
Date: 01/13/15 Time: 08:09:49

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-100
Test Date: 3 Nov 2012

AQUIFER DATA

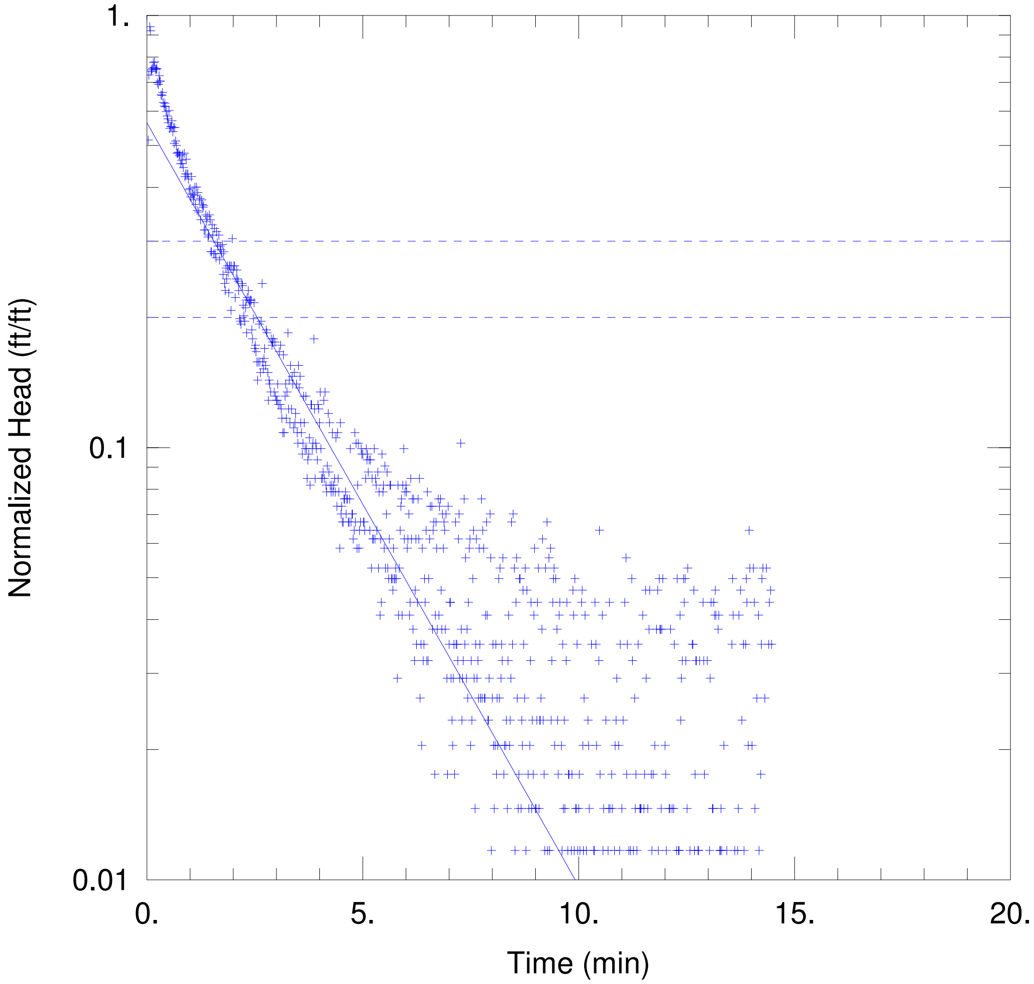
Saturated Thickness: 57.23 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-100)

Initial Displacement: 1.654 ft
Total Well Penetration Depth: 57.23 ft
Casing Radius: 0.167 ft
Static Water Column Height: 57.23 ft
Screen Length: 57.23 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.352 ft/day
y0 = 0.6285 ft



MW-100 SLUG F FALLING HEAD

Data Set: S:\...\MW-100_SlugFFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:10:48

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-100
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 57.23 ft
Anisotropy Ratio (Kz/Kr): 0.1

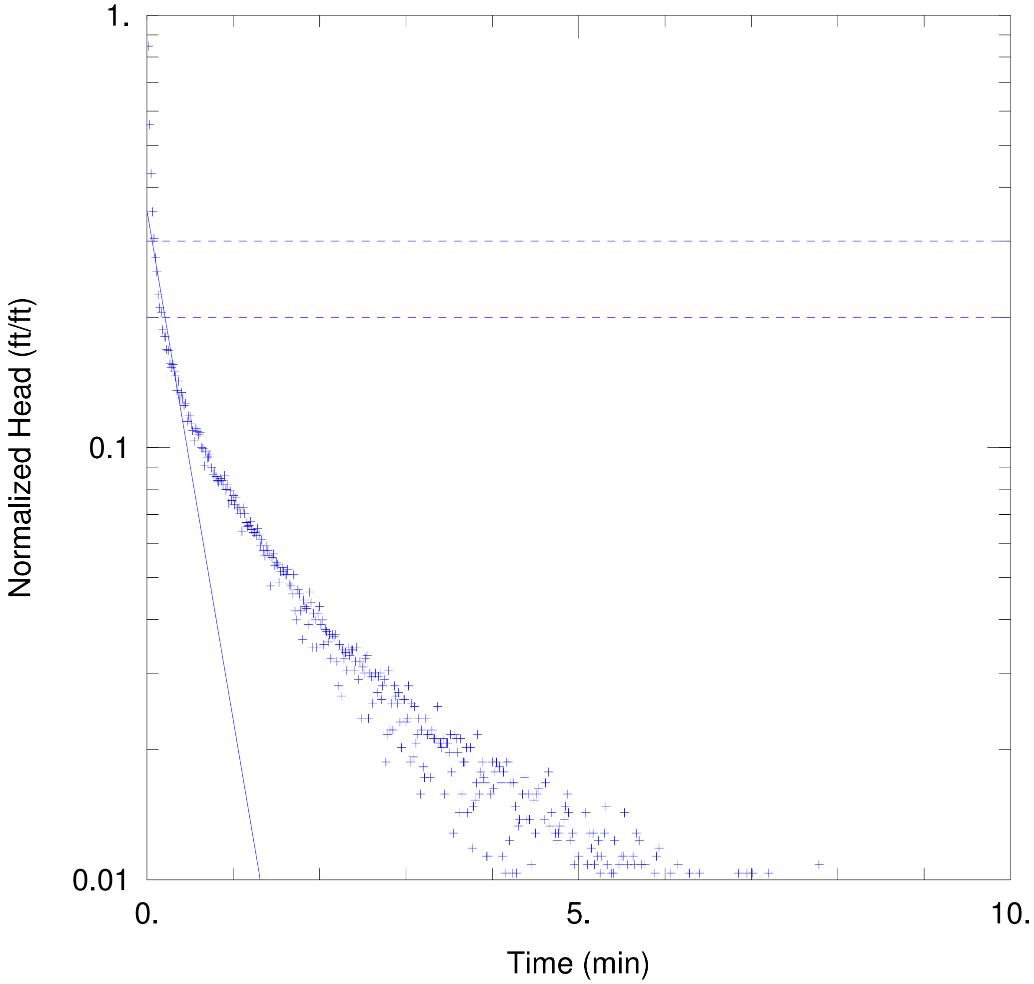
WELL DATA (MW-100)

Initial Displacement: 0.342 ft
Total Well Penetration Depth: 57.23 ft
Casing Radius: 0.167 ft
Static Water Column Height: 57.23 ft
Screen Length: 57.23 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.5697 ft/day
y0 = 0.1929 ft



MW-100 SLUG F RISING HEAD

Data Set: S:\...\MW-100_SlugFRisingHead_Kz.aqt
Date: 01/13/15 Time: 08:11:31

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-100
Test Date: 3 Nov 2012

AQUIFER DATA

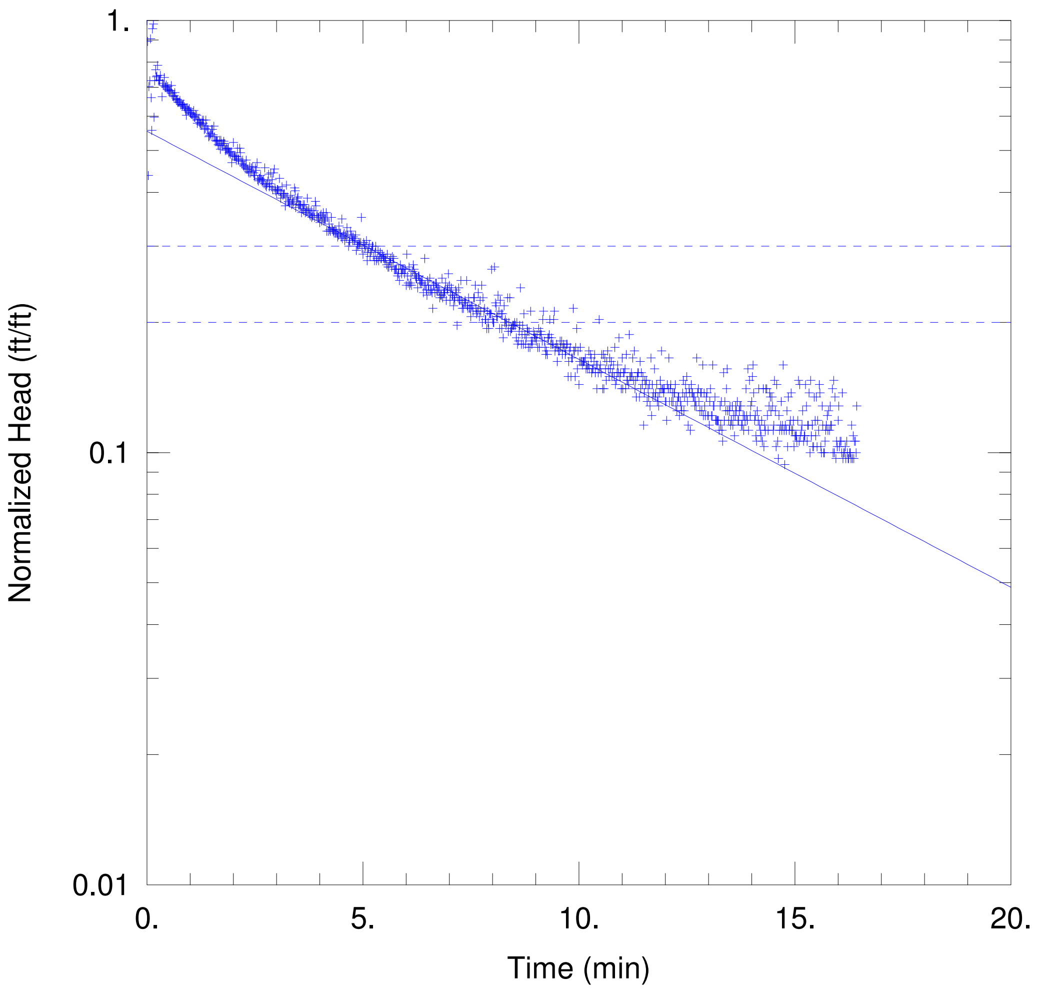
Saturated Thickness: 57.23 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-100)

Initial Displacement: 2.029 ft
Total Well Penetration Depth: 57.23 ft
Casing Radius: 0.167 ft
Static Water Column Height: 57.23 ft
Screen Length: 57.23 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.81 ft/day
y0 = 0.7185 ft



MW-101 SLUG A FALLING HEAD

Data Set: S:\...\MW-101_SlugAFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:18:26

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-101
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 9.765 ft
Anisotropy Ratio (Kz/Kr): 0.1

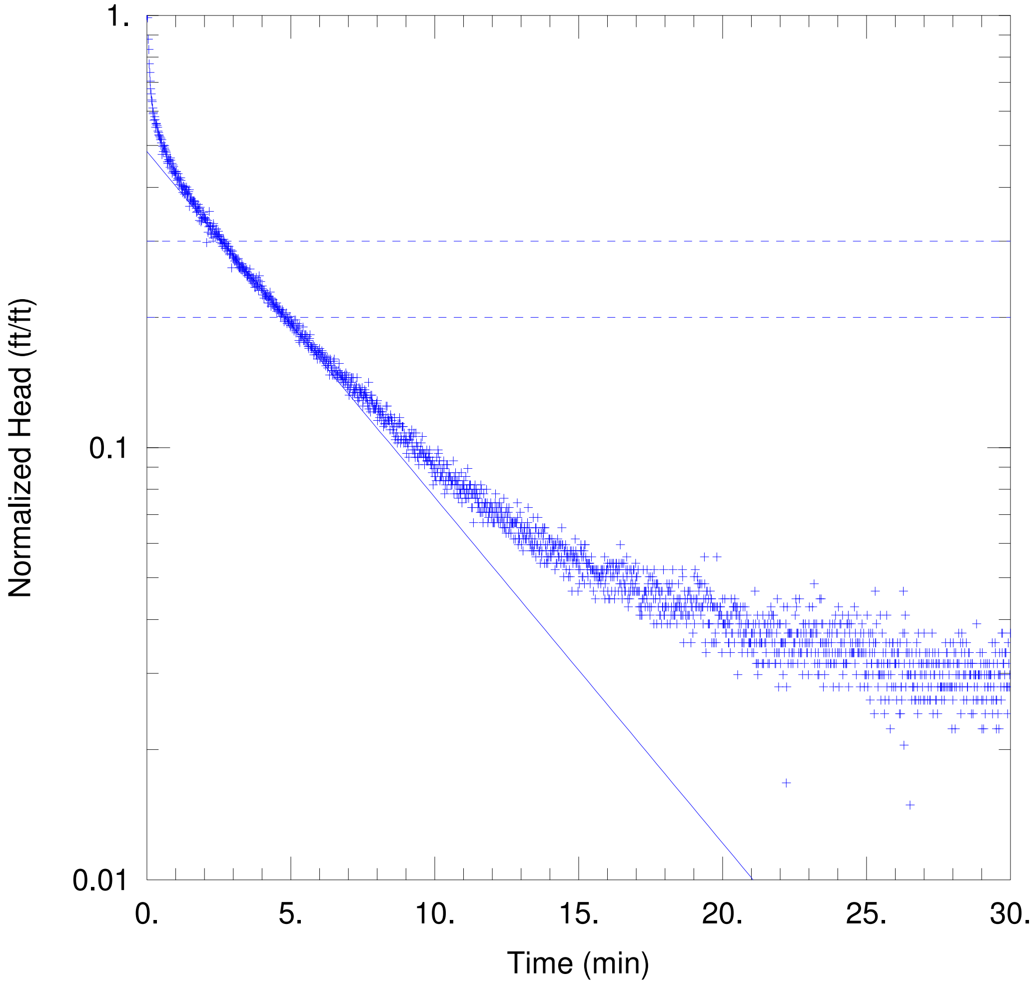
WELL DATA (MW-101)

Initial Displacement: 0.32 ft
Total Well Penetration Depth: 9.765 ft
Casing Radius: 0.167 ft
Static Water Column Height: 9.765 ft
Screen Length: 9.765 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.637 ft/day
y0 = 0.1772 ft



MW-101 SLUG A RISING HEAD

Data Set: S:\...\MW-101_SlugARisingHead_Kz.aqt
Date: 01/13/15 Time: 08:19:17

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-101
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 9.765 ft
Anisotropy Ratio (Kz/Kr): 0.1

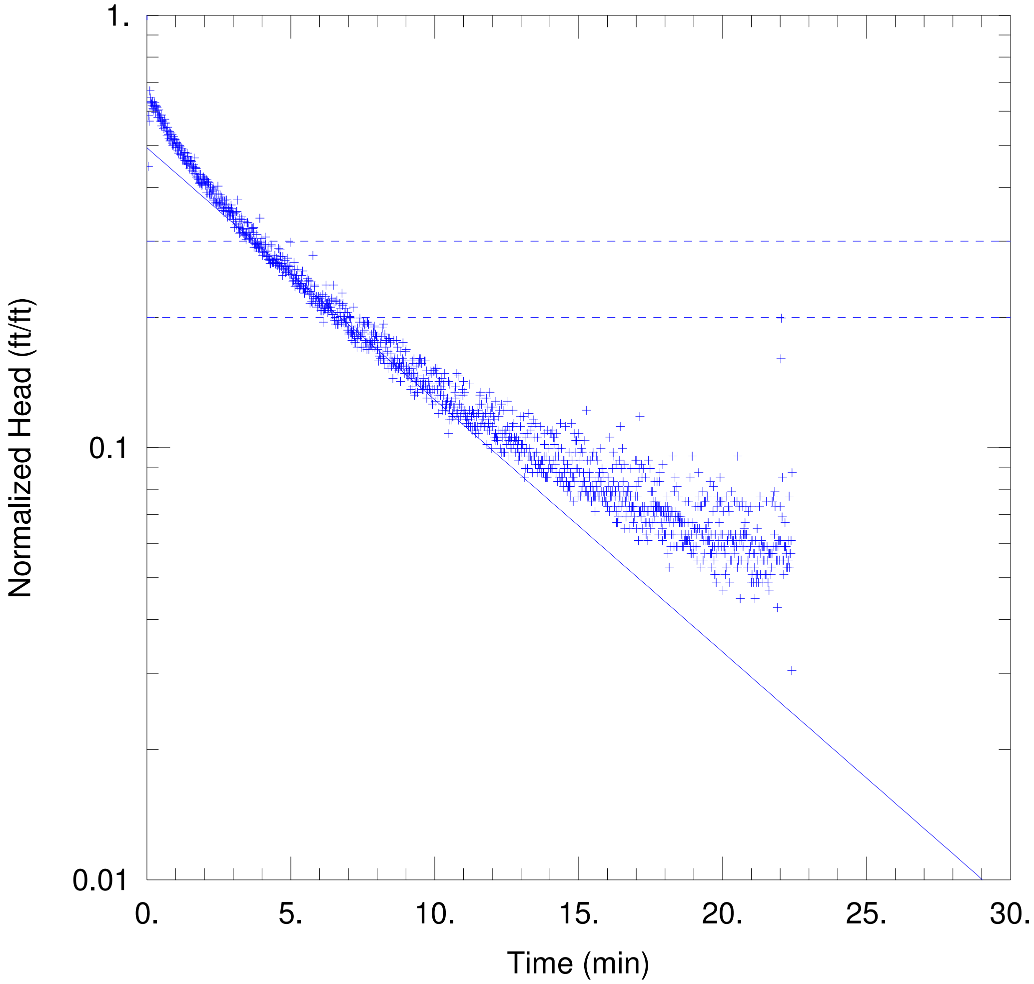
WELL DATA (MW-101)

Initial Displacement: 0.537 ft
Total Well Penetration Depth: 9.765 ft
Casing Radius: 0.167 ft
Static Water Column Height: 9.765 ft
Screen Length: 9.765 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.9664 ft/day
y0 = 0.26 ft



MW-101 SLUG G FALLING HEAD

Data Set: S:\...\MW-101_SlugGFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:23:13

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-101
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 9.765 ft
Anisotropy Ratio (Kz/Kr): 0.1

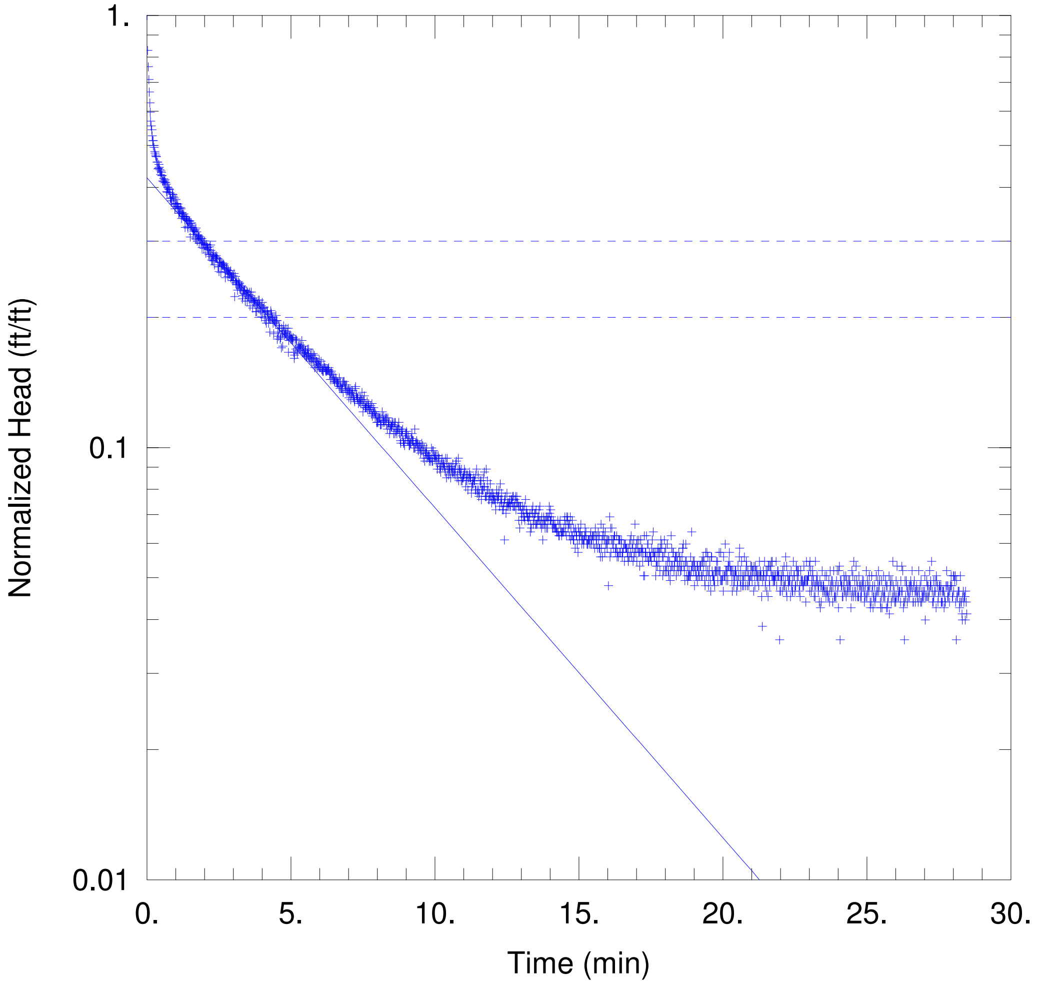
WELL DATA (MW-101)

Initial Displacement: 0.492 ft
Total Well Penetration Depth: 9.765 ft
Casing Radius: 0.167 ft
Static Water Column Height: 9.765 ft
Screen Length: 9.765 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.7047 ft/day
y0 = 0.2431 ft



MW-101 SLUG G RISING HEAD

Data Set: S:\...\MW-101_SlugGRisingHead_Kz.aqt
Date: 01/13/15 Time: 08:24:58

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-101
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 9.765 ft
Anisotropy Ratio (Kz/Kr): 0.1

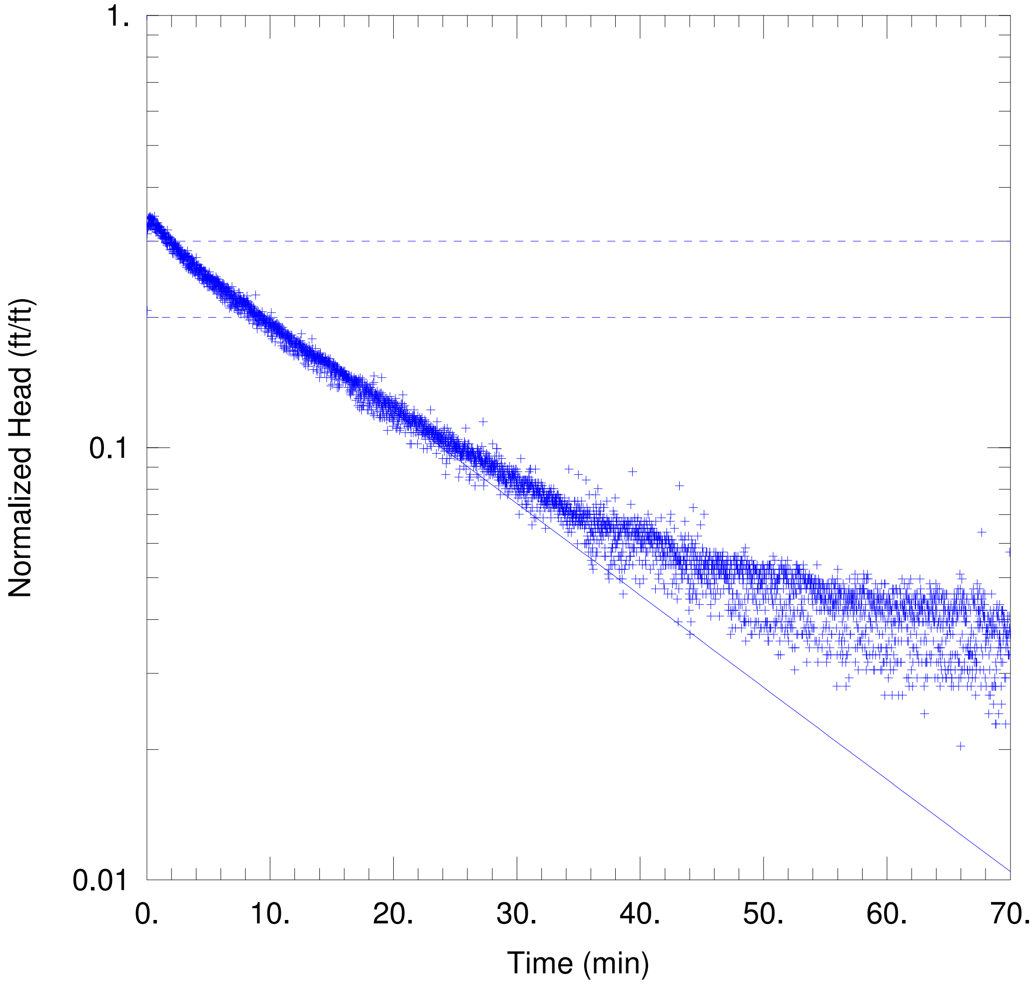
WELL DATA (MW-101)

Initial Displacement: 0.752 ft
Static Water Column Height: 9.765 ft
Total Well Penetration Depth: 9.765 ft
Screen Length: 9.765 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.9221 ft/day
y0 = 0.3164 ft



MW-102 SLUG A FALLING HEAD

Data Set: S:\...\MW-102_SlugAFallingHead_Kz.aqt
Date: 01/13/15
Time: 08:26:53

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 9.233 ft
Anisotropy Ratio (Kz/Kr): 0.1

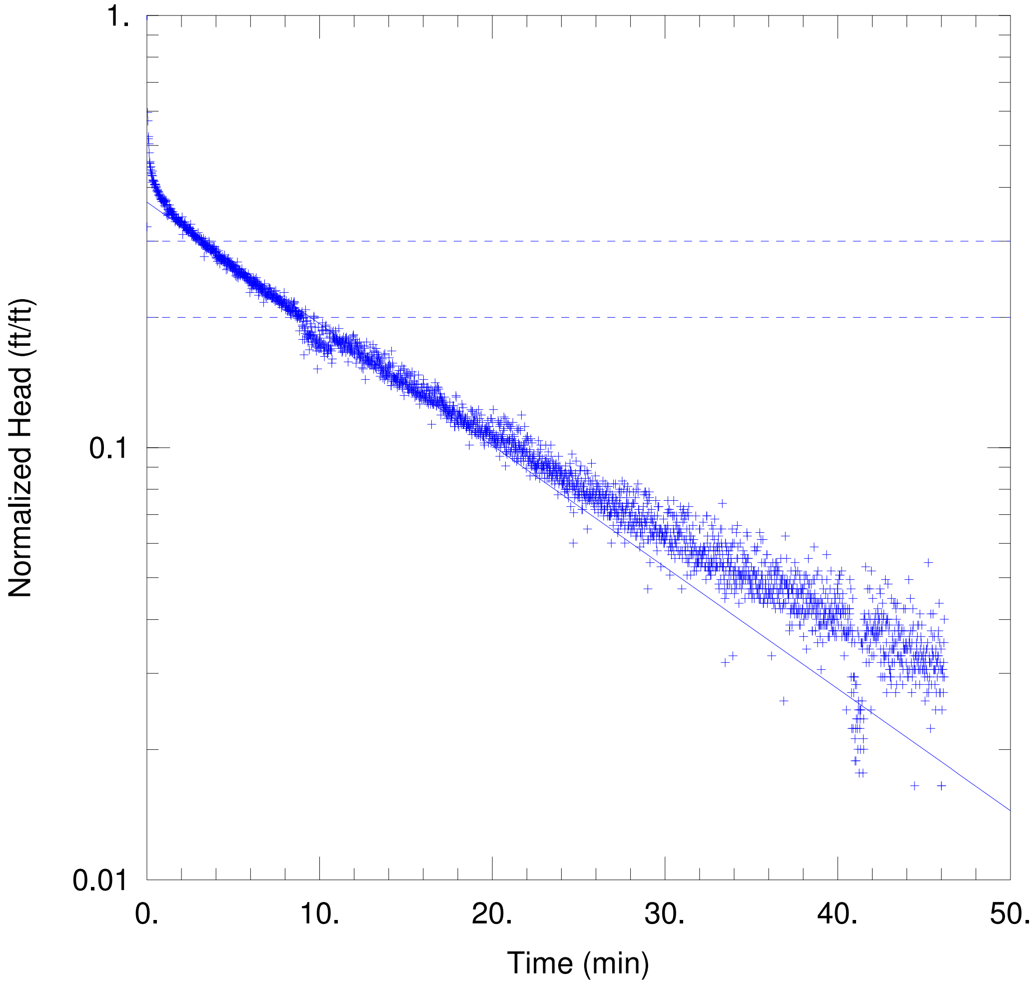
WELL DATA (MW-102)

Initial Displacement: 0.785 ft
Total Well Penetration Depth: 9.233 ft
Casing Radius: 0.167 ft
Static Water Column Height: 9.233 ft
Screen Length: 9.233 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.2671 ft/day
y0 = 0.2541 ft



MW-102 SLUG A RISING HEAD

Data Set: S:\...\MW-102_SlugARisingHead_Kz.aqt
Date: 01/13/15 Time: 08:27:36

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 9.233 ft
Anisotropy Ratio (Kz/Kr): 0.1

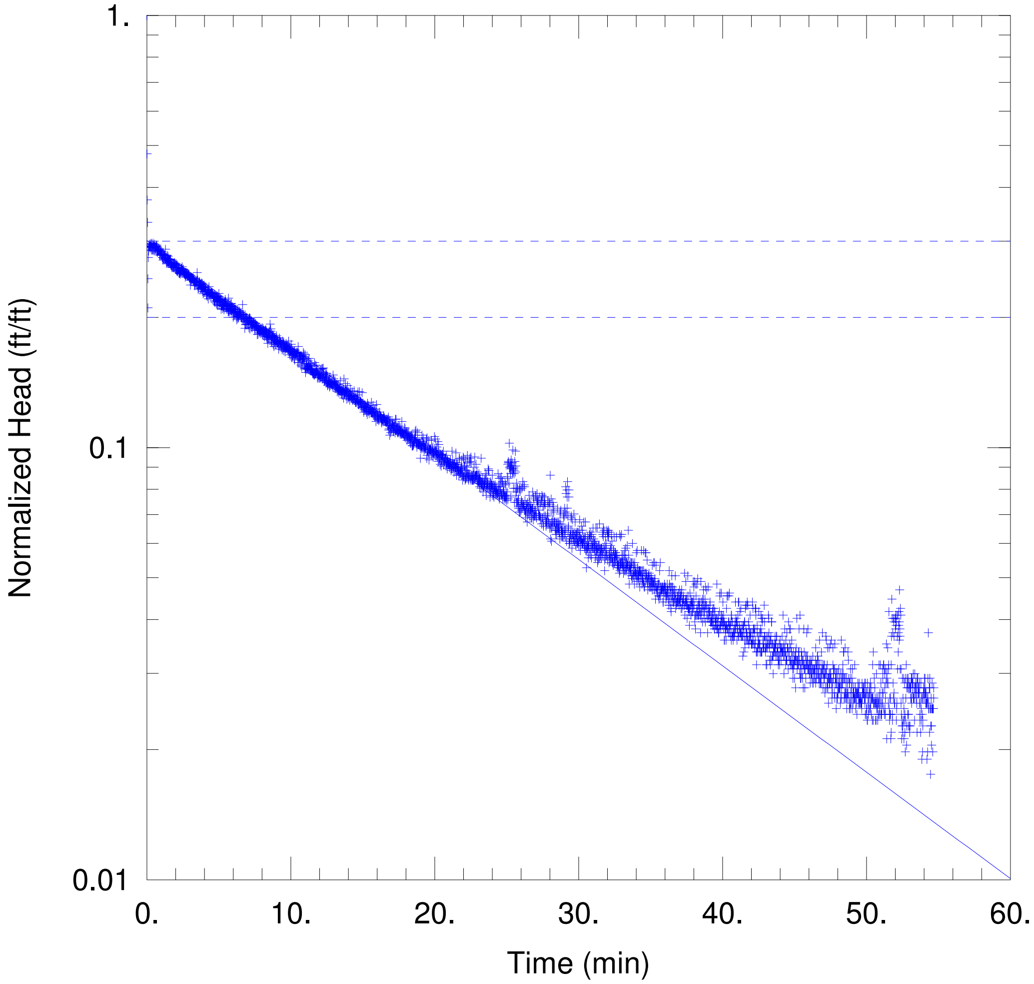
WELL DATA (MW-102)

Initial Displacement: 0.849 ft
Total Well Penetration Depth: 9.233 ft
Casing Radius: 0.167 ft
Static Water Column Height: 9.233 ft
Screen Length: 9.233 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3529 ft/day
y0 = 0.3139 ft



MW-102 SLUG F FALLING HEAD

Data Set: S:\...\MW-102_SlugFFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:28:39

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 9.233 ft
Anisotropy Ratio (Kz/Kr): 0.1

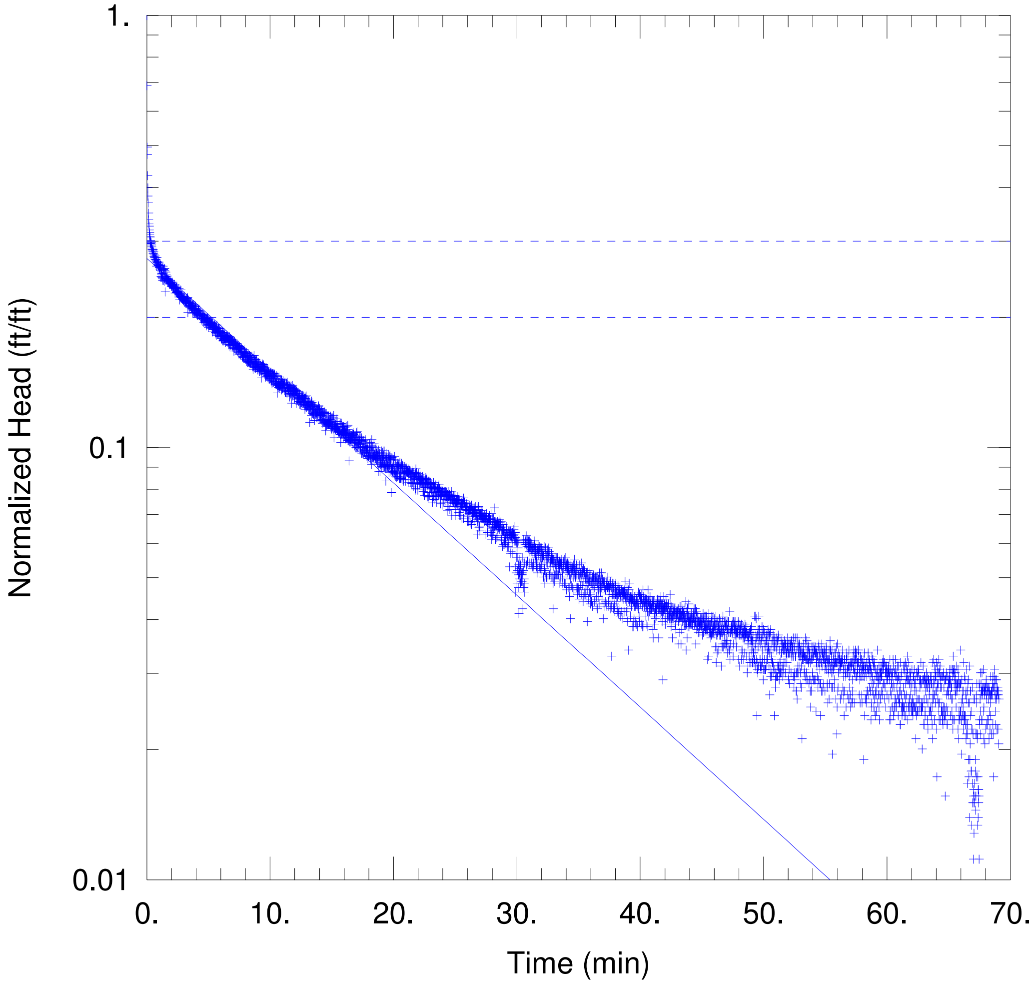
WELL DATA (MW-102)

Initial Displacement: 1.367 ft
Total Well Penetration Depth: 9.233 ft
Casing Radius: 0.167 ft
Static Water Column Height: 9.233 ft
Screen Length: 9.233 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3085 ft/day
y0 = 0.412 ft



MW-102 SLUG F RISING HEAD

Data Set: S:\...\MW-102_SlugFRisingHead_Kz.aqt
Date: 01/13/15 Time: 08:29:20

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102
Test Date: 3 Nov 2012

AQUIFER DATA

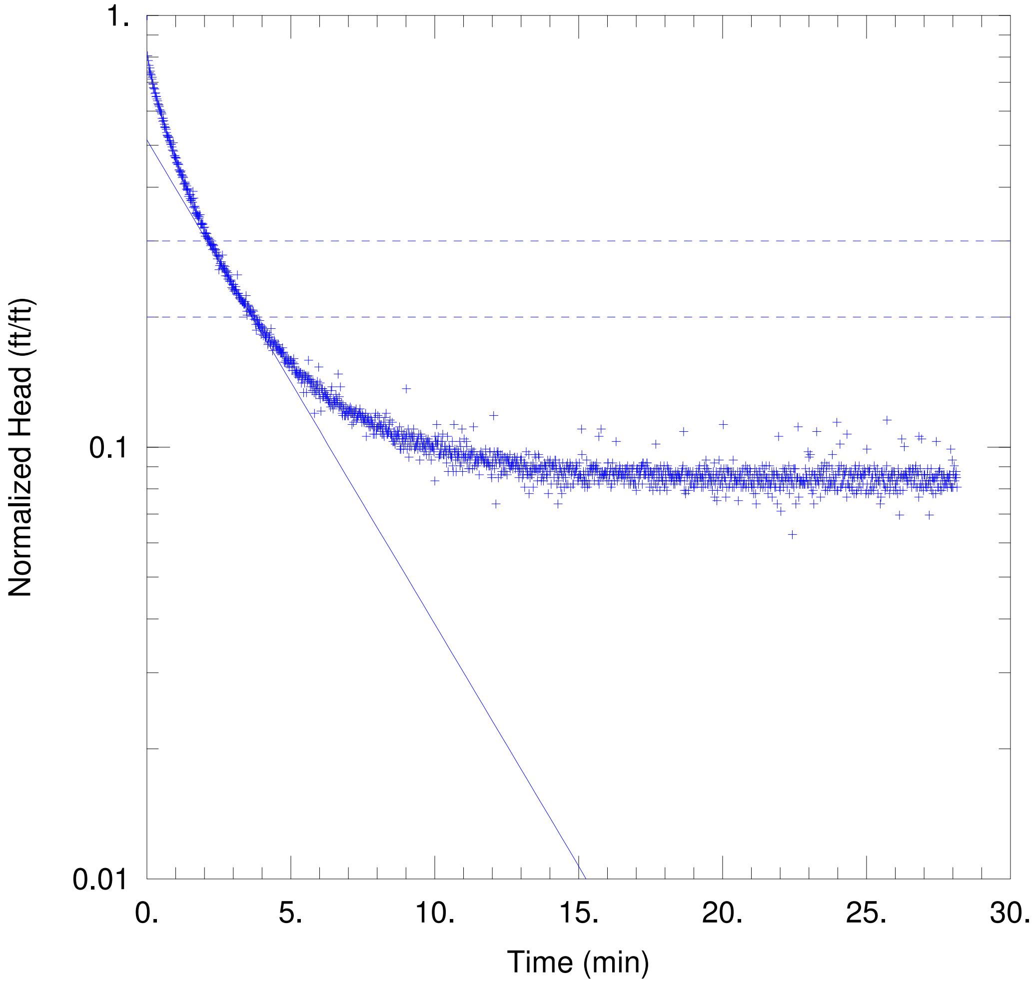
Saturated Thickness: 9.233 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-102)

Initial Displacement: 1.793 ft
Total Well Penetration Depth: 9.233 ft
Casing Radius: 0.167 ft
Static Water Column Height: 9.233 ft
Screen Length: 9.233 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.3254 ft/day
y0 = 0.491 ft



MW-102DB SLUG A FALLING HEAD

Data Set: S:\...\MW-102DB_SlugAFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:31:13

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102DB
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 50.28 ft Anisotropy Ratio (Kz/Kr): 0.1

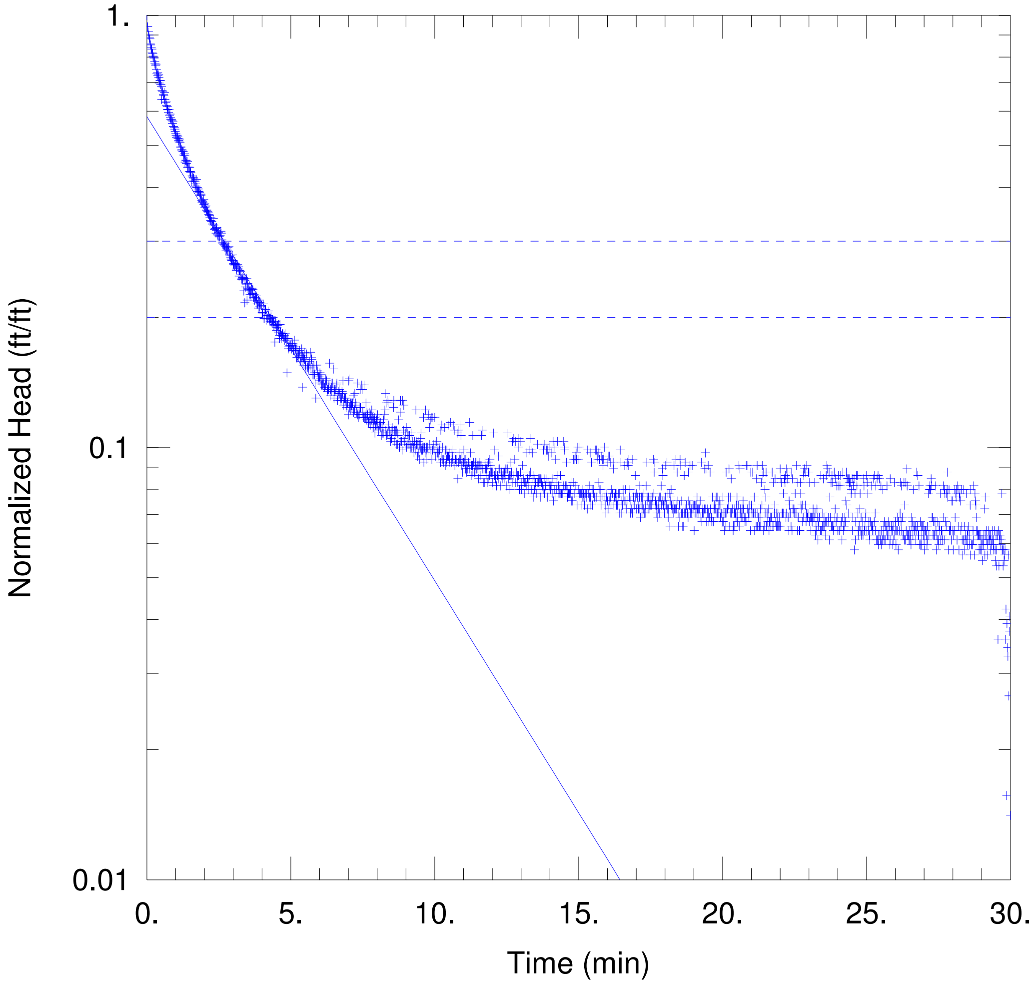
WELL DATA (MW-102DB)

Initial Displacement: 0.718 ft
Total Well Penetration Depth: 49.88 ft
Casing Radius: 0.167 ft
Static Water Column Height: 50.28 ft
Screen Length: 30. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.8231 ft/day y0 = 0.3693 ft



MW-102DB SLUG A RISING HEAD

Data Set: S:\...\MW-102DB_SlugARisingHead_Kz.aqt
Date: 01/13/15
Time: 08:31:27

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102DB
Test Date: 3 Nov 2012

AQUIFER DATA

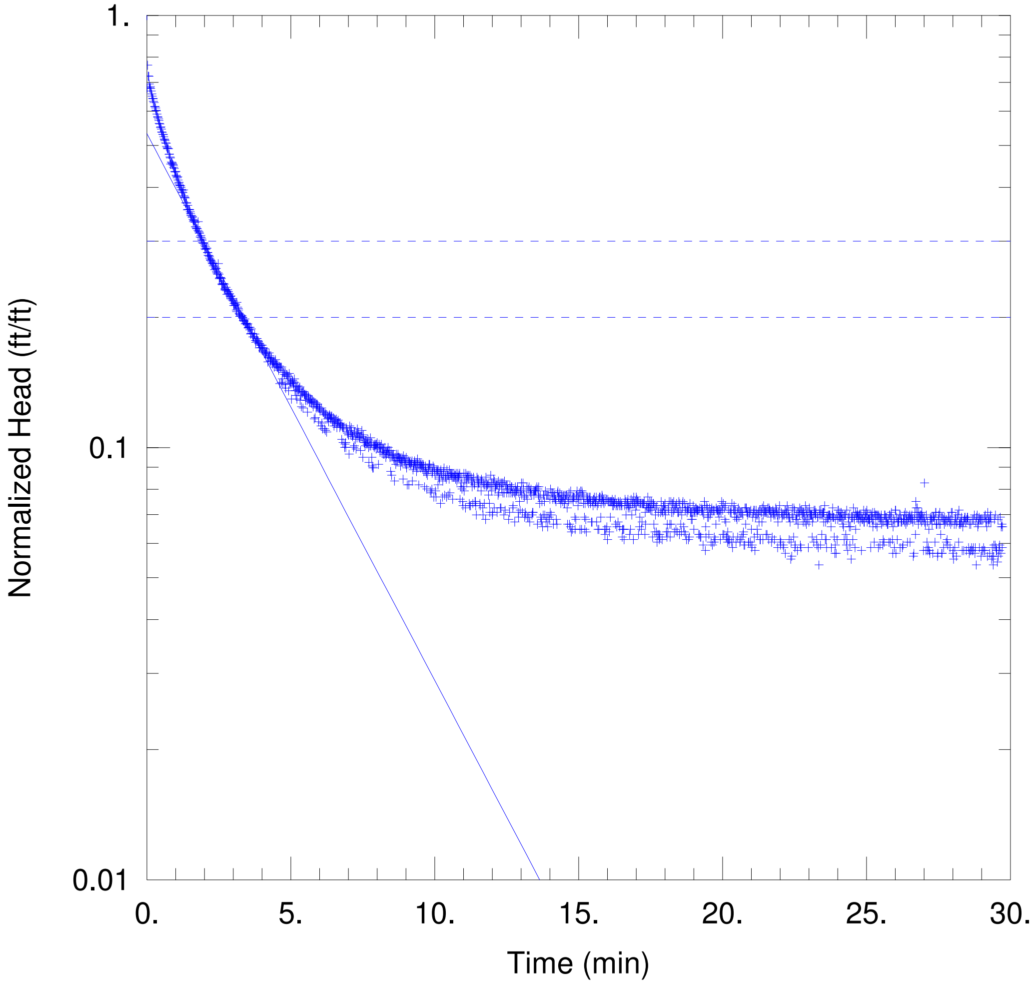
Saturated Thickness: 50.28 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-102DB)

Initial Displacement: 0.638 ft
Total Well Penetration Depth: 49.88 ft
Casing Radius: 0.167 ft
Static Water Column Height: 50.28 ft
Screen Length: 30. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.7887 ft/day
y0 = 0.3721 ft



MW-102DB SLUG B FALLING HEAD

Data Set: S:\...\MW-102DB_SlugBFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:31:56

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102DB
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 50.28 ft
Anisotropy Ratio (Kz/Kr): 0.1

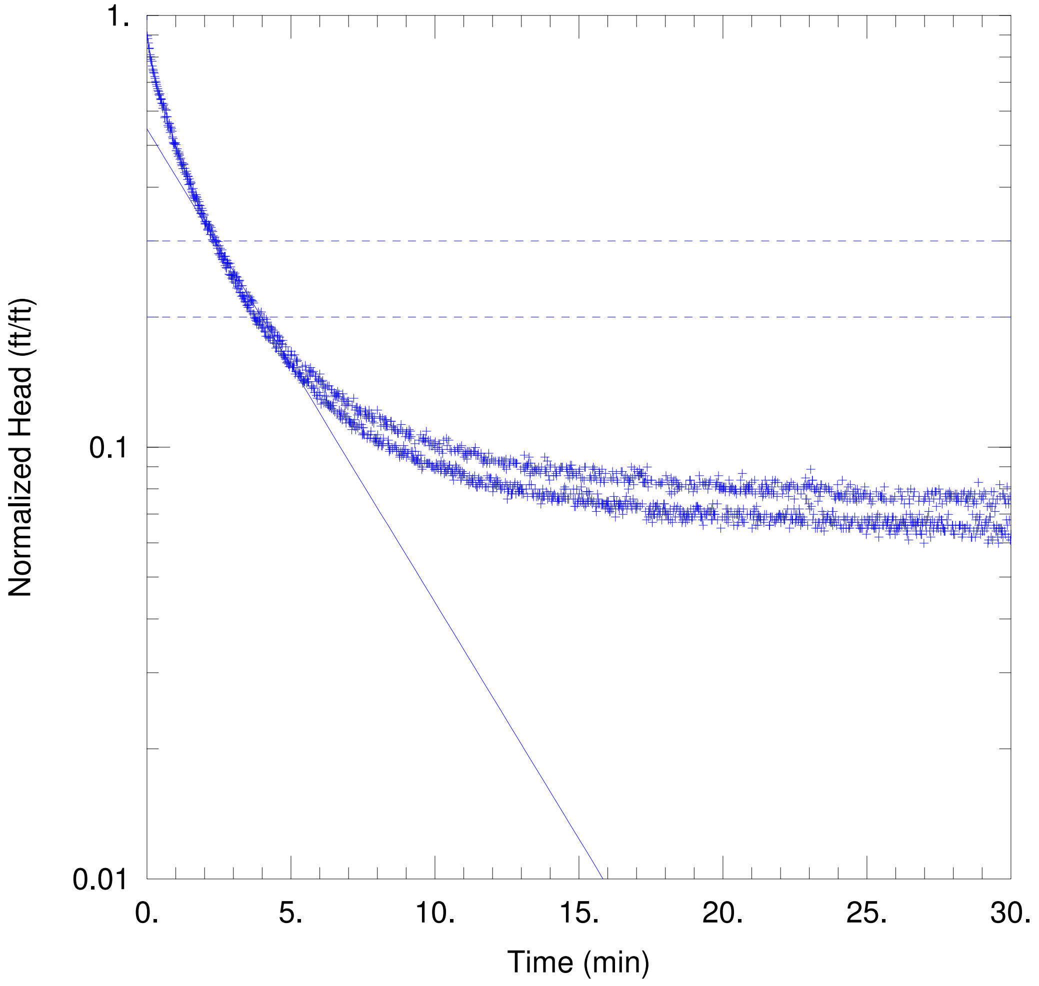
WELL DATA (MW-102DB)

Initial Displacement: 1.159 ft
Static Water Column Height: 50.28 ft
Total Well Penetration Depth: 49.88 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.9288 ft/day
y0 = 0.6169 ft



MW-102DB SLUG B RISING HEAD

Data Set: S:\...\MW-102DB_SlugBRisingHead_Kz.aqt
Date: 01/13/15 Time: 08:32:34

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102DB
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 50.28 ft
Anisotropy Ratio (Kz/Kr): 0.1

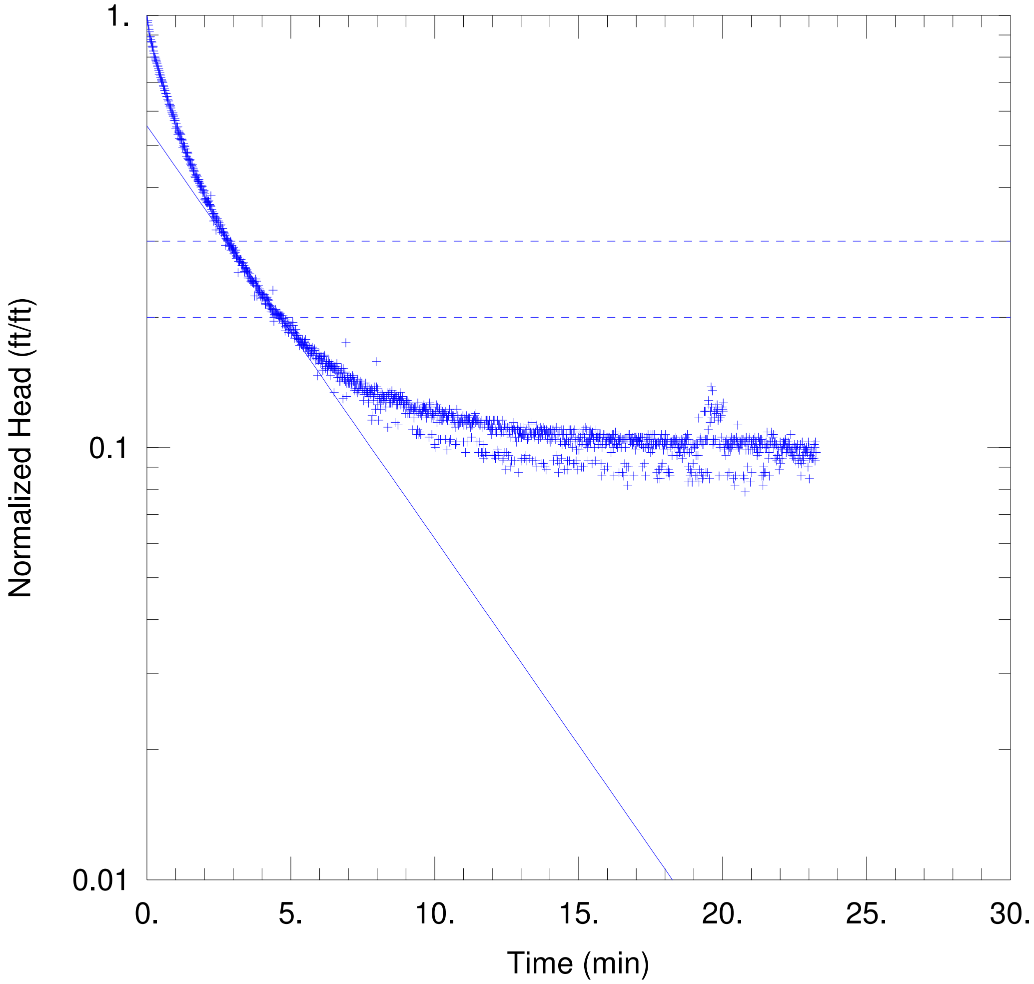
WELL DATA (MW-102DB)

Initial Displacement: 1.002 ft
Static Water Column Height: 50.28 ft
Total Well Penetration Depth: 49.88 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.805 ft/day
y0 = 0.5466 ft



MW-102DB SLUG G FALLING HEAD

Data Set: S:\...\MW-102DB_SlugGFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:33:42

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102DB
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 50.28 ft
Anisotropy Ratio (Kz/Kr): 0.1

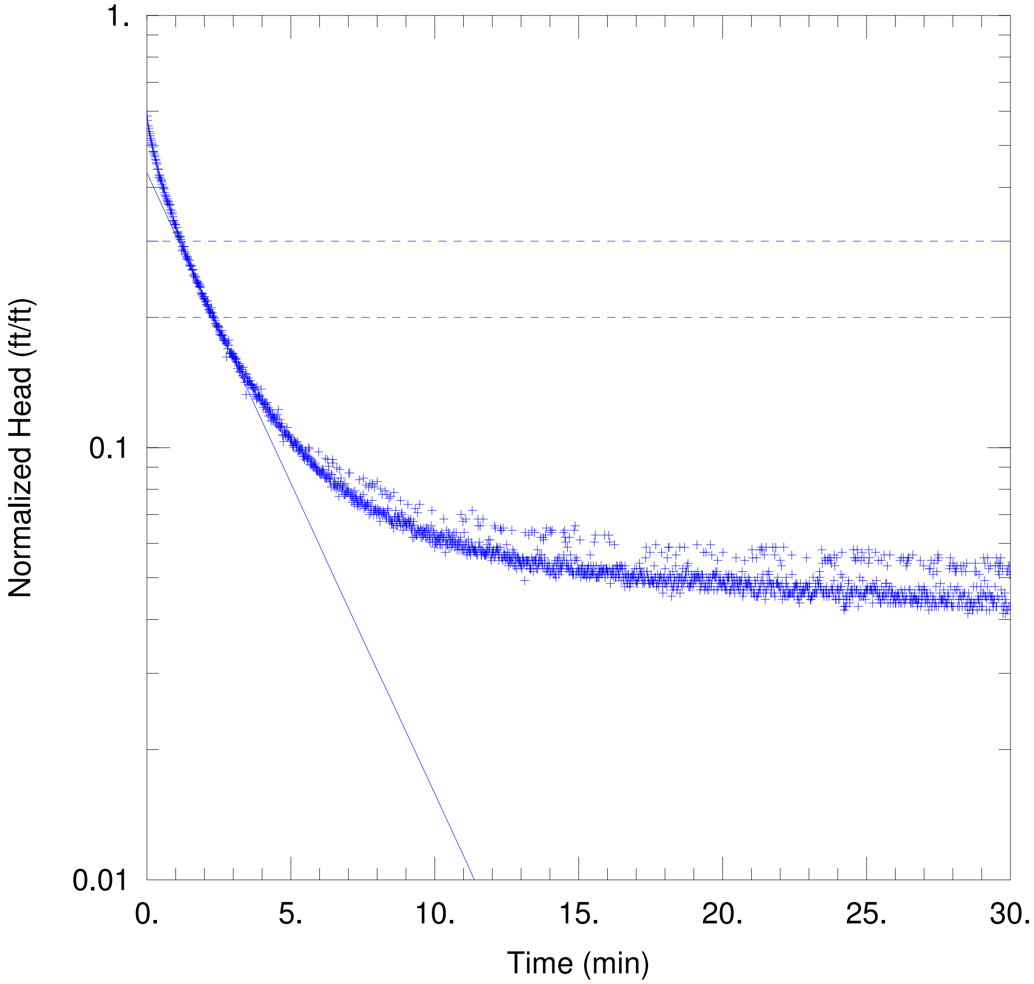
WELL DATA (MW-102DB)

Initial Displacement: 0.709 ft
Total Well Penetration Depth: 49.88 ft
Casing Radius: 0.167 ft
Static Water Column Height: 50.28 ft
Screen Length: 30. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.7015 ft/day
y0 = 0.3936 ft



MW-102DB SLUG G RISING HEAD

Data Set: S:\...\MW-102DB_SlugGRisingHead_Kz.aqt
Date: 01/13/15 Time: 08:33:59

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-102DB
Test Date: 3 Nov 2012

AQUIFER DATA

Saturated Thickness: 50.28 ft
Anisotropy Ratio (Kz/Kr): 0.1

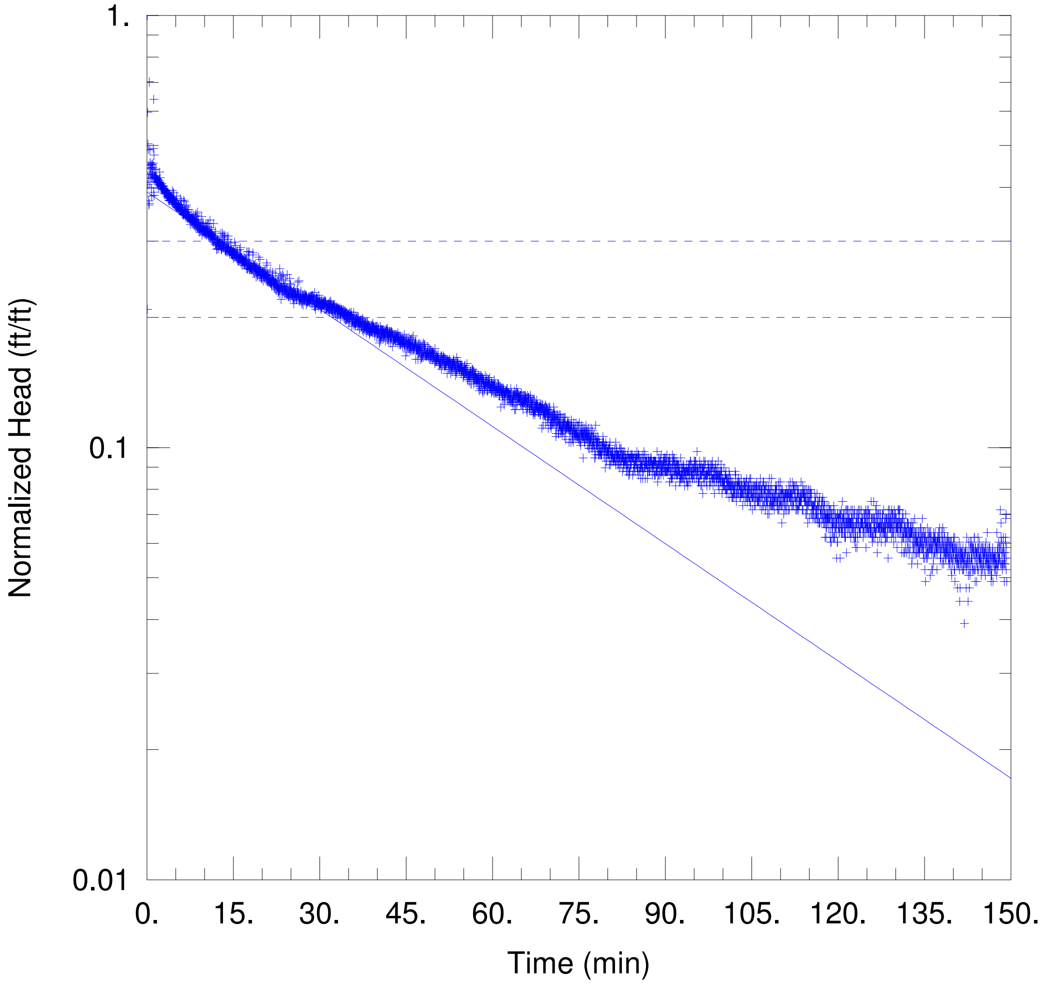
WELL DATA (MW-102DB)

Initial Displacement: 1.259 ft
Static Water Column Height: 50.28 ft
Total Well Penetration Depth: 49.88 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.055 ft/day
y0 = 0.5441 ft



MW-103 SLUG A FALLING HEAD

Data Set: S:\...\MW-103_SlugAFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:37:30

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-103
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 27.75 ft Anisotropy Ratio (Kz/Kr): 0.1

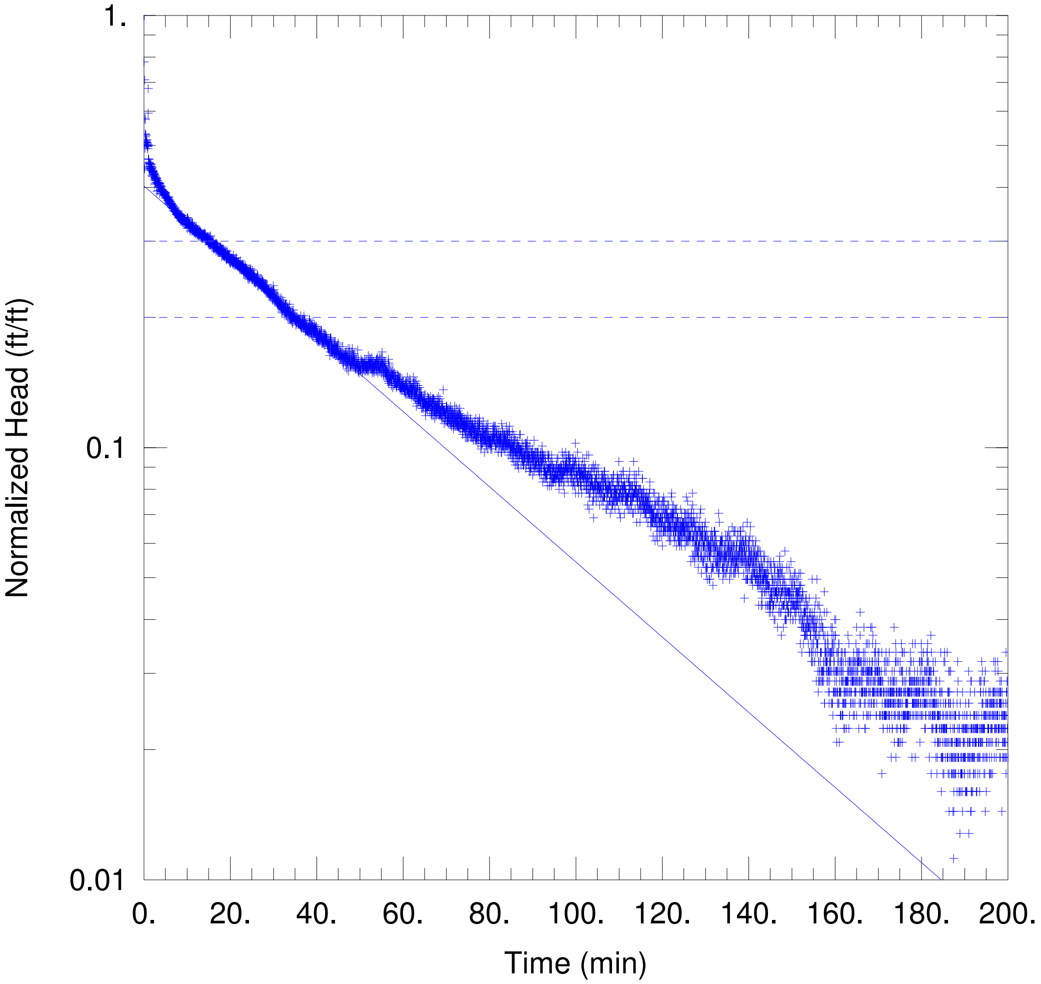
WELL DATA (MW-103)

Initial Displacement: 0.613 ft
Total Well Penetration Depth: 27.75 ft
Casing Radius: 0.167 ft
Static Water Column Height: 27.75 ft
Screen Length: 27.75 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.05122 ft/day y0 = 0.2392 ft



MW-103 SLUG A RISING HEAD

Data Set: S:\...\MW-103_SlugARisingHead_Kz.aqt
Date: 01/13/15 Time: 09:41:21

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-103
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 27.75 ft
Anisotropy Ratio (Kz/Kr): 0.1

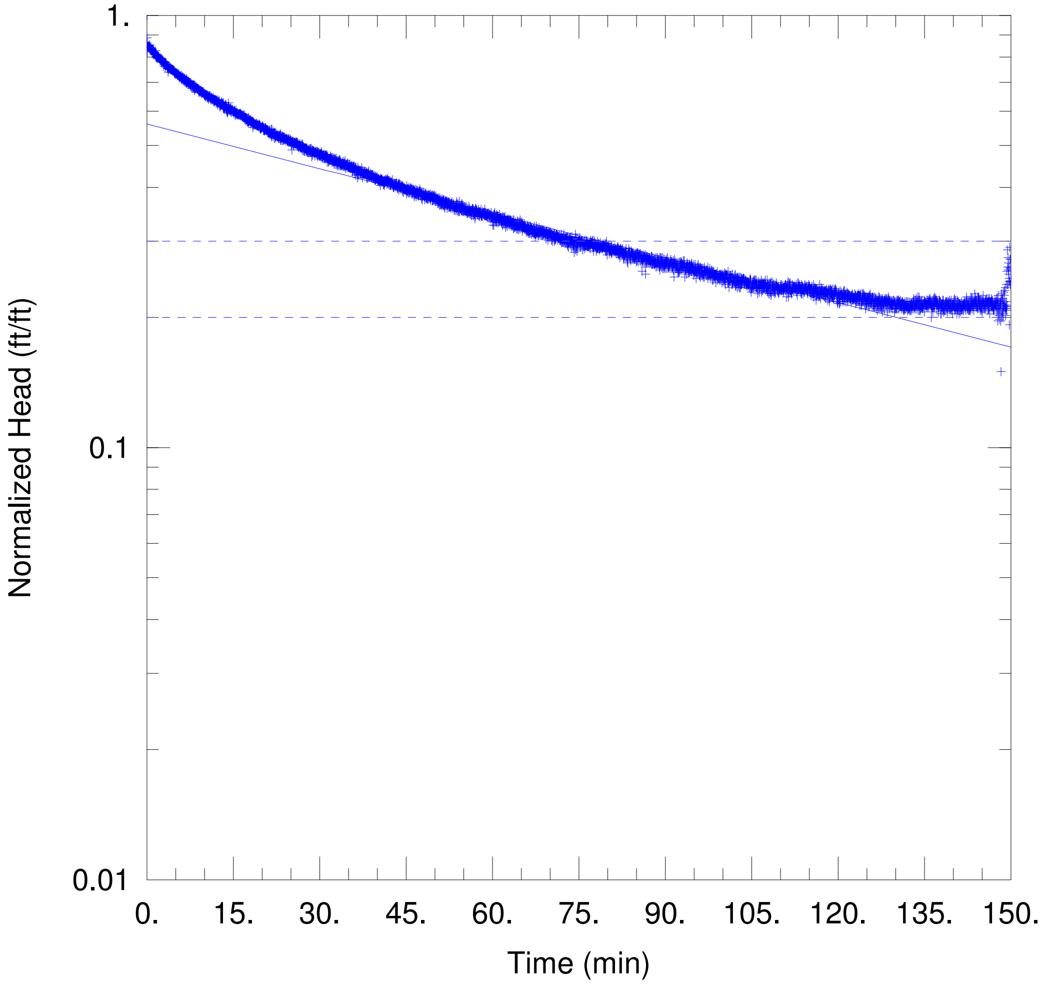
WELL DATA (MW-103)

Initial Displacement: 0.625 ft
Total Well Penetration Depth: 27.75 ft
Casing Radius: 0.167 ft
Static Water Column Height: 27.75 ft
Screen Length: 27.75 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.04926 ft/day
y0 = 0.2516 ft



MW-103 SLUG F FALLING HEAD

Data Set: S:\...\MW-103_SlugFFallingHead_Kz.aqt
Date: 01/13/15 Time: 08:39:43

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-103
Test Date: 4 Nov 2012

AQUIFER DATA

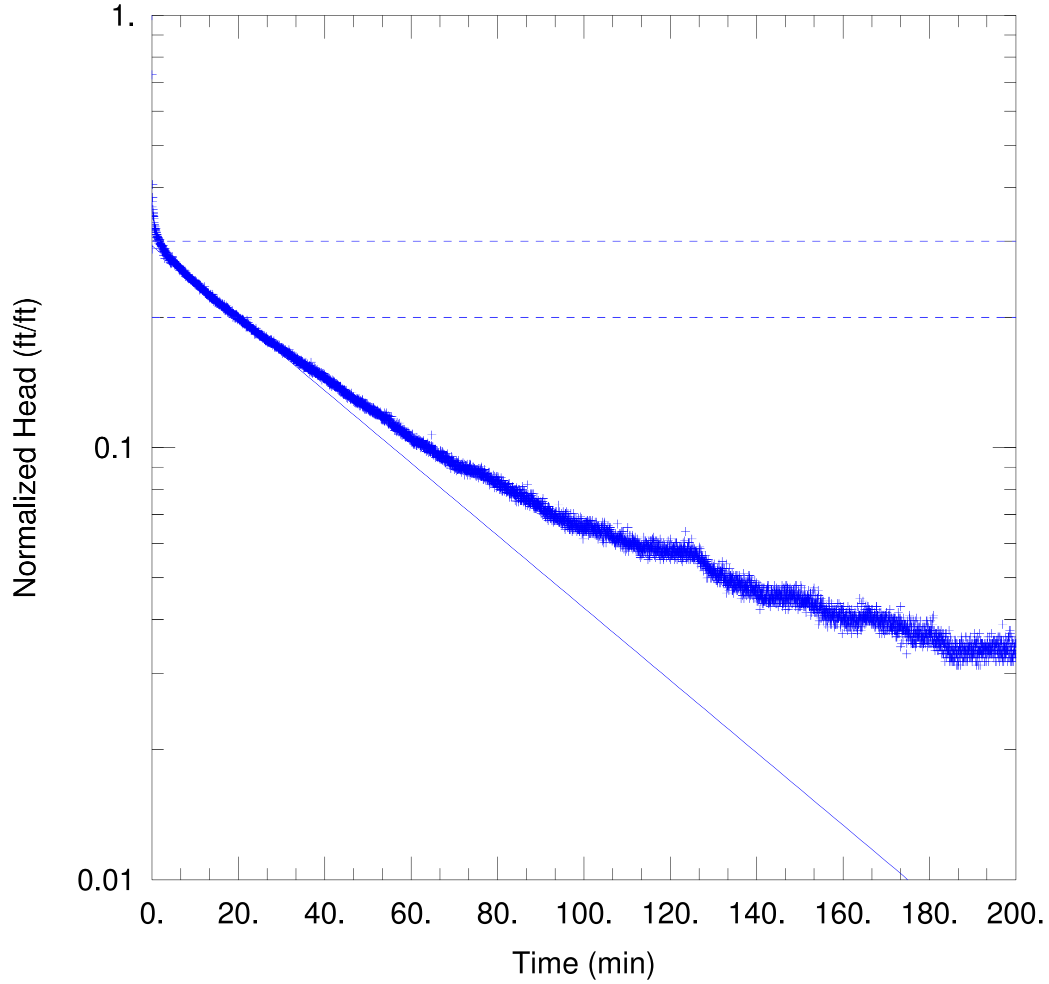
Saturated Thickness: 27.75 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-103)

Initial Displacement: 0.52 ft
Total Well Penetration Depth: 27.75 ft
Casing Radius: 0.167 ft
Static Water Column Height: 27.75 ft
Screen Length: 27.75 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.01949 ft/day
y0 = 0.2913 ft



MW-103 SLUG F RISING HEAD

Data Set: S:\...\MW-103_SlugFRisingHead_Kz.aqt
Date: 01/13/15 Time: 08:40:29

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-103
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 27.75 ft
Anisotropy Ratio (Kz/Kr): 0.1

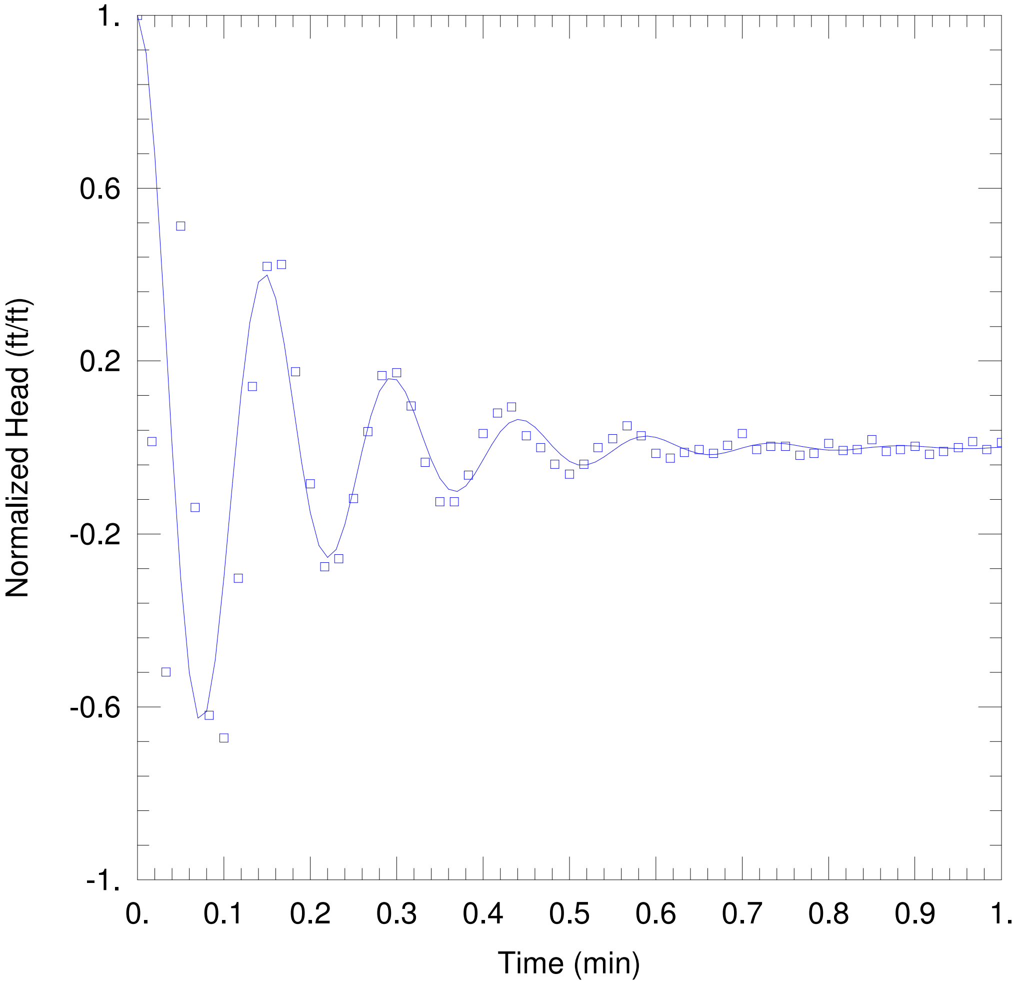
WELL DATA (MW-103)

Initial Displacement: 1.562 ft
Total Well Penetration Depth: 27.75 ft
Casing Radius: 0.167 ft
Static Water Column Height: 27.75 ft
Screen Length: 27.75 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.04746 ft/day
y0 = 0.4576 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-13_SlugAFallingHeadButler_Kz.aqt
Date: 01/12/15 Time: 15:58:09

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-13
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 113.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

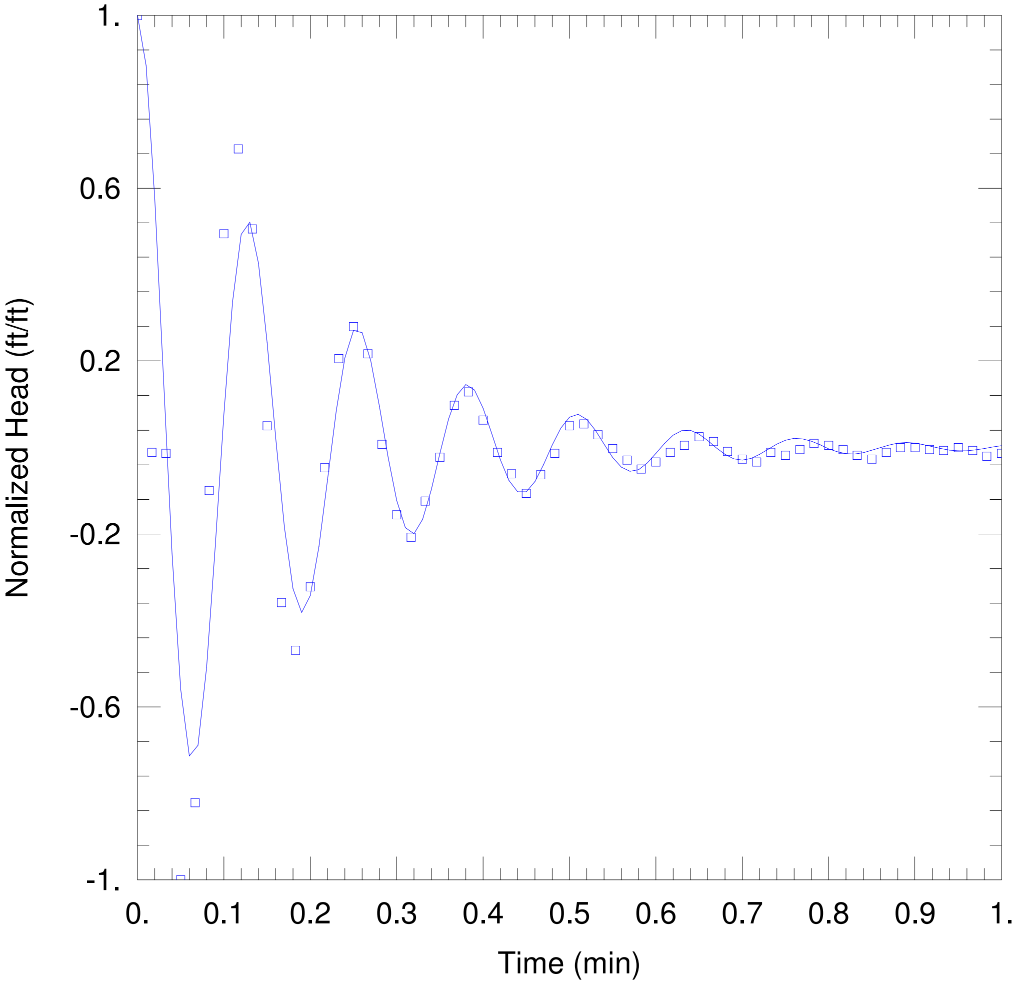
WELL DATA (MW-13 Slug A Falling Head)

Initial Displacement: 0.439 ft
Static Water Column Height: 113.5 ft
Total Well Penetration Depth: 110.7 ft
Screen Length: 76.2 ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler

K = 261.4 ft/day
Le = 62.23 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-13_SlugARisingHeadButler_Kz.aqt
Date: 01/12/15 Time: 16:01:22

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-13
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 113.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

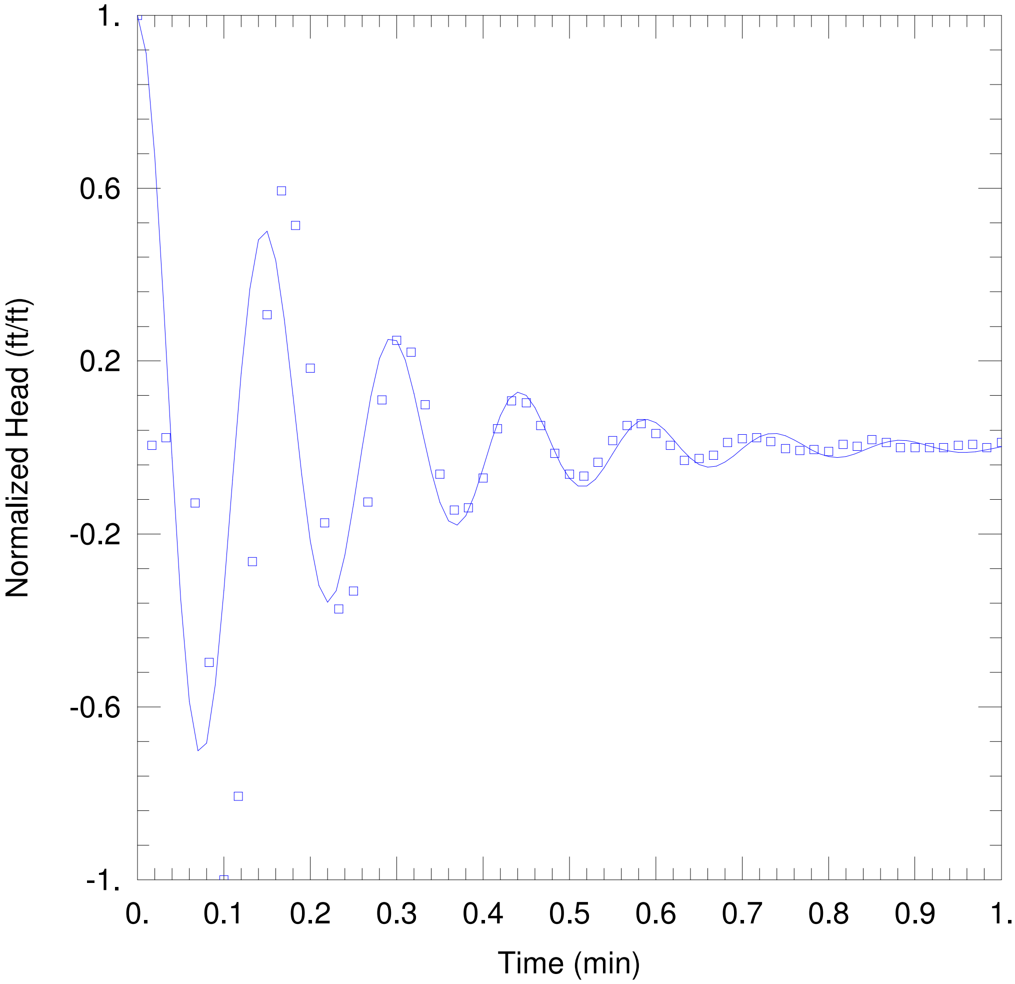
WELL DATA (MW-13 Slug A Rising Head)

Initial Displacement: 0.443 ft
Static Water Column Height: 113.5 ft
Total Well Penetration Depth: 110.7 ft
Screen Length: 76.2 ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler

K = 425. ft/day
Le = 46.92 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-13_SlugB1FalllingHeadButler_Kz.aqt
Date: 01/12/15 Time: 16:31:23

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-13
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 113.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

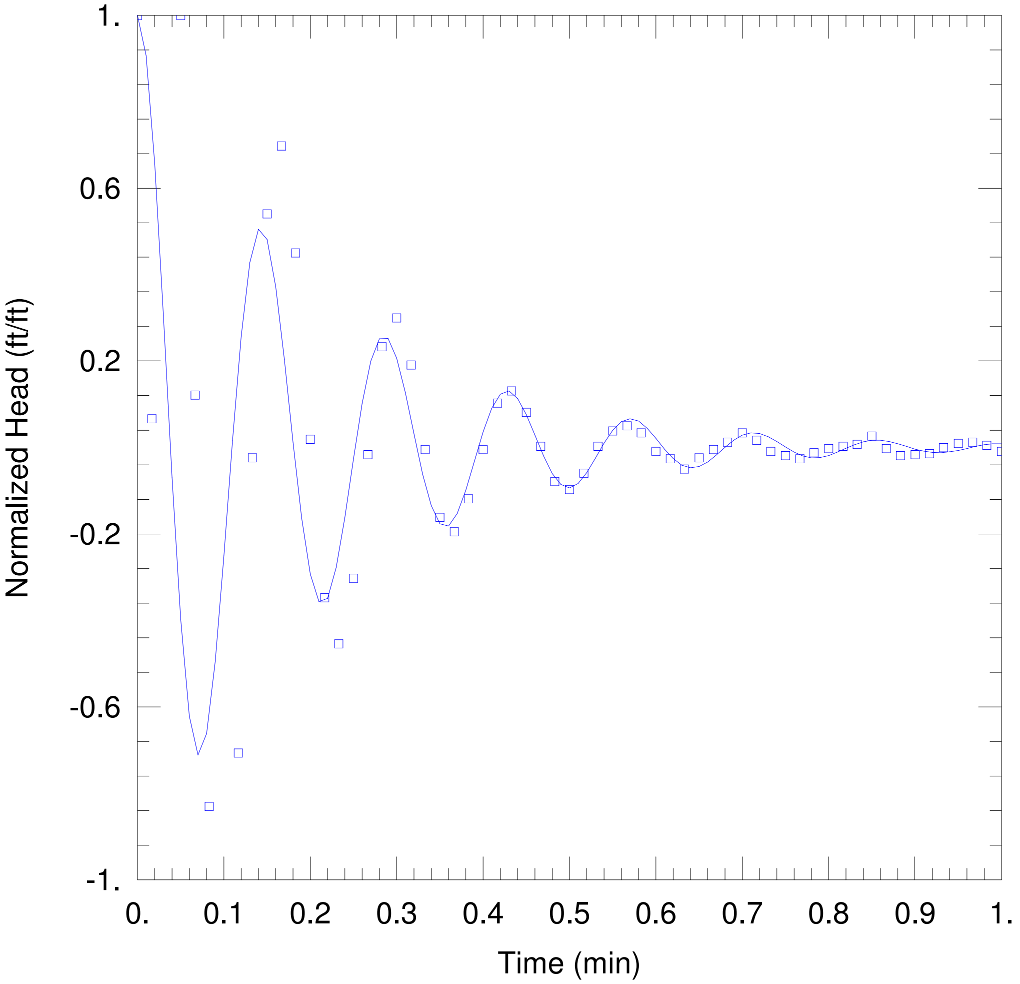
WELL DATA (MW-13 Slug B1 Falling Head)

Initial Displacement: 0.436 ft
Static Water Column Height: 113.5 ft
Total Well Penetration Depth: 110.7 ft
Screen Length: 76.2 ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler

K = 344.9 ft/day
Le = 62.8 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-13_SlugB1RisingHeadButler_Kz.aqt
Date: 01/12/15 Time: 16:33:32

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-13
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 113.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

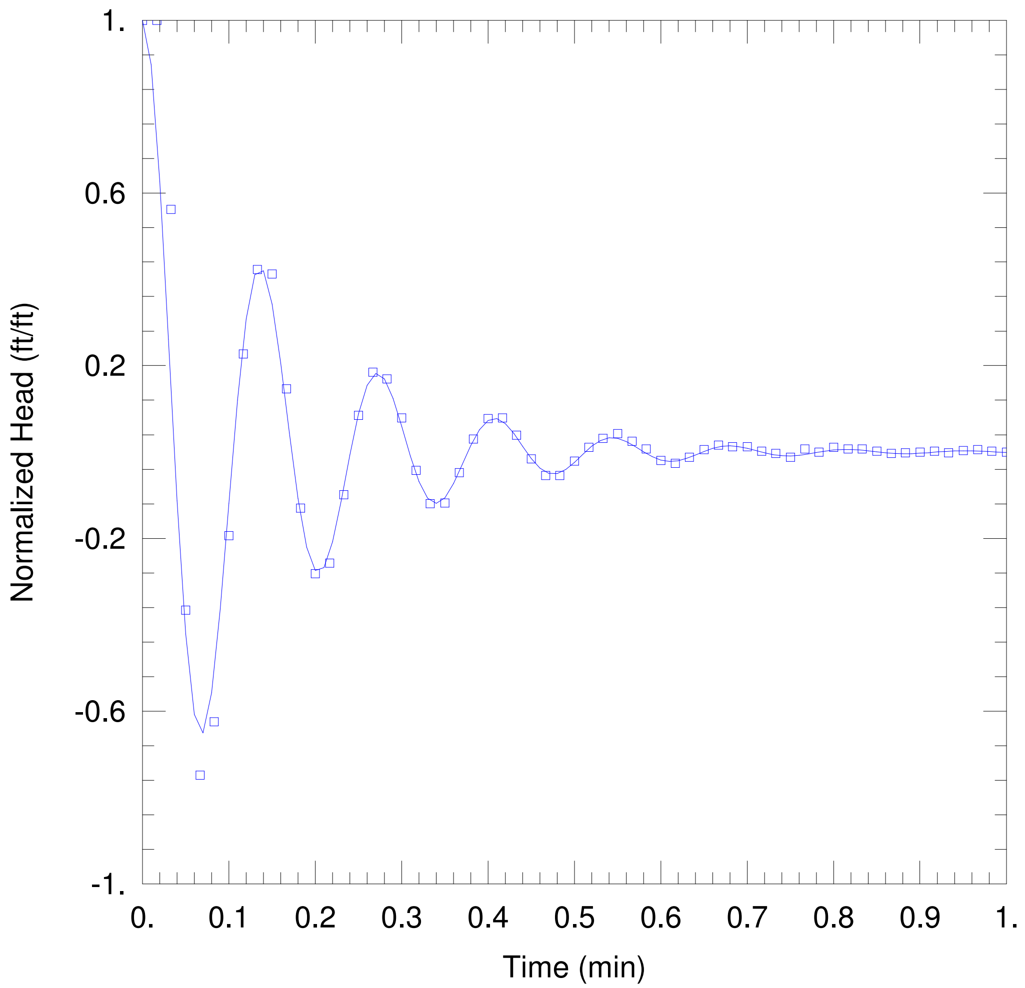
WELL DATA (MW-13 Slug B1 Rising Head)

Initial Displacement: 0.42 ft
Static Water Column Height: 113.5 ft
Total Well Penetration Depth: 110.7 ft
Screen Length: 76.2 ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler

K = 359.7 ft/day
Le = 58.96 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-13_SlugB2FallingHeadButler_Kz.aqt
Date: 01/12/15 Time: 16:36:02

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-13
Test Date: 26 Aug 2012

AQUIFER DATA

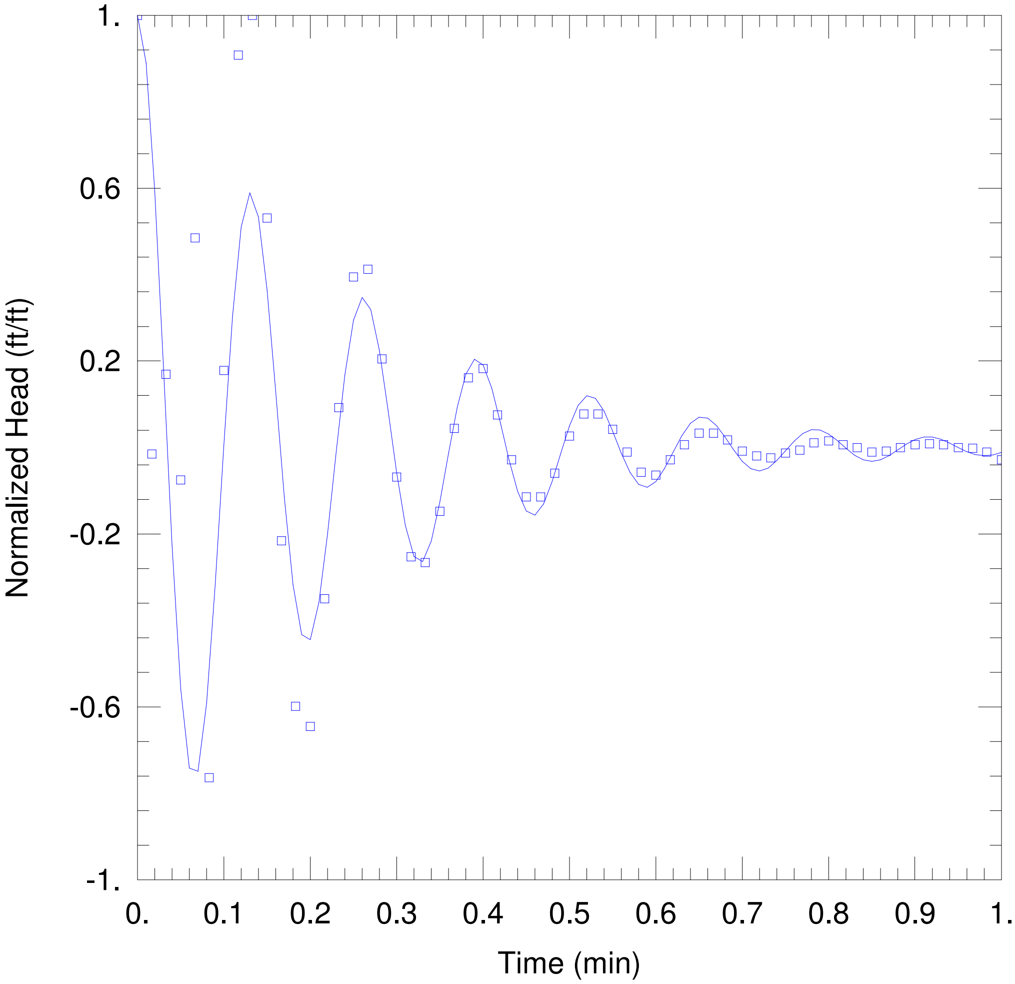
Saturated Thickness: 113.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-13 Slug B2 Falling Head)

Initial Displacement: 0.568 ft
Total Well Penetration Depth: 106.2 ft
Casing Radius: 0.167 ft
Static Water Column Height: 113.5 ft
Screen Length: 30. ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler
K = 659.8 ft/day
Le = 53.17 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-13_SlugB2RisingHeadButler_Kz.aqt
Date: 01/12/15 Time: 16:37:38

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-13
Test Date: 26 Aug 2012

AQUIFER DATA

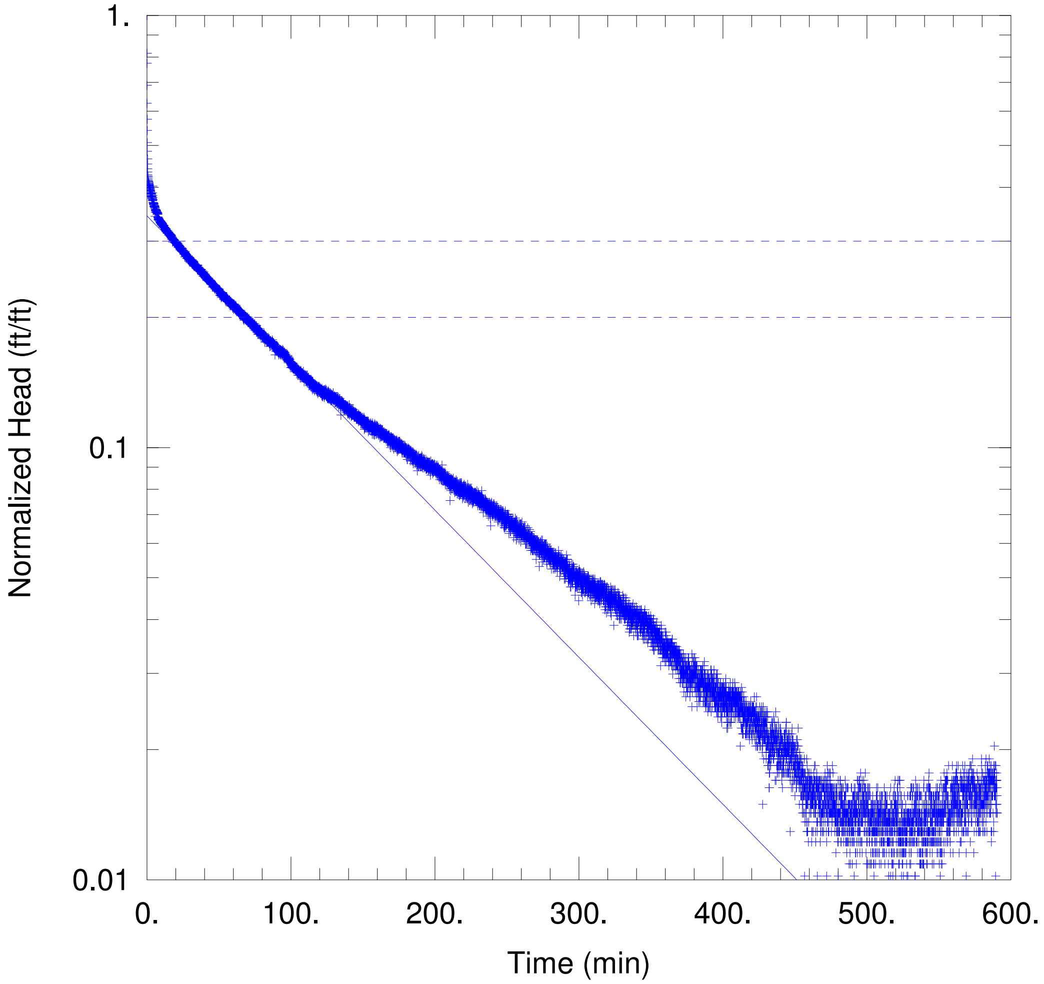
Saturated Thickness: 113.5 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-13 Slug B2 Rising Head)

Initial Displacement: 0.454 ft
Static Water Column Height: 113.5 ft
Total Well Penetration Depth: 64.47 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler
K = 1092.1 ft/day
Le = 49.78 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-5_SlugDFalling Head_Kz.aqt
Date: 01/13/15
Time: 13:00:28

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-5
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 42.35 ft
Anisotropy Ratio (Kz/Kr): 0.1

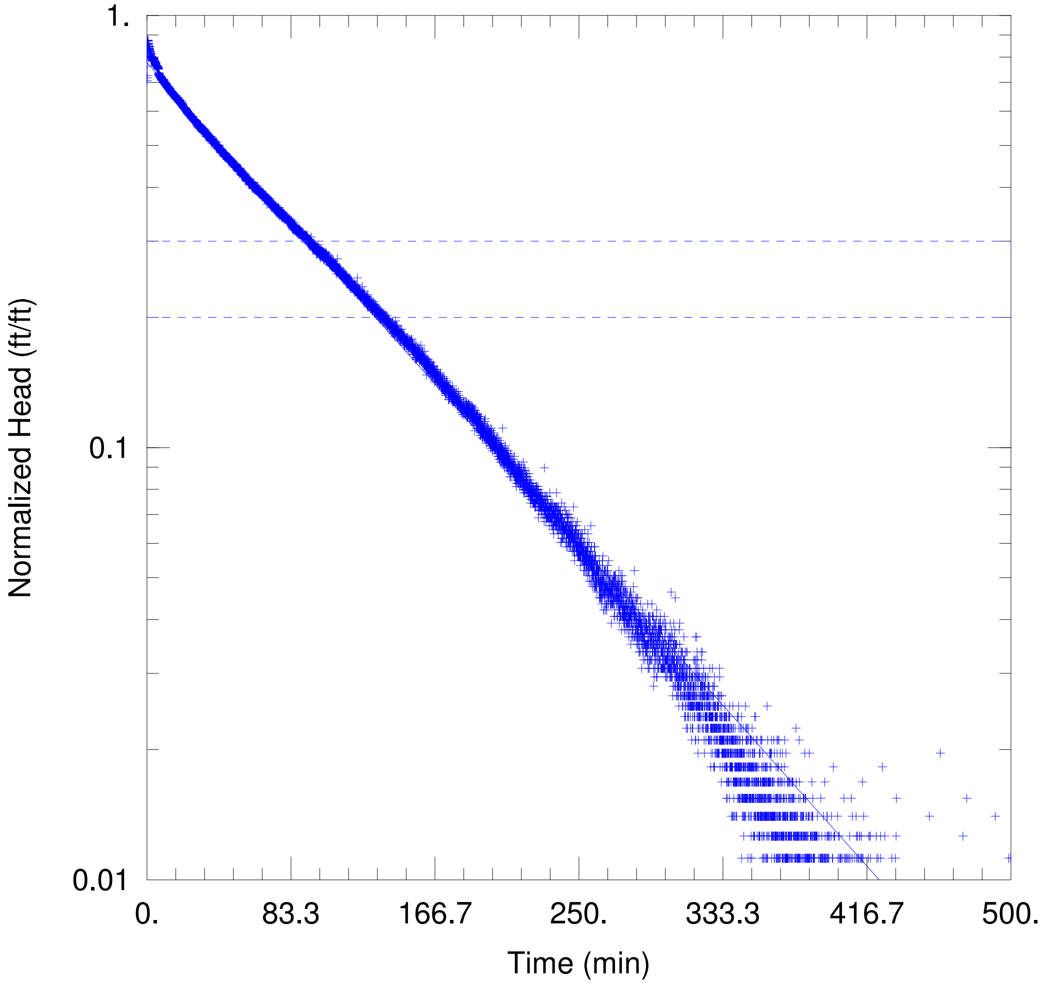
WELL DATA (MW-5 Slug D Falling Head)

Initial Displacement: 1.471 ft
Static Water Column Height: 42.35 ft
Total Well Penetration Depth: 42.35 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.02472 ft/day
y0 = 0.505 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-5_SlugDRising Head_Kz.aqt
Date: 01/12/15 Time: 13:30:37

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-5
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 42.35 ft Anisotropy Ratio (Kz/Kr): 0.1

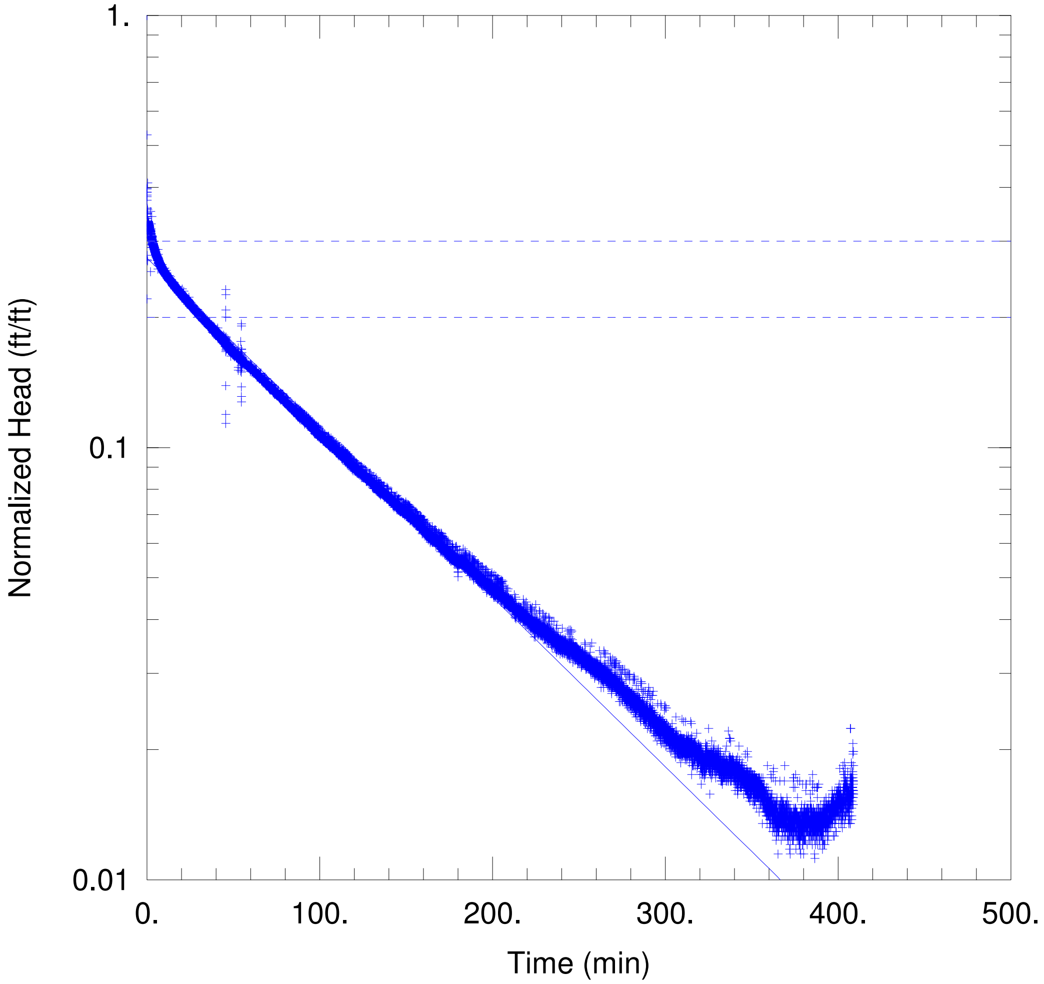
WELL DATA (MW-5 Slug D Rising Head)

Initial Displacement: 0.713 ft
Total Well Penetration Depth: 42.35 ft
Casing Radius: 0.167 ft
Static Water Column Height: 42.35 ft
Screen Length: 30. ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.03241 ft/day y0 = 0.5543 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-5_SlugEFallingHead_Kz.aqt
Date: 01/12/15 Time: 13:57:44

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-5
Test Date: 27 Aug 2012

AQUIFER DATA

Saturated Thickness: 42.35 ft
Anisotropy Ratio (Kz/Kr): 0.1

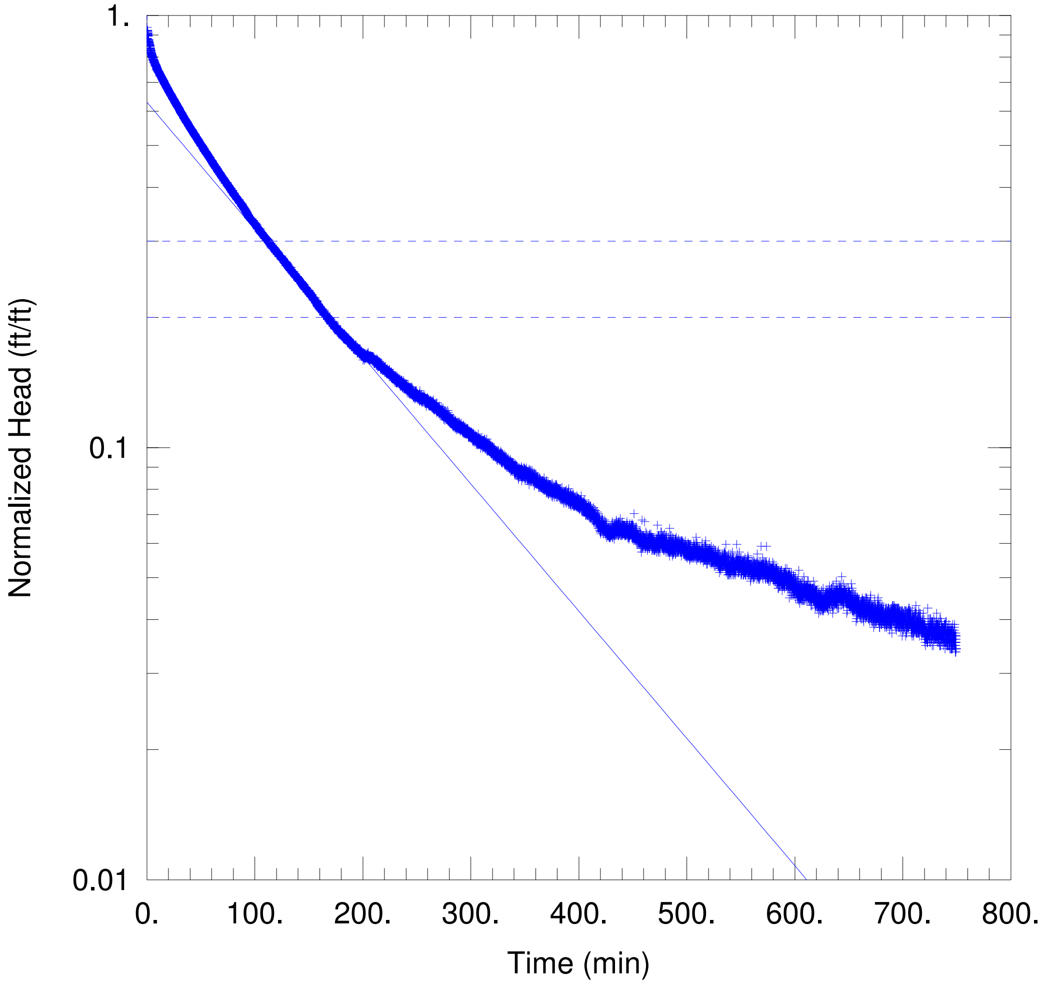
WELL DATA (MW-5 Slug E Falling Head)

Initial Displacement: 3.484 ft
Total Well Penetration Depth: 42.35 ft
Casing Radius: 0.167 ft
Static Water Column Height: 42.35 ft
Screen Length: 30. ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0285 ft/day
y0 = 0.9559 ft



WELL TEST ANALYSIS

Data Set: S:\...\MW-5_SlugERisingHead_Kz.aqt
Date: 01/12/15 Time: 13:59:17

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: MW-5
Test Date: 27 Aug 2012

AQUIFER DATA

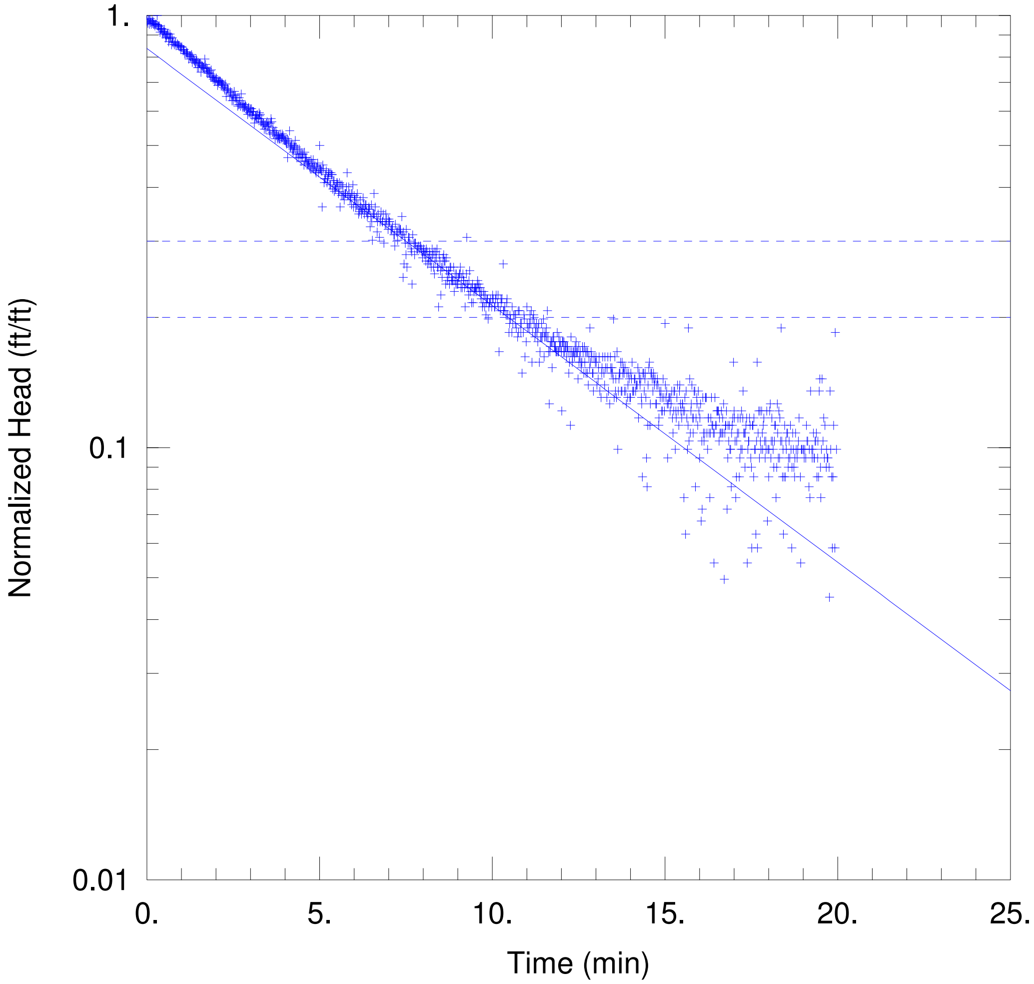
Saturated Thickness: 42.35 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-5 Slug E Rising Head)

Initial Displacement: 1.693 ft
Static Water Column Height: 42.35 ft
Total Well Penetration Depth: 42.35 ft
Screen Length: 30. ft
Casing Radius: 0.167 ft
Well Radius: 0.328 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.02138 ft/day
y0 = 1.065 ft



WELL TEST ANALYSIS

Data Set: S:\...\OW-UT9_SlugBFallingHead_Kz.aqt
Date: 01/13/15 Time: 09:02:56

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: OW-UT9
Test Date: 29 Aug 2012

AQUIFER DATA

Saturated Thickness: 16.54 ft
Anisotropy Ratio (Kz/Kr): 0.1

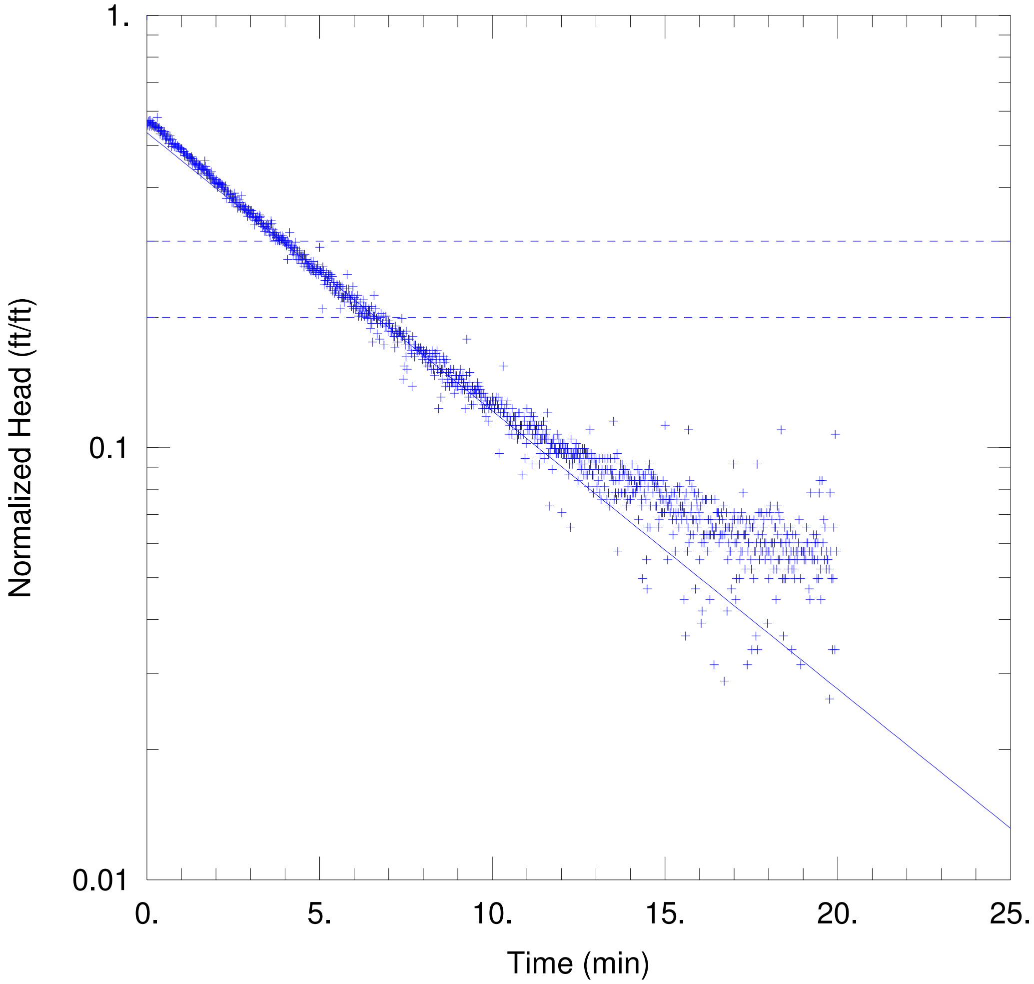
WELL DATA (OW-UT9 Slug B Falling Head)

Initial Displacement: 0.222 ft
Static Water Column Height: 16.54 ft
Total Well Penetration Depth: 16.54 ft
Screen Length: 16.54 ft
Casing Radius: 0.25 ft
Well Radius: 0.4115 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.049 ft/day
y0 = 0.186 ft



WELL TEST ANALYSIS

Data Set: S:\...\OW-UT9_SlugBRisingHead_Kz.aqt
Date: 01/13/15 Time: 09:04:38

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: OW-UT9
Test Date: 29 Aug 2012

AQUIFER DATA

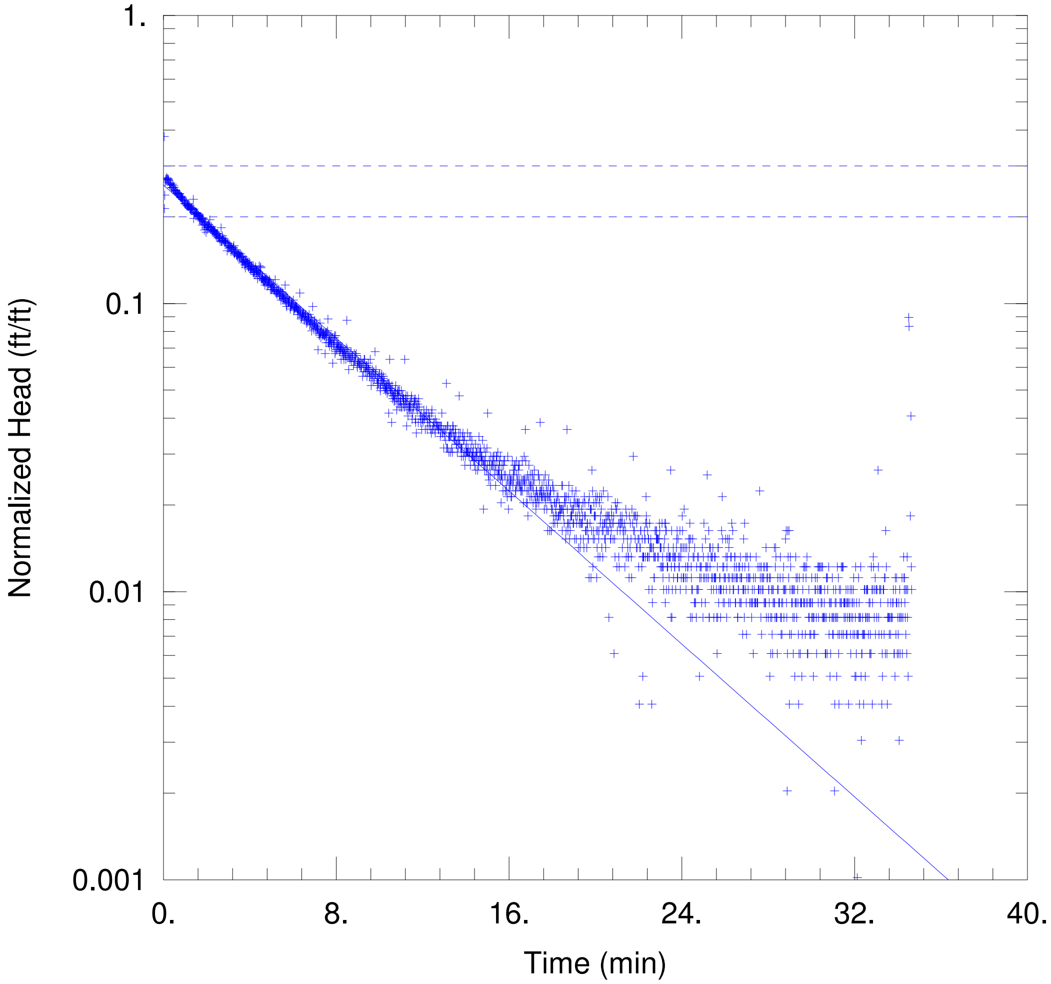
Saturated Thickness: 16.54 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (OW-UT9 Slug B Rising Head)

Initial Displacement: 0.382 ft
Static Water Column Height: 16.54 ft
Total Well Penetration Depth: 16.54 ft
Screen Length: 16.54 ft
Casing Radius: 0.25 ft
Well Radius: 0.4115 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.136 ft/day
y0 = 0.2044 ft



WELL TEST ANALYSIS

Data Set: S:\...\OW-UT9_SlugCFallingHead_Kz.aqt
Date: 01/13/15 Time: 09:22:17

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: OW-UT9
Test Date: 29 Aug 2012

AQUIFER DATA

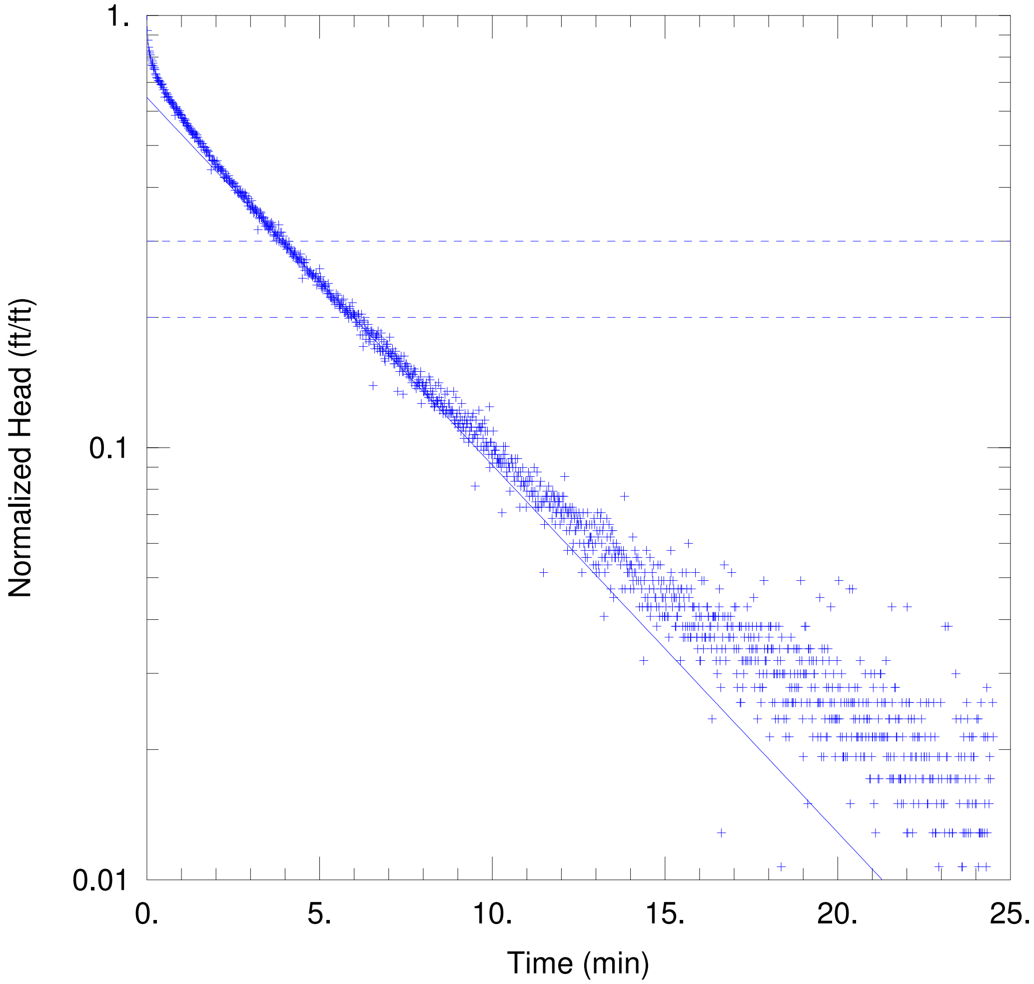
Saturated Thickness: 16.54 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (OW-UT9 Slug C Falling Head)

Initial Displacement: 0.984 ft
Static Water Column Height: 16.54 ft
Total Well Penetration Depth: 16.54 ft
Screen Length: 16.54 ft
Casing Radius: 0.25 ft
Well Radius: 0.4115 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.17 ft/day
y0 = 0.2532 ft



WELL TEST ANALYSIS

Data Set: S:\...\OW-UT9_SlugCRisingHead_Kz.aqt
Date: 01/13/15 Time: 09:23:31

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: OW-UT9
Test Date: 29 Aug 2012

AQUIFER DATA

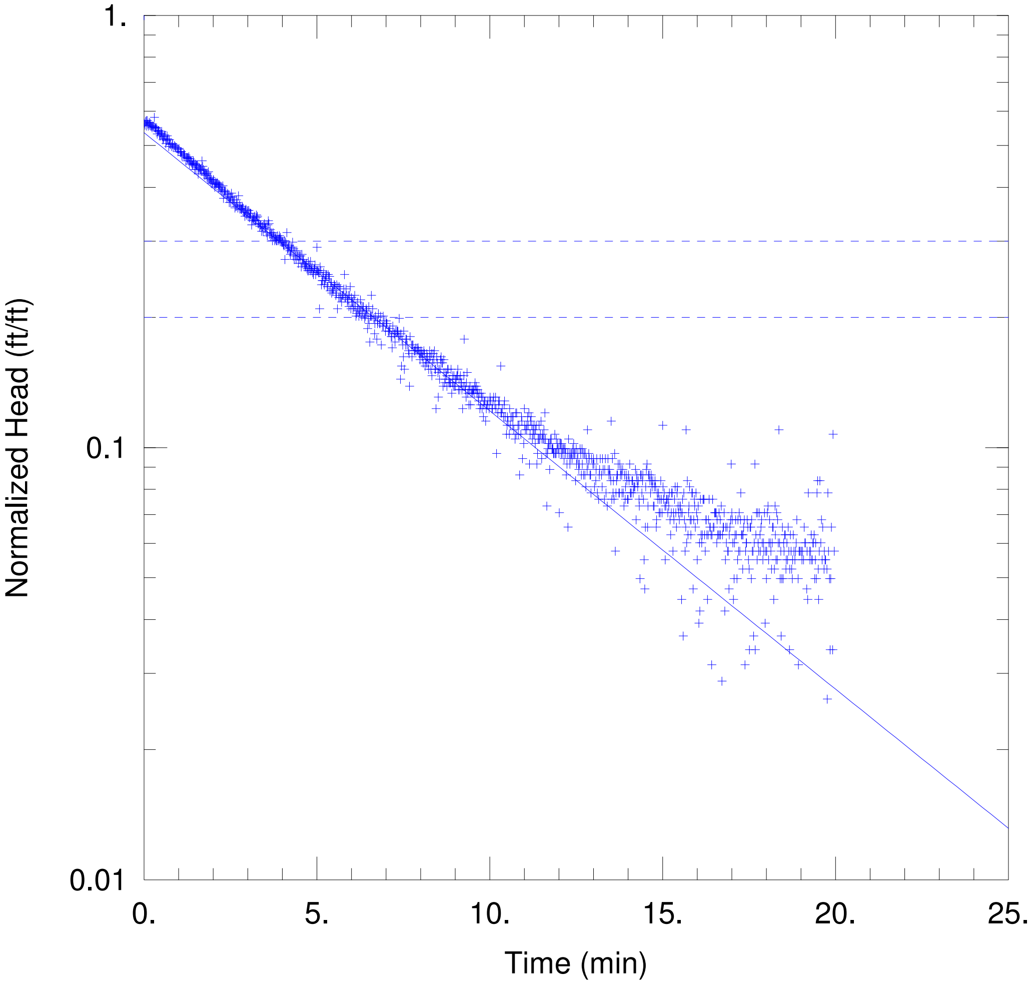
Saturated Thickness: 16.54 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (OW-UT9 Slug C Rising Head)

Initial Displacement: 0.467 ft
Static Water Column Height: 16.54 ft
Total Well Penetration Depth: 16.54 ft
Screen Length: 16.54 ft
Casing Radius: 0.25 ft
Well Radius: 0.4115 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.5 ft/day
y0 = 0.3013 ft



WELL TEST ANALYSIS

Data Set: S:\...\OW-UT9_SlugDFallingHead_Kz.aqt
Date: 01/13/15 Time: 09:24:45

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: OW-UT9
Test Date: 29 Aug 2012

AQUIFER DATA

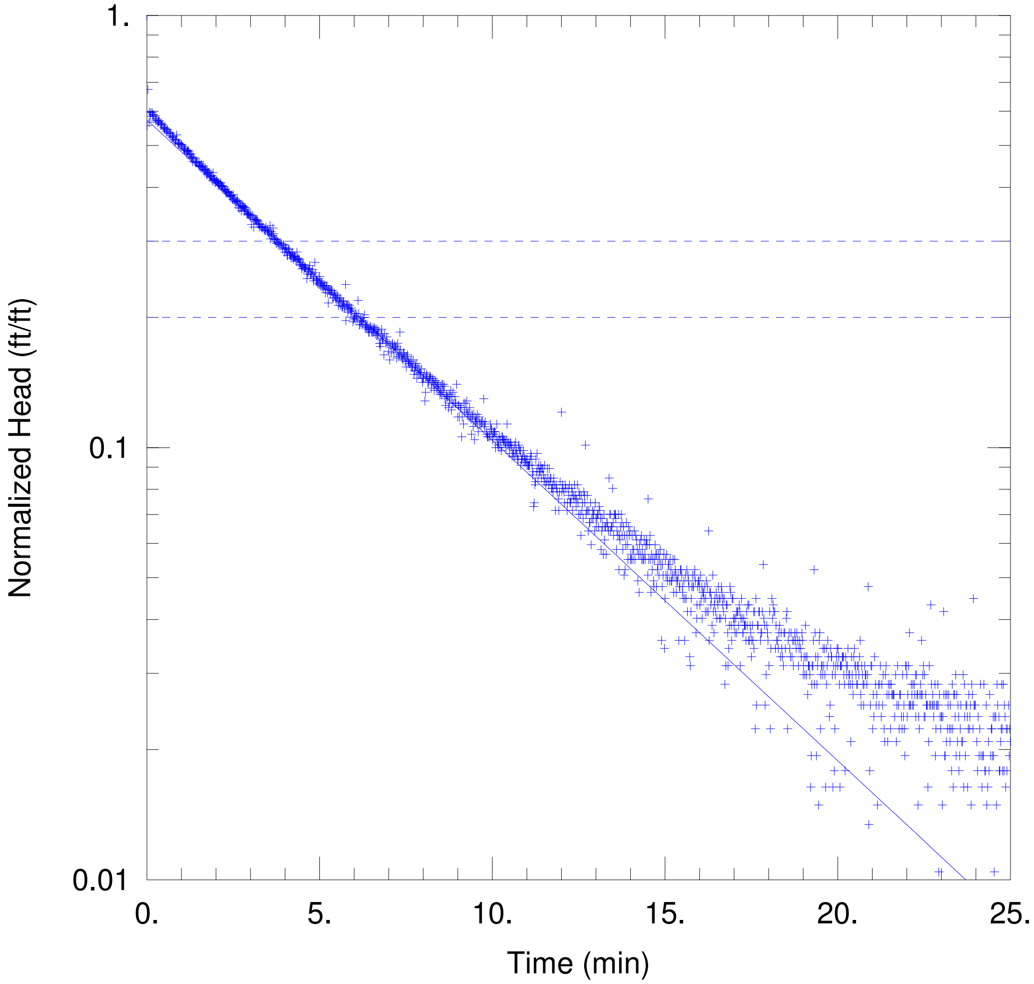
Saturated Thickness: 16.54 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (OW-UT9 Slug B Rising Head)

Initial Displacement: 0.382 ft
Static Water Column Height: 16.54 ft
Total Well Penetration Depth: 16.54 ft
Screen Length: 16.54 ft
Casing Radius: 0.25 ft
Well Radius: 0.4115 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.136 ft/day
y0 = 0.2044 ft



WELL TEST ANALYSIS

Data Set: S:\...\OW-UT9_SlugDRisingHead_Kz.aqt
Date: 01/13/15 Time: 09:25:36

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: OW-UT9
Test Date: 29 Aug 2012

AQUIFER DATA

Saturated Thickness: 16.54 ft
Anisotropy Ratio (Kz/Kr): 0.1

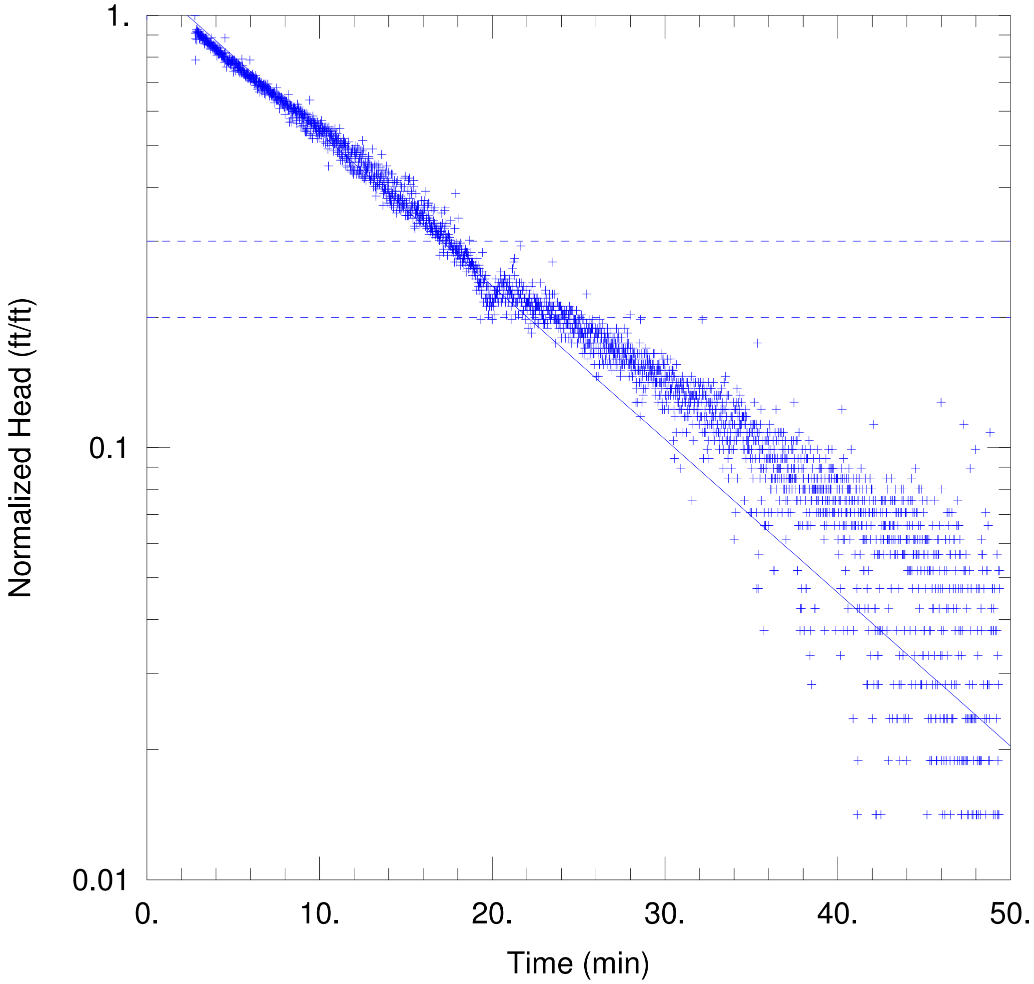
WELL DATA (OW-UT9 Slug D Rising Head)

Initial Displacement: 0.671 ft
Total Well Penetration Depth: 16.54 ft
Casing Radius: 0.25 ft
Static Water Column Height: 16.54 ft
Screen Length: 16.54 ft
Well Radius: 0.4115 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.308 ft/day
y0 = 0.3846 ft



RL-1 SLUG A

Data Set: S:\...\RL-1_SlugAFallingHead_Kz.aqt
Date: 01/13/15 Time: 10:44:51

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-1
Test Date: 28 Aug 2012

AQUIFER DATA

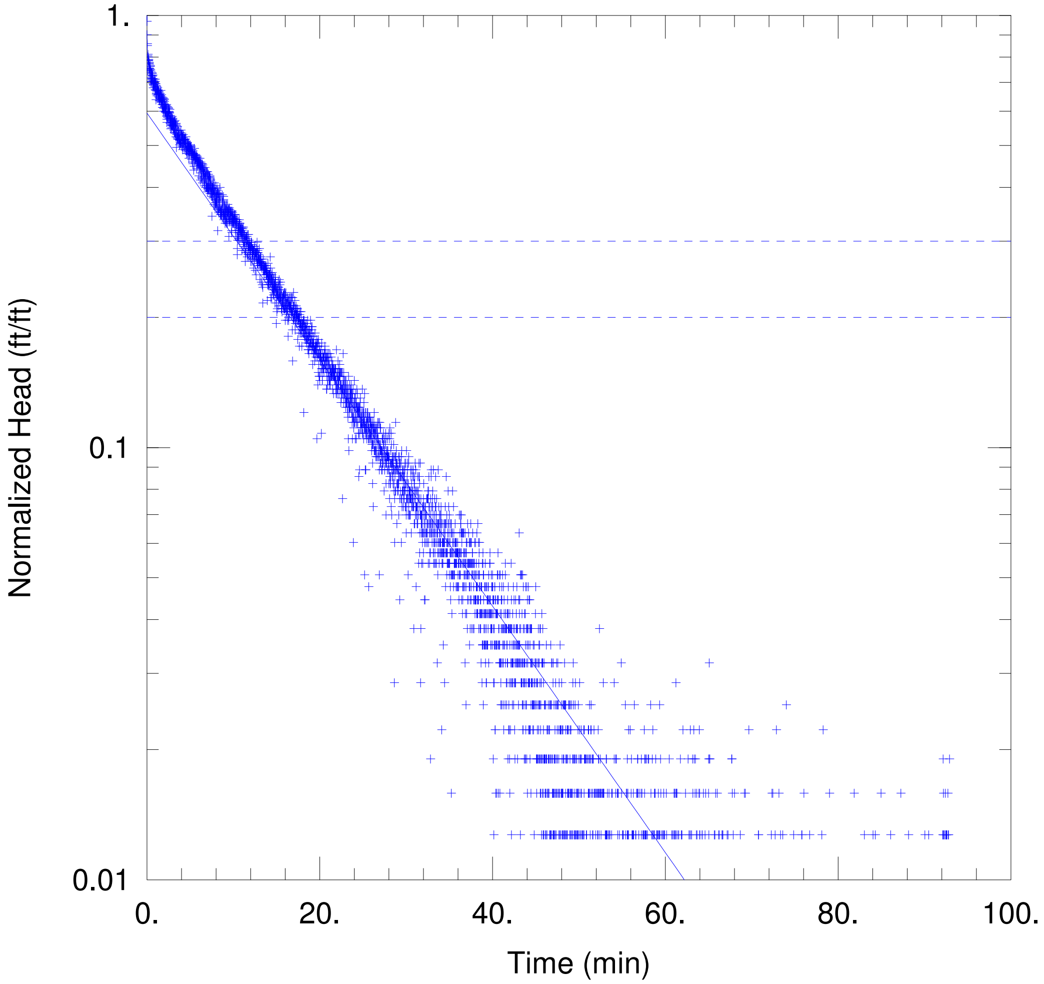
Saturated Thickness: 8.8 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (RL-1 Slug A)

Initial Displacement: 0.212 ft
Total Well Penetration Depth: 8.8 ft
Casing Radius: 0.208 ft
Static Water Column Height: 8.8 ft
Screen Length: 8.8 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.6889 ft/day
y0 = 0.2565 ft



RL-1 SLUG A

Data Set: S:\...\RL-1_SlugARisingHead_Kz.aqt
Date: 01/13/15 Time: 10:46:09

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-1
Test Date: 28 Aug 2012

AQUIFER DATA

Saturated Thickness: 8.8 ft
Anisotropy Ratio (Kz/Kr): 0.1

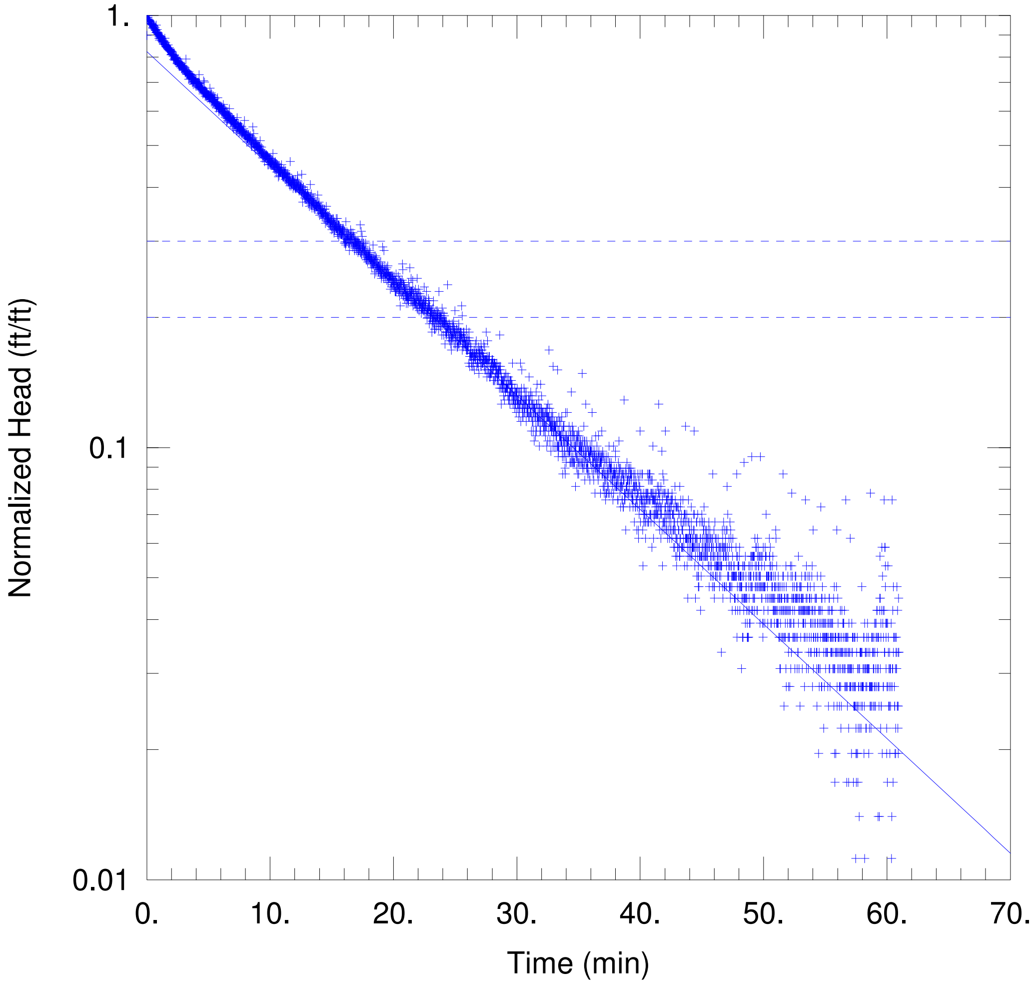
WELL DATA (RL-1 Slug A)

Initial Displacement: 0.315 ft
Static Water Column Height: 8.8 ft
Total Well Penetration Depth: 8.8 ft
Screen Length: 8.8 ft
Casing Radius: 0.208 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.5538 ft/day
y0 = 0.1871 ft



RL-1 SLUG B

Data Set: S:\...\RL-1_SlugBFallingHead_Kz.aqt
Date: 01/13/15 Time: 13:35:47

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-1
Test Date: 28 Aug 2012

AQUIFER DATA

Saturated Thickness: 8.8 ft
Anisotropy Ratio (Kz/Kr): 0.1

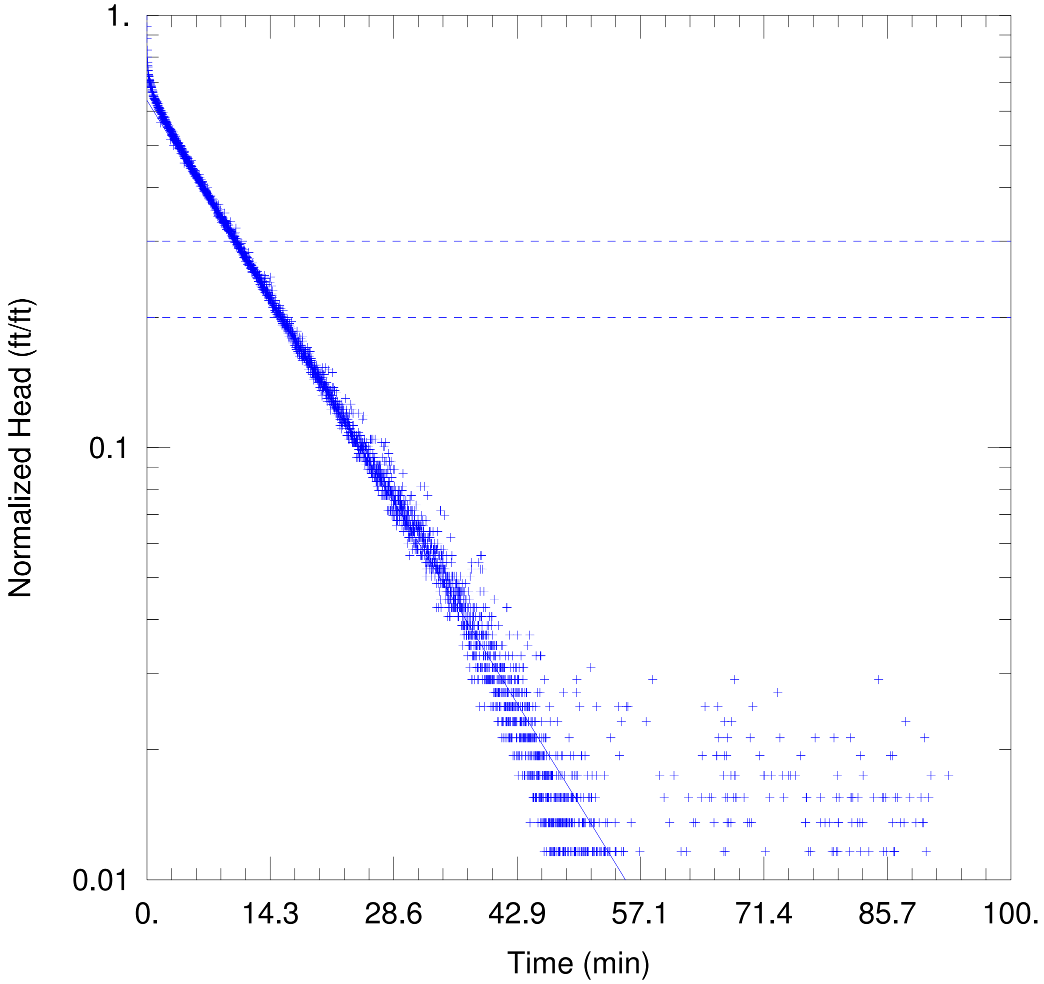
WELL DATA (RL-1 Slug B)

Initial Displacement: 0.357 ft
Total Well Penetration Depth: 8.8 ft
Casing Radius: 0.208 ft
Static Water Column Height: 8.8 ft
Screen Length: 8.8 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.5145 ft/day
y0 = 0.2941 ft



RL-1 SLUG B

Data Set: S:\...\RL-1_SlugBRisingHead_Kz.aqt
Date: 01/13/15 Time: 13:35:00

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-1
Test Date: 28 Aug 2012

AQUIFER DATA

Saturated Thickness: 8.8 ft
Anisotropy Ratio (Kz/Kr): 0.1

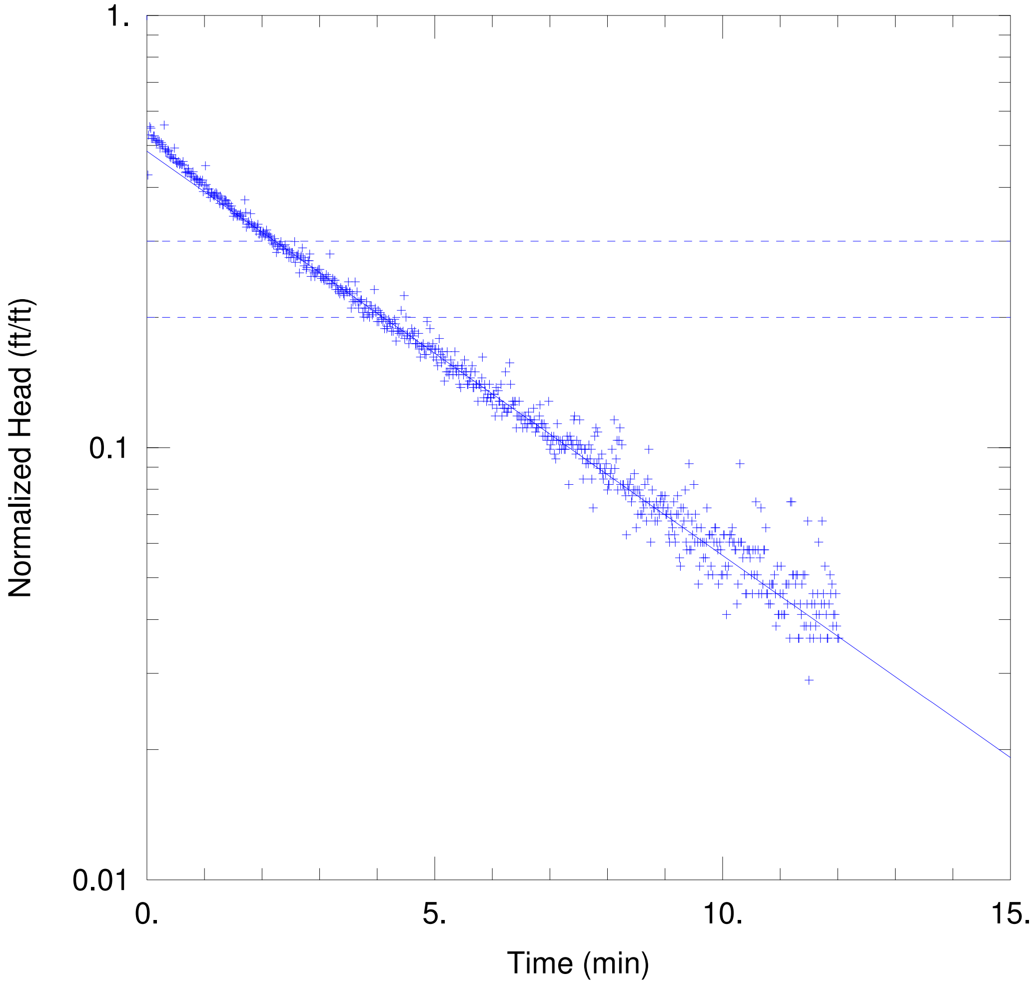
WELL DATA (RL-1 Slug B)

Initial Displacement: 0.516 ft
Static Water Column Height: 8.8 ft
Total Well Penetration Depth: 8.8 ft
Screen Length: 8.8 ft
Casing Radius: 0.208 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.6324 ft/day
y0 = 0.3279 ft



RL-3 SLUG A FALLING HEAD

Data Set: S:\...\RL-3_SlugAFallingHead_Kz.aqt
Date: 01/13/15 Time: 10:49:39

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-3
Test Date: 2 Nov 2012

AQUIFER DATA

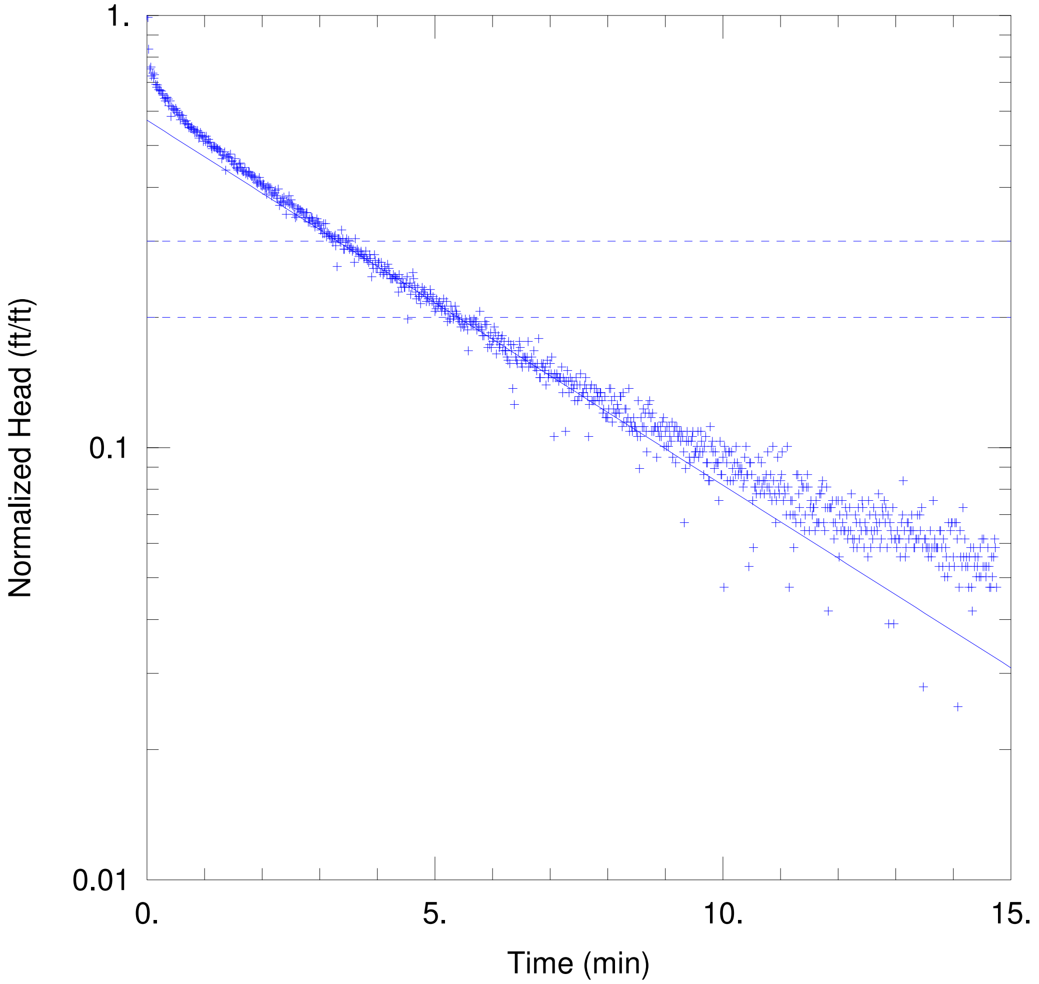
Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (RL-3)

Initial Displacement: 0.414 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.208 ft
Static Water Column Height: 15. ft
Screen Length: 15. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.267 ft/day
y0 = 0.2006 ft



RL-3 SLUG A RISING HEAD

Data Set: S:\...\RL-3_SlugARisingHead_Kz.aqt
Date: 01/13/15 Time: 14:03:11

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-3
Test Date: 2 Nov 2012

AQUIFER DATA

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 0.1

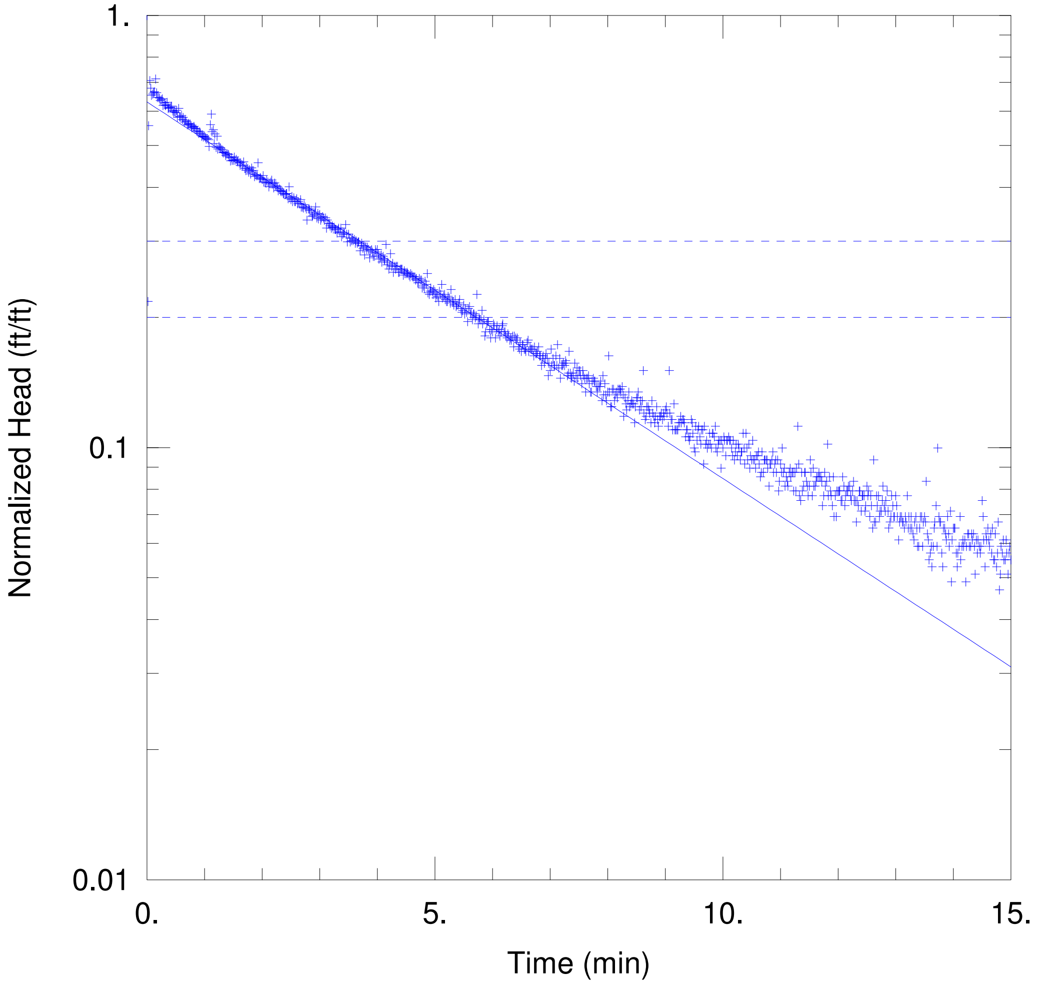
WELL DATA (RL-3)

Initial Displacement: 0.358 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.208 ft
Static Water Column Height: 15. ft
Screen Length: 15. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.145 ft/day
y0 = 0.2047 ft



RL-3 SLUG B FALLING HEAD

Data Set: S:\...\RL-3_SlugBFallingHead_Kz.aqt
Date: 01/13/15 Time: 10:50:46

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-3
Test Date: 2 Nov 2012

AQUIFER DATA

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 0.1

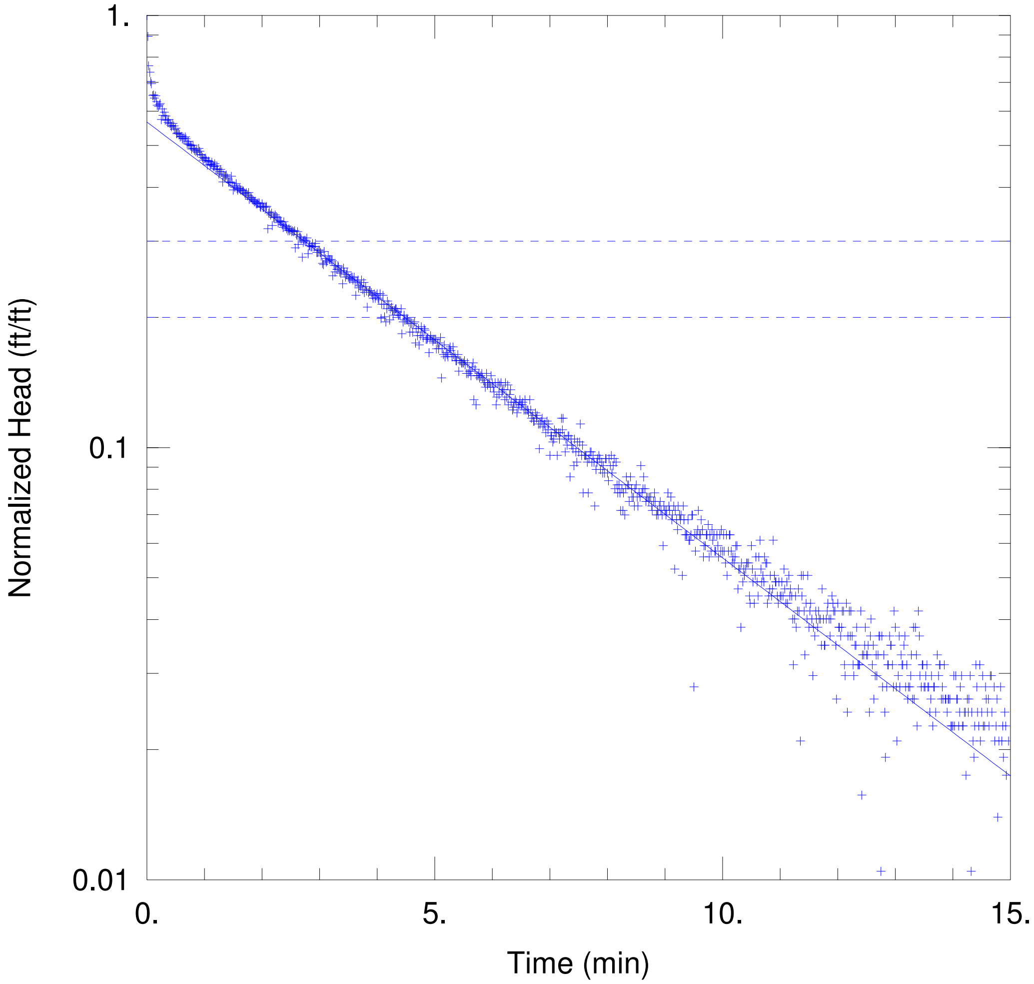
WELL DATA (RL-3)

Initial Displacement: 0.491 ft
Static Water Column Height: 15. ft
Total Well Penetration Depth: 15. ft
Screen Length: 15. ft
Casing Radius: 0.208 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.181 ft/day
y0 = 0.3096 ft



RL-3 SLUG B RISING HEAD

Data Set: S:\...\RL-3_SlugBRisingHead_Kz.aqt
Date: 01/13/15
Time: 10:51:57

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-3
Test Date: 2 Nov 2012

AQUIFER DATA

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 0.1

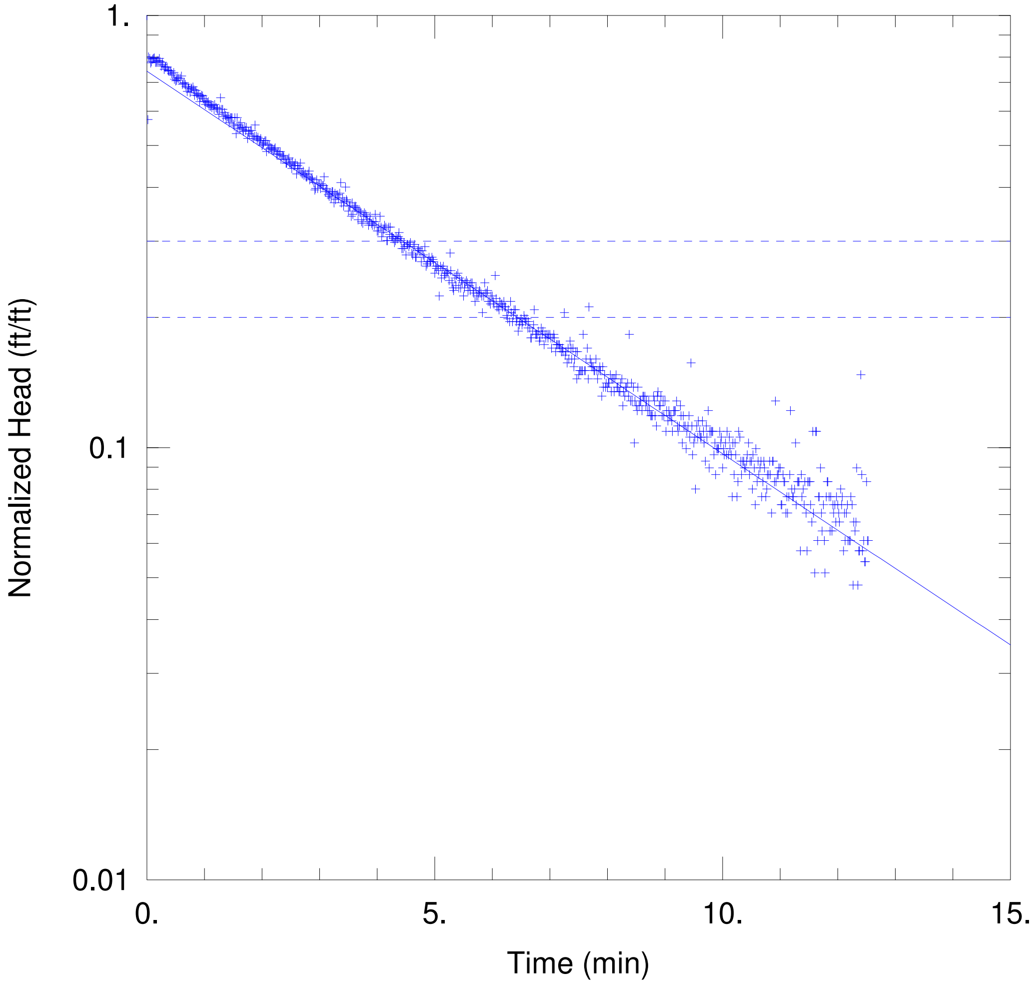
WELL DATA (RL-3)

Initial Displacement: 0.573 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.208 ft
Static Water Column Height: 15. ft
Screen Length: 15. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.367 ft/day
y0 = 0.3246 ft



RL-3 SLUG G FALLING HEAD

Data Set: S:\...\RL-3_SlugGFallingHead_Kz.aqt
Date: 01/13/15 Time: 10:53:02

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-3
Test Date: 2 Nov 2012

AQUIFER DATA

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 0.1

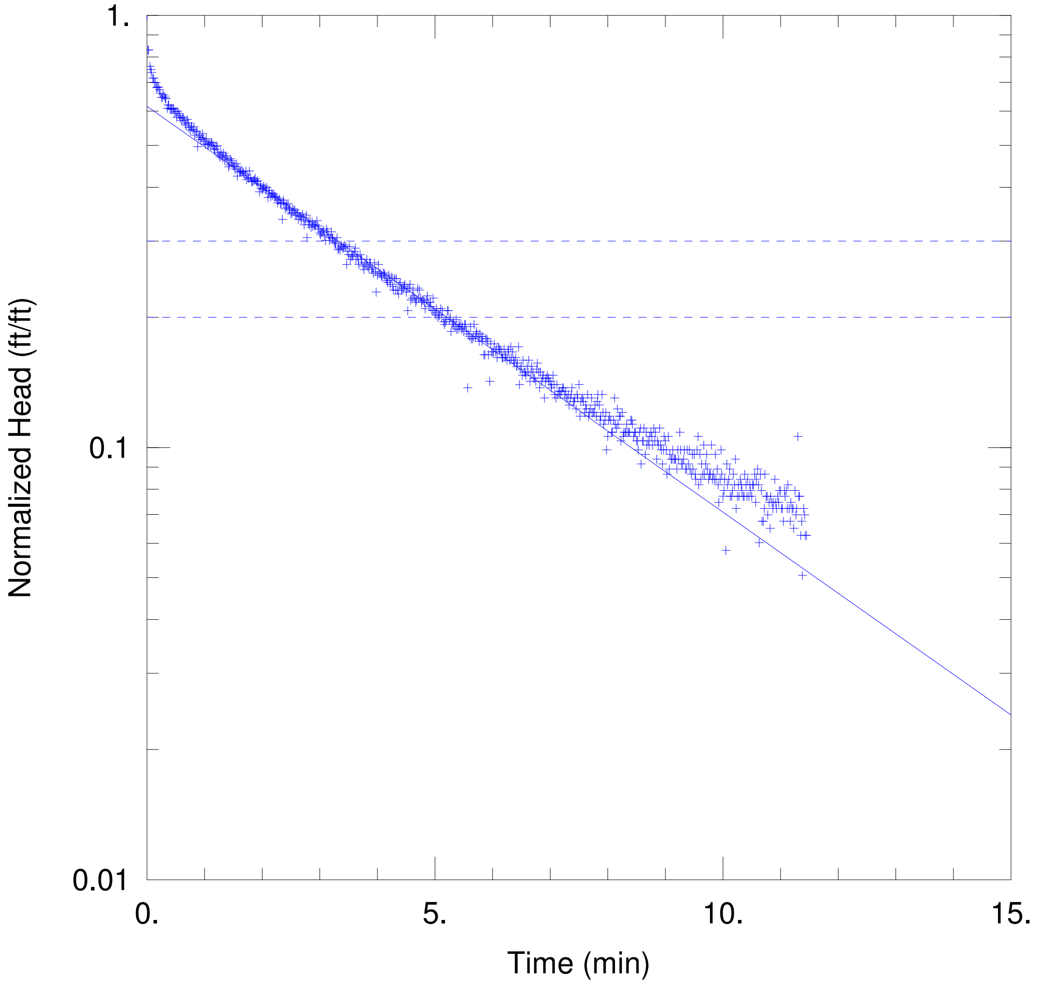
WELL DATA (RL-3)

Initial Displacement: 0.312 ft
Static Water Column Height: 15. ft
Total Well Penetration Depth: 15. ft
Screen Length: 15. ft
Casing Radius: 0.208 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.199 ft/day
y0 = 0.2316 ft



RL-3 SLUG G RISING HEAD

Data Set: S:\...\RL-3_SlugGRisingHead_Kz.aqt
Date: 01/13/15 Time: 10:53:44

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-3
Test Date: 2 Nov 2012

AQUIFER DATA

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 0.1

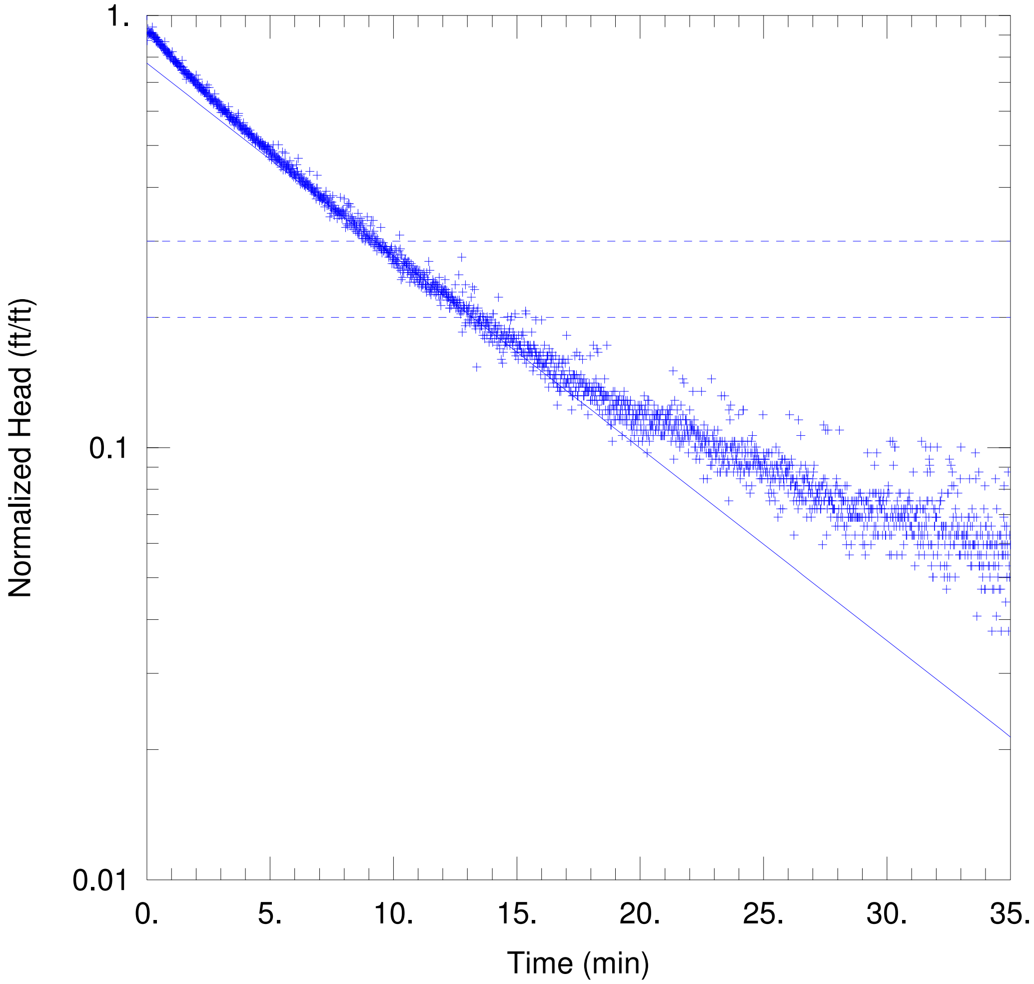
WELL DATA (RL-3)

Initial Displacement: 0.415 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.208 ft
Static Water Column Height: 15. ft
Screen Length: 15. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.273 ft/day
y0 = 0.2556 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-4_SlugBFallingHead_Kz.aqt
Date: 01/13/15 Time: 10:57:38

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-4
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 21.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

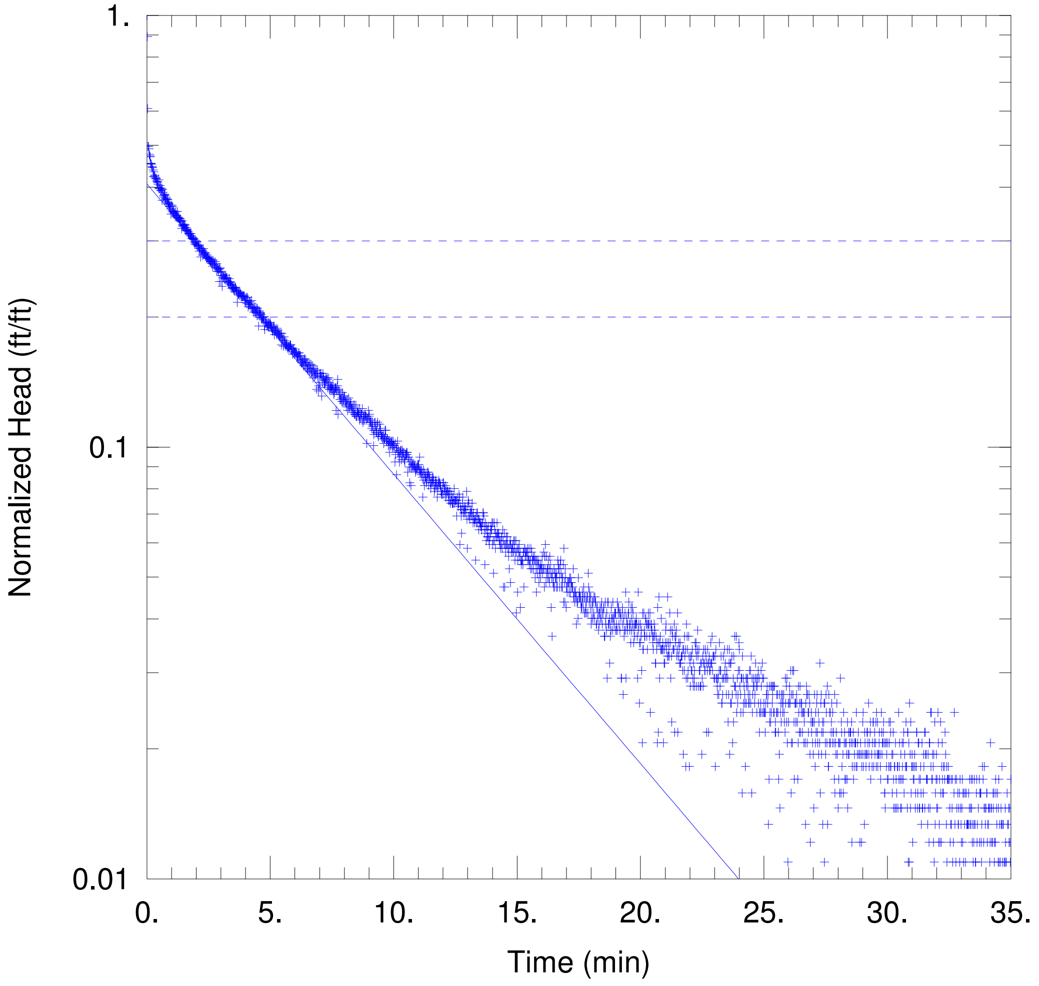
WELL DATA (RL-4 Slug B Falling Head)

Initial Displacement: 0.319 ft
Total Well Penetration Depth: 21.9 ft
Casing Radius: 0.2083 ft
Static Water Column Height: 21.9 ft
Screen Length: 21.9 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.4594 ft/day
y0 = 0.2471 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-4_SlugBRisingHead_Kz.aqt
Date: 01/13/15 Time: 10:58:18

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-4
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 21.9 ft Anisotropy Ratio (Kz/Kr): 0.1

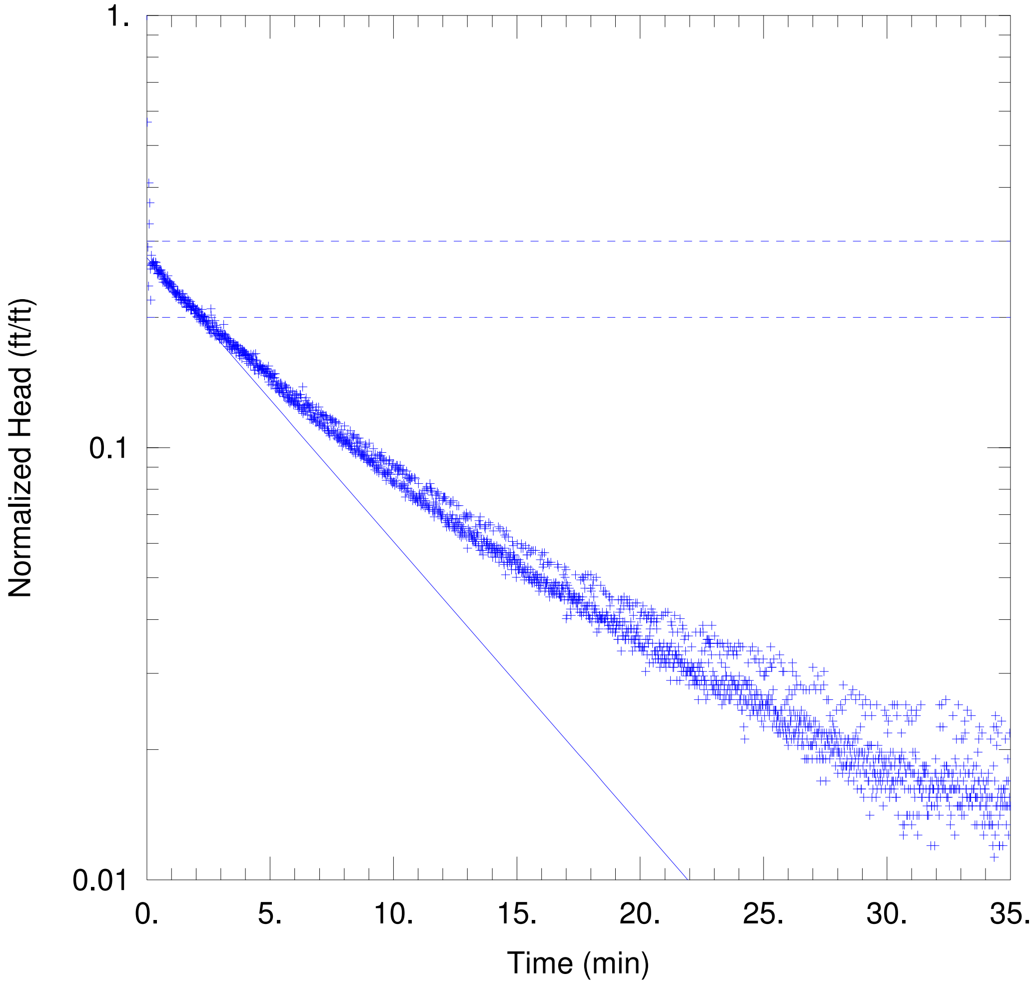
WELL DATA (RL-4 Slug B Rising Head)

Initial Displacement: 0.823 ft Static Water Column Height: 21.9 ft
Total Well Penetration Depth: 21.9 ft Screen Length: 21.9 ft
Casing Radius: 0.2083 ft Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.6925 ft/day y0 = 0.3344 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-4_SlugCFallingHead_Kz.aqt
Date: 01/13/15 Time: 10:59:52

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-4
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 21.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

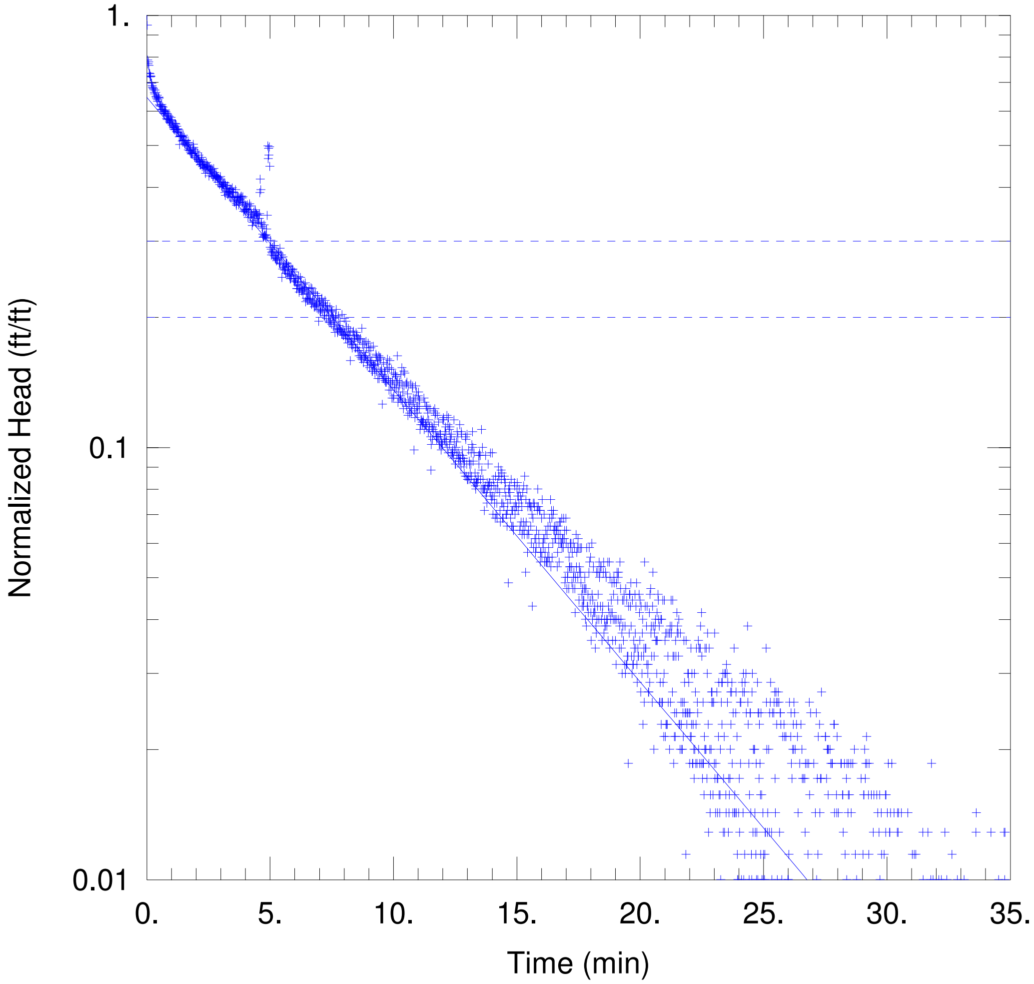
WELL DATA (RL-4 Slug C Falling Head)

Initial Displacement: 1.418 ft
Static Water Column Height: 21.9 ft
Total Well Penetration Depth: 21.9 ft
Screen Length: 21.9 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.6769 ft/day
y0 = 0.3894 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-4_SlugCRisingHead_Kz.aqt
Date: 01/13/15 Time: 11:00:52

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-4
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 21.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

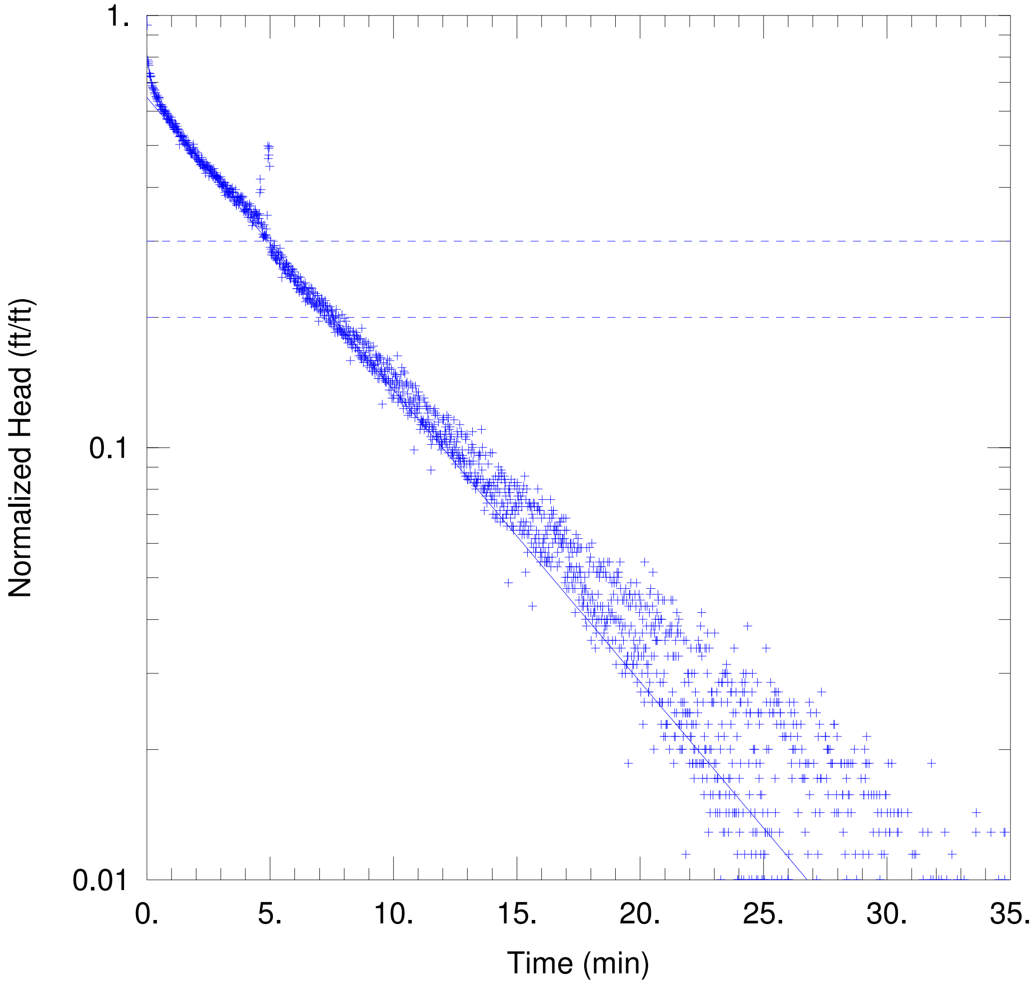
WELL DATA (RL-4 Slug C Rising Head)

Initial Displacement: 0.699 ft
Static Water Column Height: 21.9 ft
Total Well Penetration Depth: 21.9 ft
Screen Length: 21.9 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.6979 ft/day
y0 = 0.4516 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-4_SlugDFallingHead_Kz.aqt
Date: 01/13/15 Time: 11:01:31

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-4
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 21.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

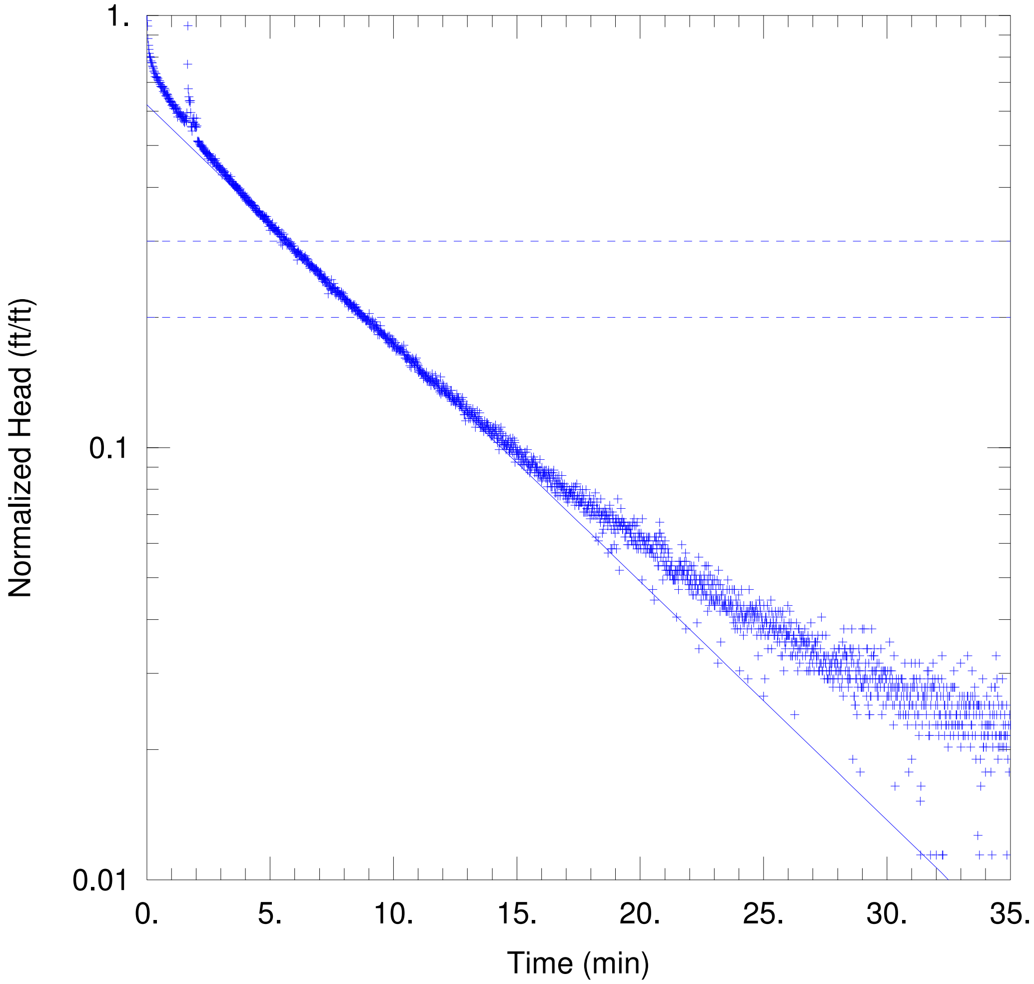
WELL DATA (RL-4 Slug C Rising Head)

Initial Displacement: 0.699 ft
Total Well Penetration Depth: 21.9 ft
Casing Radius: 0.2083 ft
Static Water Column Height: 21.9 ft
Screen Length: 21.9 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.6979 ft/day
y0 = 0.4516 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-4_SlugDRisingHead_Kz.aqt
Date: 01/13/15 Time: 11:03:18

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-4
Test Date: 26 Aug 2012

AQUIFER DATA

Saturated Thickness: 21.9 ft
Anisotropy Ratio (Kz/Kr): 0.1

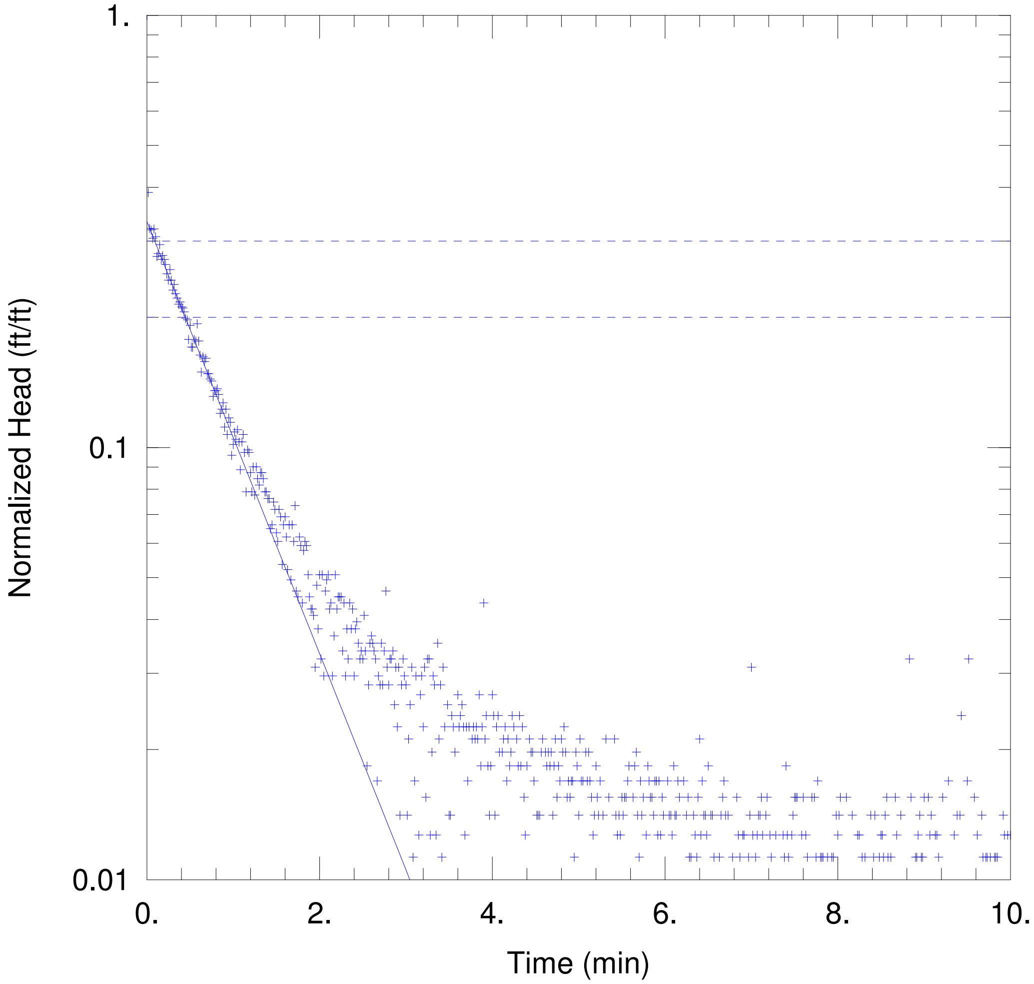
WELL DATA (RL-4 Slug D Rising Head)

Initial Displacement: 0.789 ft
Total Well Penetration Depth: 21.9 ft
Casing Radius: 0.2083 ft
Static Water Column Height: 21.9 ft
Screen Length: 21.9 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.5693 ft/day
y0 = 0.4902 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-5_SlugBFallingHeadGraph_Kz.aqt
Date: 01/13/15 Time: 11:07:20

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-5
Test Date: 25 Aug 2012

AQUIFER DATA

Saturated Thickness: 36.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

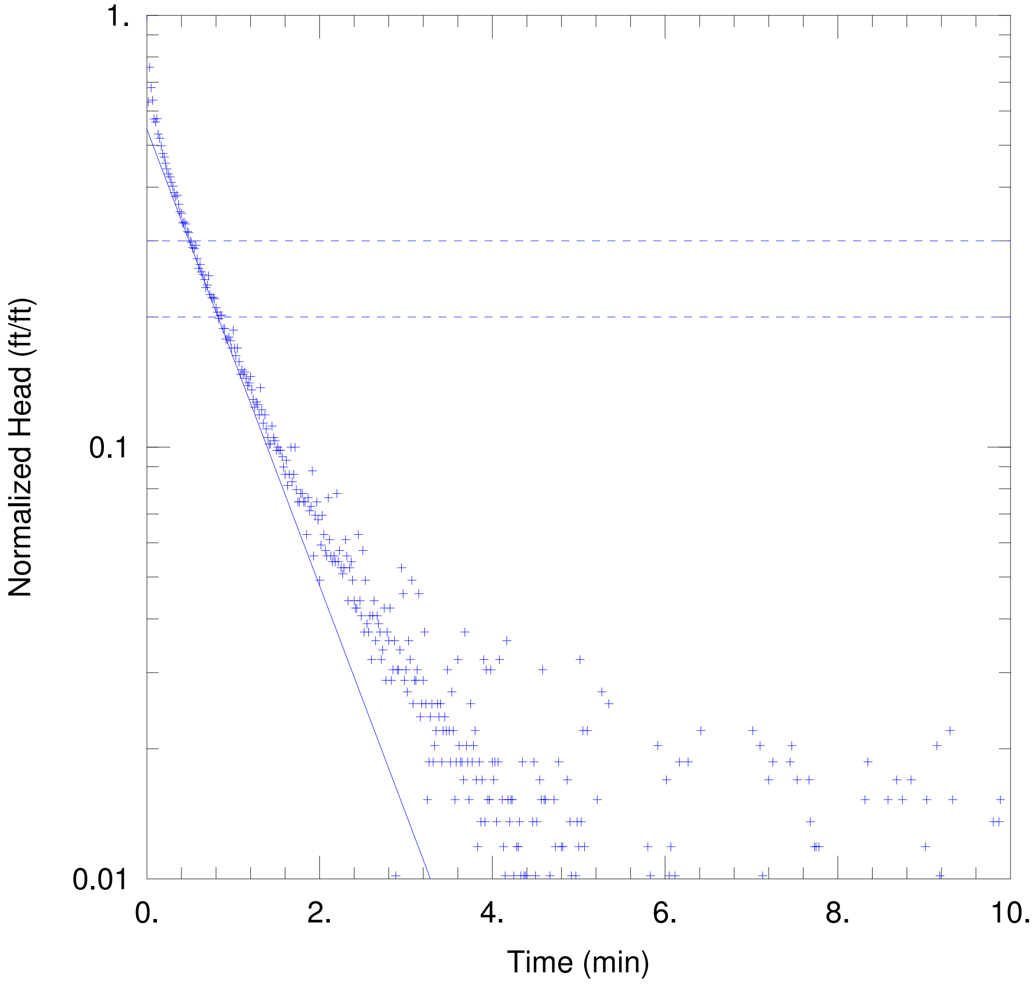
WELL DATA (RL-5 Slug B Falling Head)

Initial Displacement: 0.709 ft
Static Water Column Height: 36.4 ft
Total Well Penetration Depth: 36.4 ft
Screen Length: 36.4 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.501 ft/day
y0 = 0.2364 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-5_SlugBRisingHeadGraph_Kz.aqt
Date: 01/13/15 Time: 11:10:11

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-5
Test Date: 25 Aug 2012

AQUIFER DATA

Saturated Thickness: 36.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

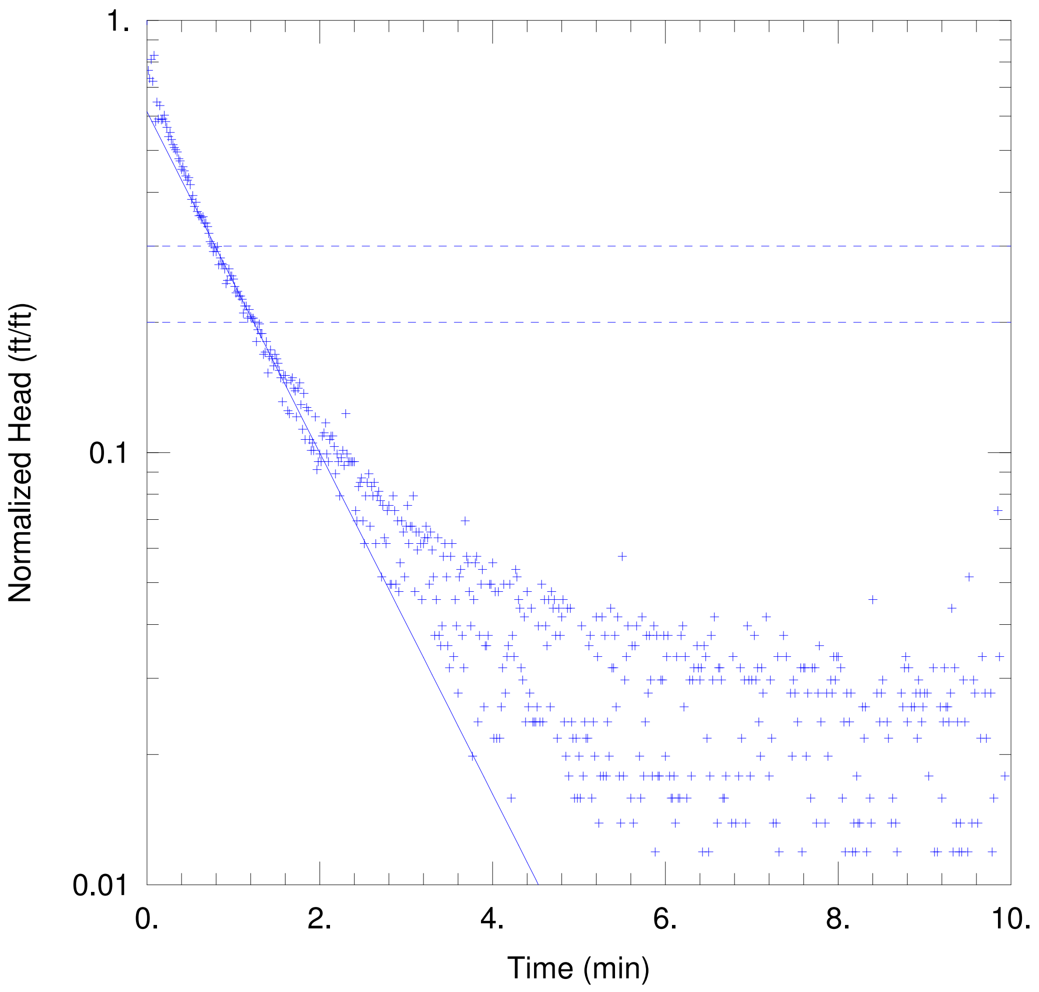
WELL DATA (RL-5 Slug B Rising Head)

Initial Displacement: 0.59 ft
Static Water Column Height: 36.4 ft
Total Well Penetration Depth: 36.4 ft
Screen Length: 36.4 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.701 ft/day
y0 = 0.321 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-5_SlugCFallingHeadGraph_Kz.aqt
Date: 01/13/15 Time: 11:11:37

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-5
Test Date: 25 Aug 2012

AQUIFER DATA

Saturated Thickness: 36.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

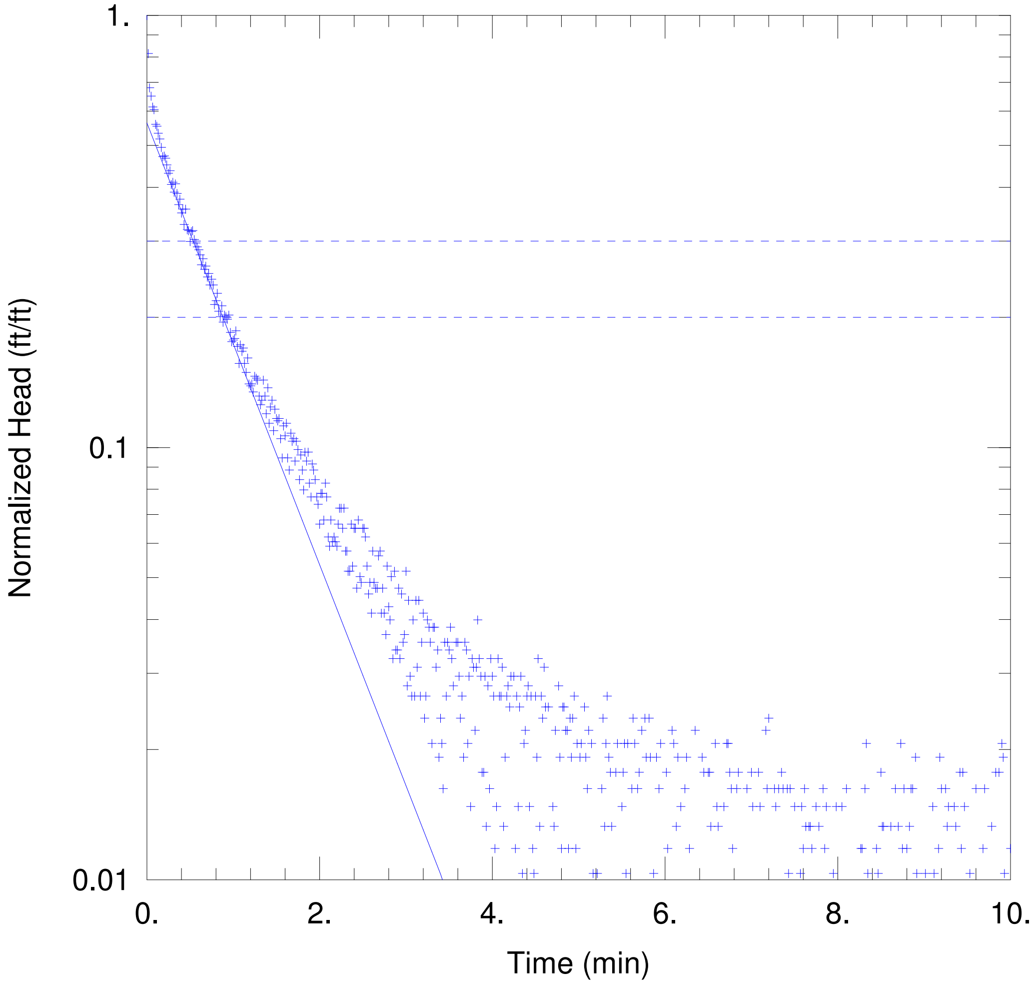
WELL DATA (RL-5 Slug C Falling Head)

Initial Displacement: 0.504 ft
Static Water Column Height: 36.4 ft
Total Well Penetration Depth: 36.4 ft
Screen Length: 36.4 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.763 ft/day
y0 = 0.3095 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-5_SlugCRisingHeadGraph_Kz.aqt
Date: 01/13/15 Time: 11:12:26

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-5
Test Date: 25 Aug 2012

AQUIFER DATA

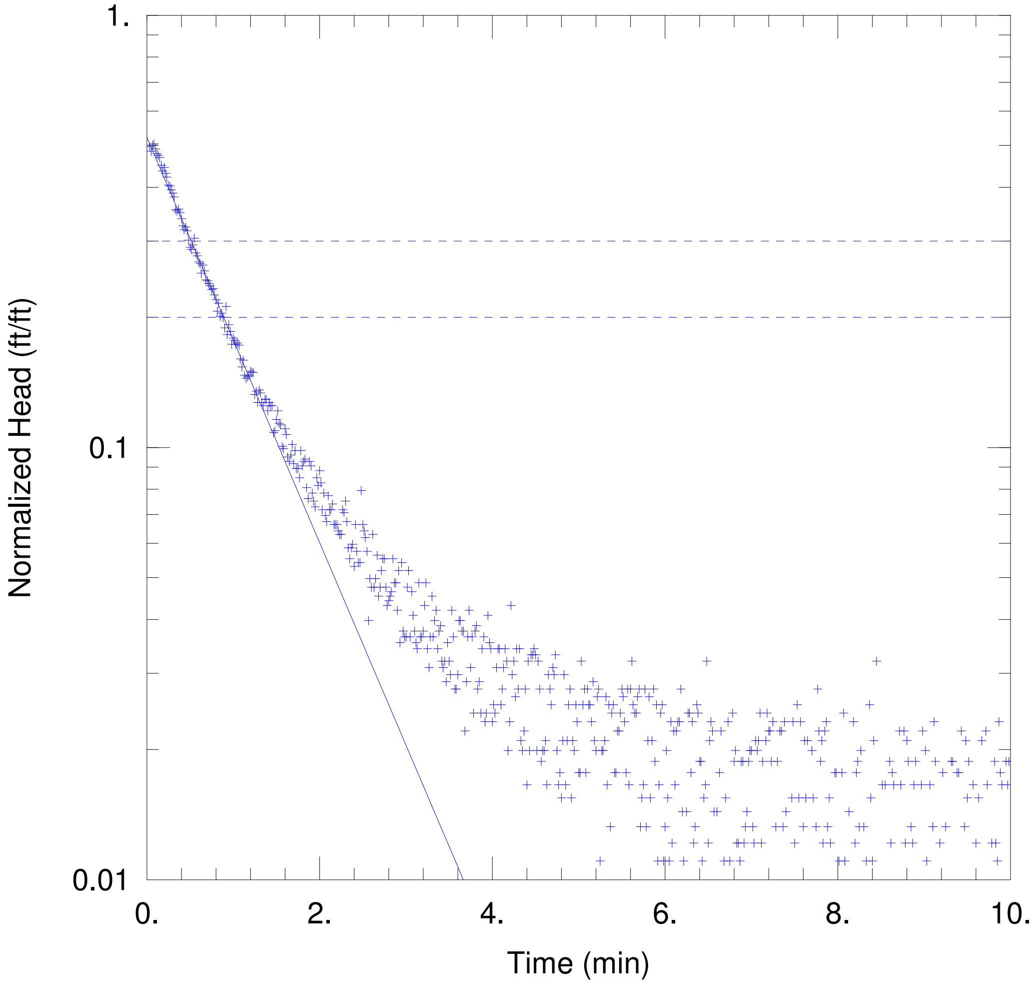
Saturated Thickness: 36.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (RL-5 Slug C Rising Head)

Initial Displacement: 0.677 ft
Static Water Column Height: 36.4 ft
Total Well Penetration Depth: 36.4 ft
Screen Length: 36.4 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.579 ft/day
y0 = 0.3815 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-5_SlugDFallingHeadGraph_Kz.aqt
Date: 01/13/15 Time: 11:13:26

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-5
Test Date: 25 Aug 2012

AQUIFER DATA

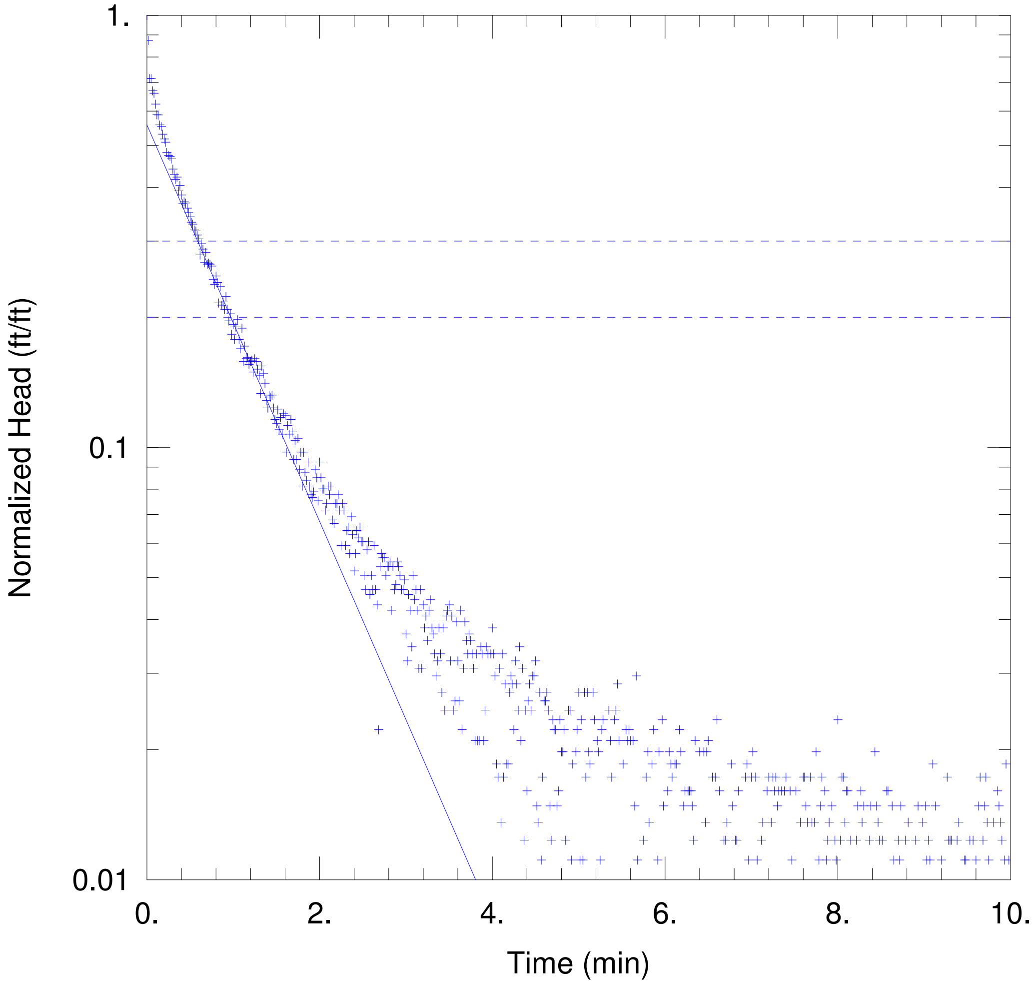
Saturated Thickness: 36.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (RL-5 Slug D Falling Head)

Initial Displacement: 0.905 ft
Static Water Column Height: 36.4 ft
Total Well Penetration Depth: 36.4 ft
Screen Length: 36.4 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.282 ft/day
y0 = 0.4722 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-5_SlugDRisingHeadGraph_Kz.aqt
Date: 01/13/15 Time: 13:51:13

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-5
Test Date: 25 Aug 2012

AQUIFER DATA

Saturated Thickness: 36.4 ft
Anisotropy Ratio (Kz/Kr): 0.1

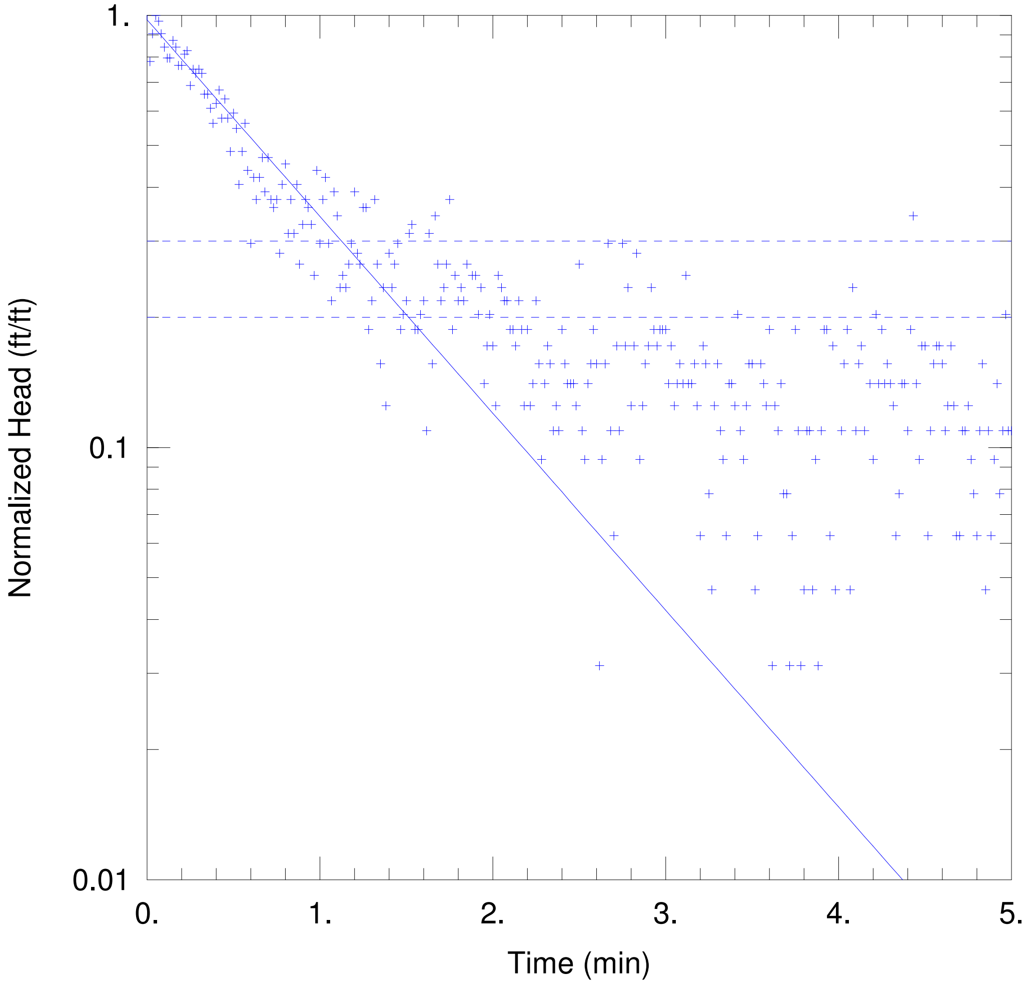
WELL DATA (RL-5 Slug D Rising Head)

Initial Displacement: 0.81 ft
Static Water Column Height: 36.4 ft
Total Well Penetration Depth: 36.4 ft
Screen Length: 36.4 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.213 ft/day
y0 = 0.4519 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-6_SlugAFallingHeadSmallHo_Kz.aqt
Date: 01/13/15 Time: 11:19:51

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-6
Test Date: 25 Aug 2012

AQUIFER DATA

Saturated Thickness: 6.03 ft
Anisotropy Ratio (Kz/Kr): 0.1

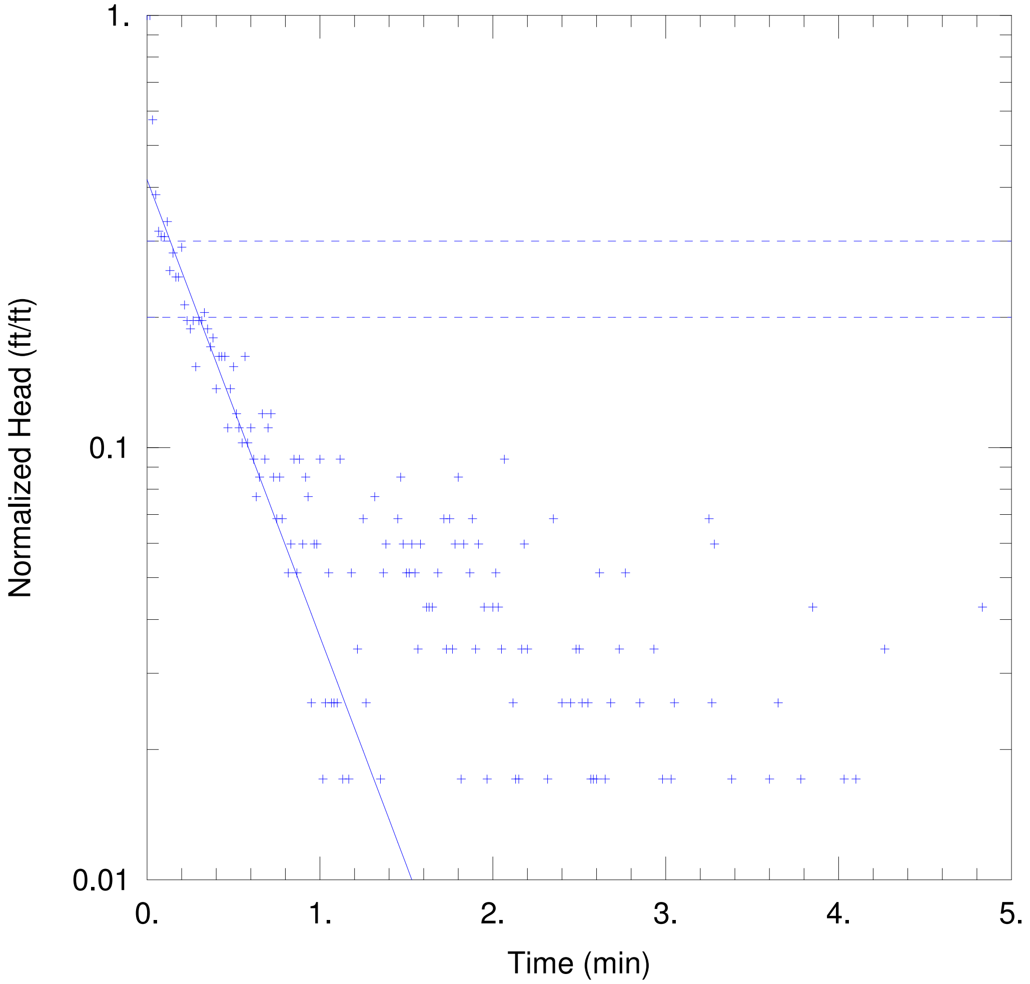
WELL DATA (RL-6 Slug A Falling Head)

Initial Displacement: 0.064 ft
Total Well Penetration Depth: 6.03 ft
Casing Radius: 0.2083 ft
Static Water Column Height: 6.03 ft
Screen Length: 6.03 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 11.17 ft/day
y0 = 0.06246 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-6_SlugARisingHeadSmallHo_Kz.aqt
Date: 01/13/15 Time: 11:20:46

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-6
Test Date: 25 Aug 2012

AQUIFER DATA

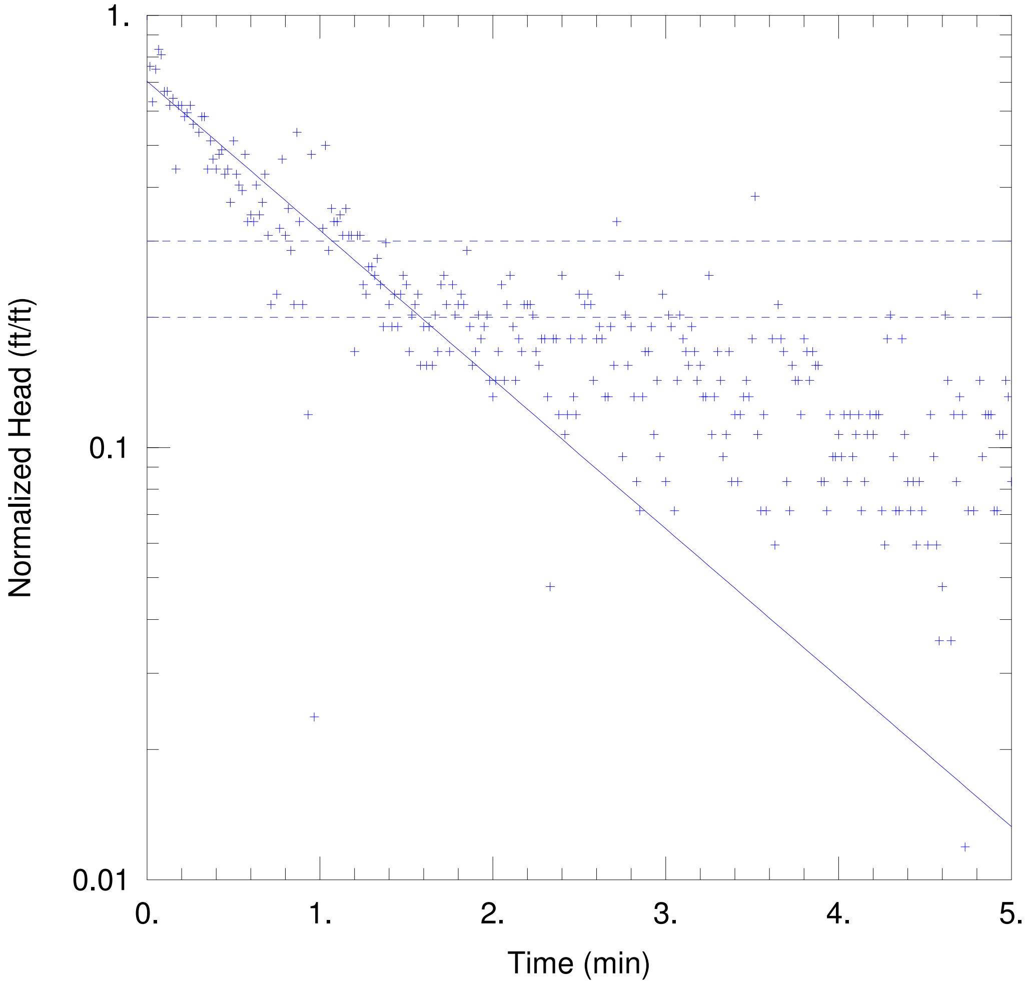
Saturated Thickness: 6.03 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (RL-6 Slug A Rising Head)

Initial Displacement: 0.117 ft
Static Water Column Height: 6.03 ft
Total Well Penetration Depth: 6.03 ft
Screen Length: 6.03 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 25.96 ft/day
y0 = 0.04869 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-6_SlugBFallingHead_Kz.aqt
Date: 01/13/15 Time: 11:21:48

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-6
Test Date: 25 Aug 2012

AQUIFER DATA

Saturated Thickness: 6.03 ft
Anisotropy Ratio (Kz/Kr): 0.1

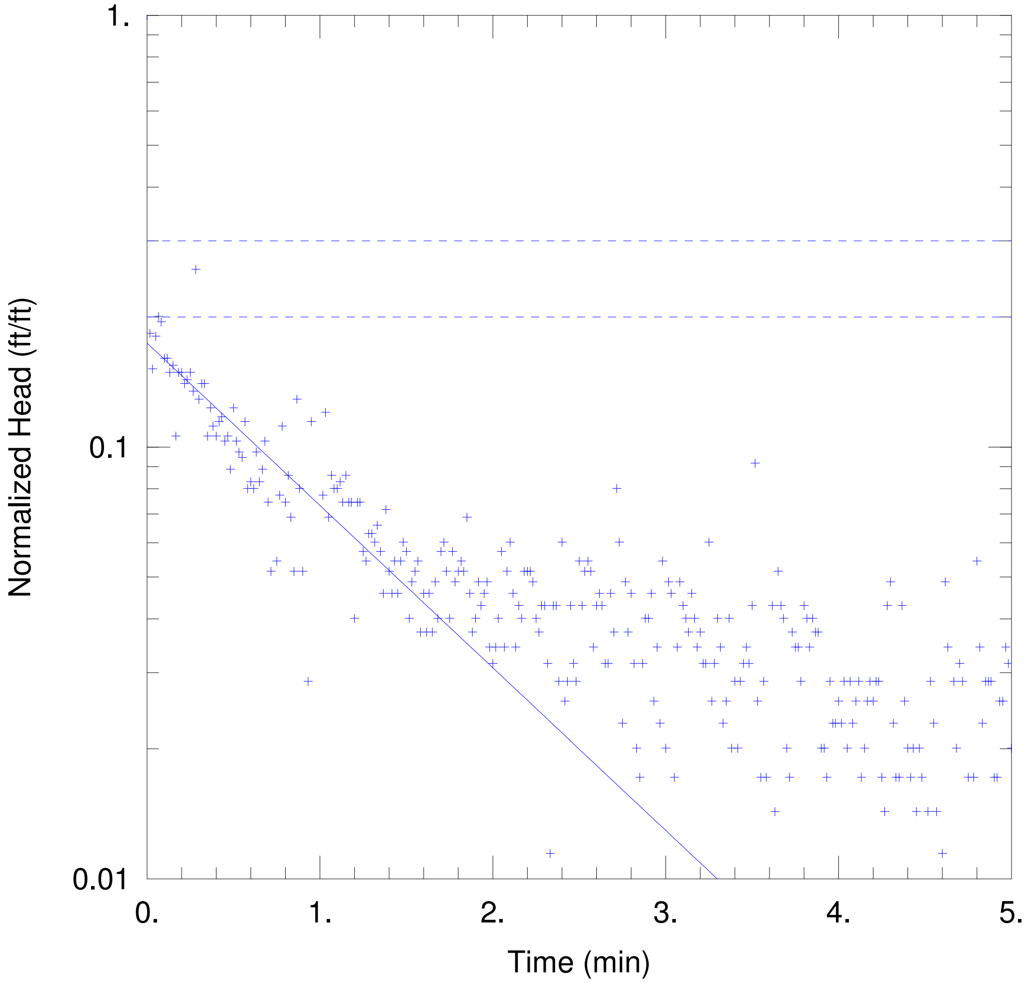
WELL DATA (RL-6 Slug B Falling Head)

Initial Displacement: 0.084 ft
Static Water Column Height: 6.03 ft
Total Well Penetration Depth: 6.03 ft
Screen Length: 6.03 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 8.465 ft/day
y0 = 0.05905 ft



WELL TEST ANALYSIS

Data Set: S:\...\RL-6_SlugBRisingHead_Kz.aqt
Date: 01/13/15 Time: 11:23:14

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: RL-6
Test Date: 25 Aug 2012

AQUIFER DATA

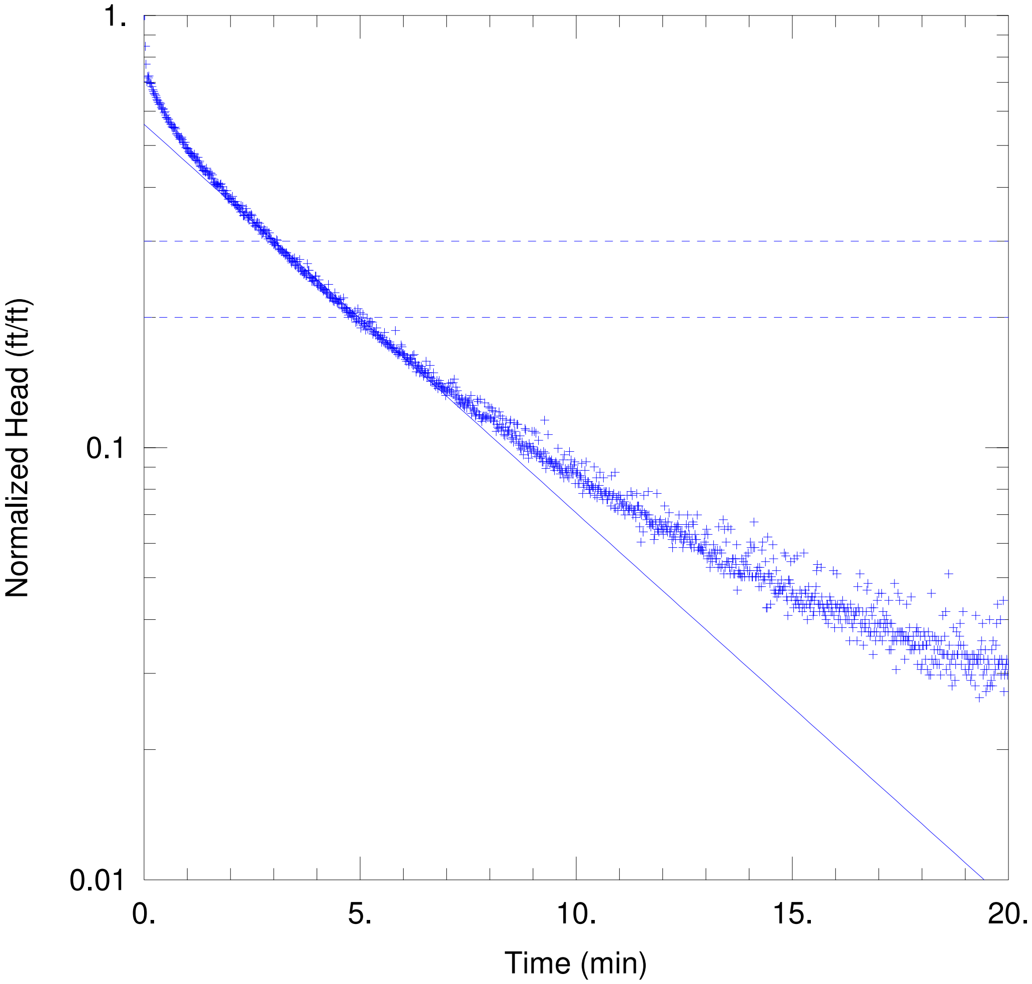
Saturated Thickness: 6.03 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (RL-6 Slug B Rising Head)

Initial Displacement: 0.349 ft
Static Water Column Height: 6.03 ft
Total Well Penetration Depth: 6.03 ft
Screen Length: 6.03 ft
Casing Radius: 0.2083 ft
Well Radius: 0.3646 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 9.233 ft/day
y0 = 0.06074 ft



UW-1 SLUG C&G FALLING HEAD

Data Set: S:\...\UW-1_SlugC&GFallingHead_Kz.aqt
Date: 01/13/15 Time: 11:24:49

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: UW-1
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 34.64 ft
Anisotropy Ratio (Kz/Kr): 0.1

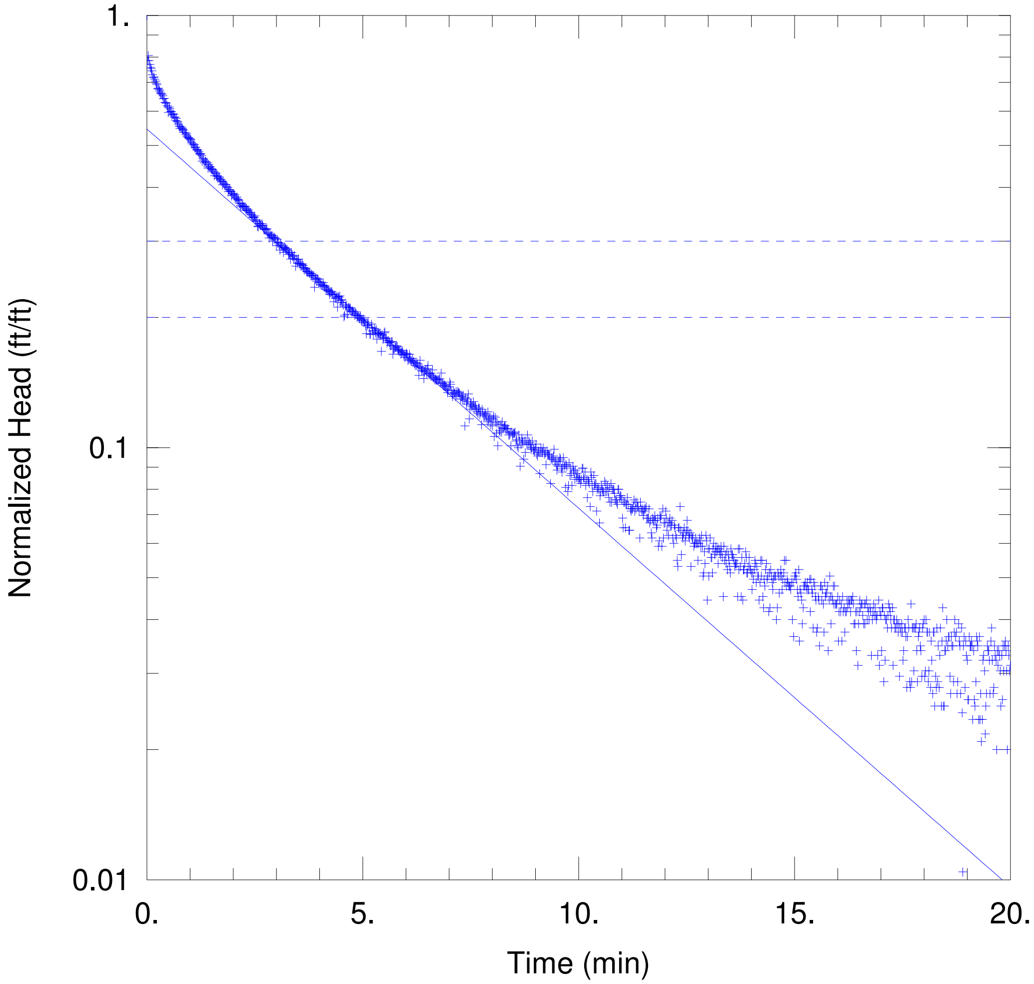
WELL DATA (UW-1)

Initial Displacement: 1.175 ft
Total Well Penetration Depth: 34.64 ft
Casing Radius: 0.167 ft
Static Water Column Height: 34.64 ft
Screen Length: 34.64 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.4291 ft/day
y0 = 0.6578 ft



UW-1 SLUG C&G RISING HEAD

Data Set: S:\...\UW-1_SlugC&GRisingHead_Kz.aqt
Date: 01/13/15 Time: 11:25:56

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: UW-1
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 34.64 ft
Anisotropy Ratio (Kz/Kr): 0.1

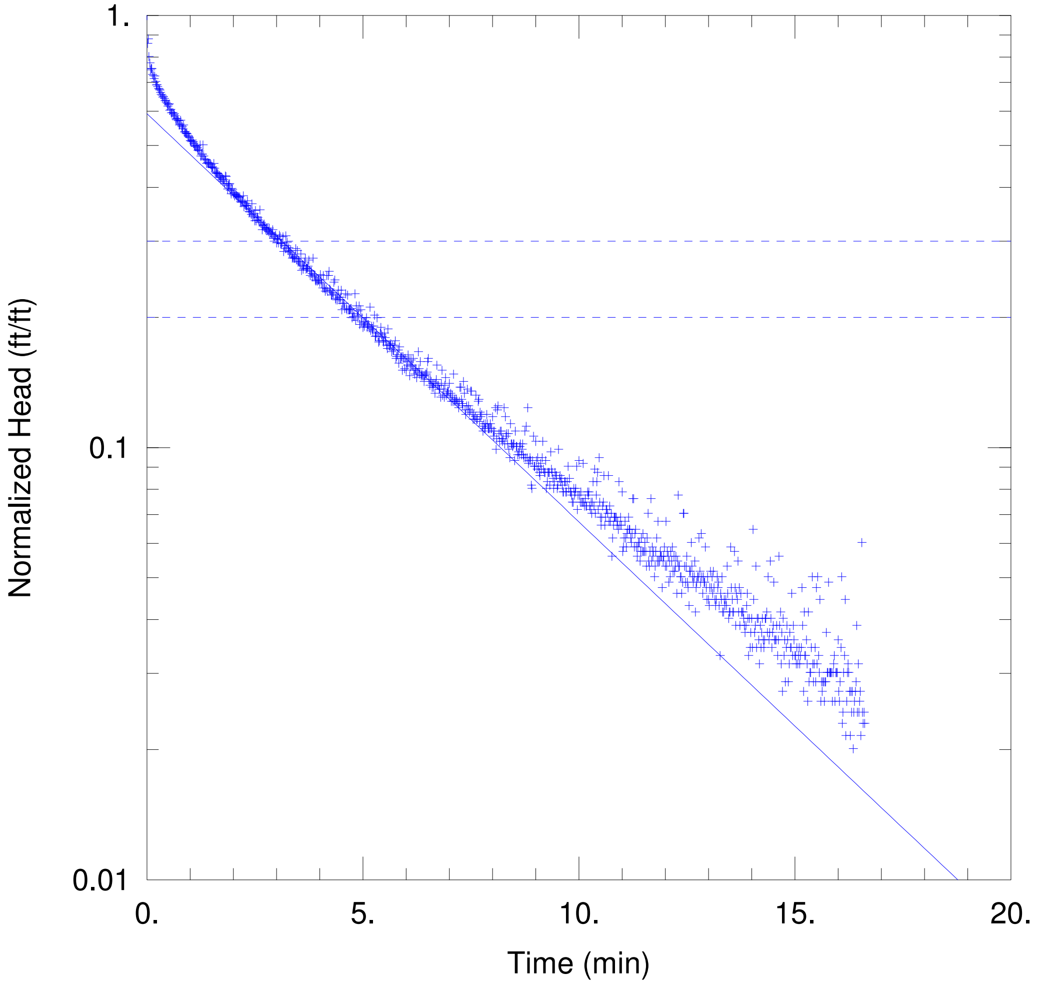
WELL DATA (UW-1)

Initial Displacement: 1.15 ft
Total Well Penetration Depth: 34.64 ft
Casing Radius: 0.167 ft
Static Water Column Height: 34.64 ft
Screen Length: 34.64 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.4184 ft/day
y0 = 0.6273 ft



UW-1 SLUG C FALLING HEAD

Data Set: S:\...\UW-1_SlugCFallingHead_Kz.aqt
Date: 01/13/15 Time: 11:27:10

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: UW-1
Test Date: 4 Nov 2012

AQUIFER DATA

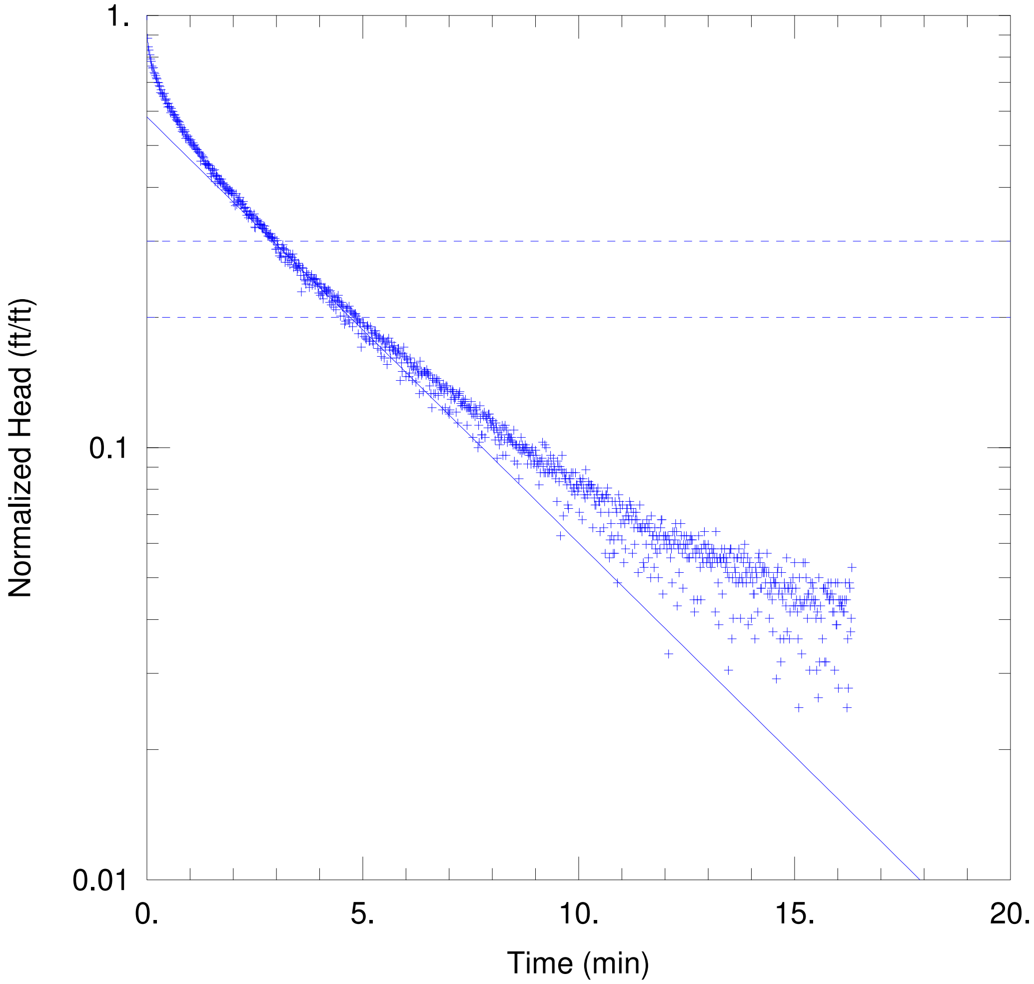
Saturated Thickness: 34.64 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (UW-1)

Initial Displacement: 0.696 ft
Static Water Column Height: 34.64 ft
Total Well Penetration Depth: 34.64 ft
Screen Length: 34.64 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.4506 ft/day
y0 = 0.4121 ft



UW-1 SLUG C RISING HEAD

Data Set: S:\...\UW-1_SlugCRisingHead_Kz.aqt
Date: 01/13/15 Time: 11:29:04

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: UW-1
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 34.64 ft
Anisotropy Ratio (Kz/Kr): 0.1

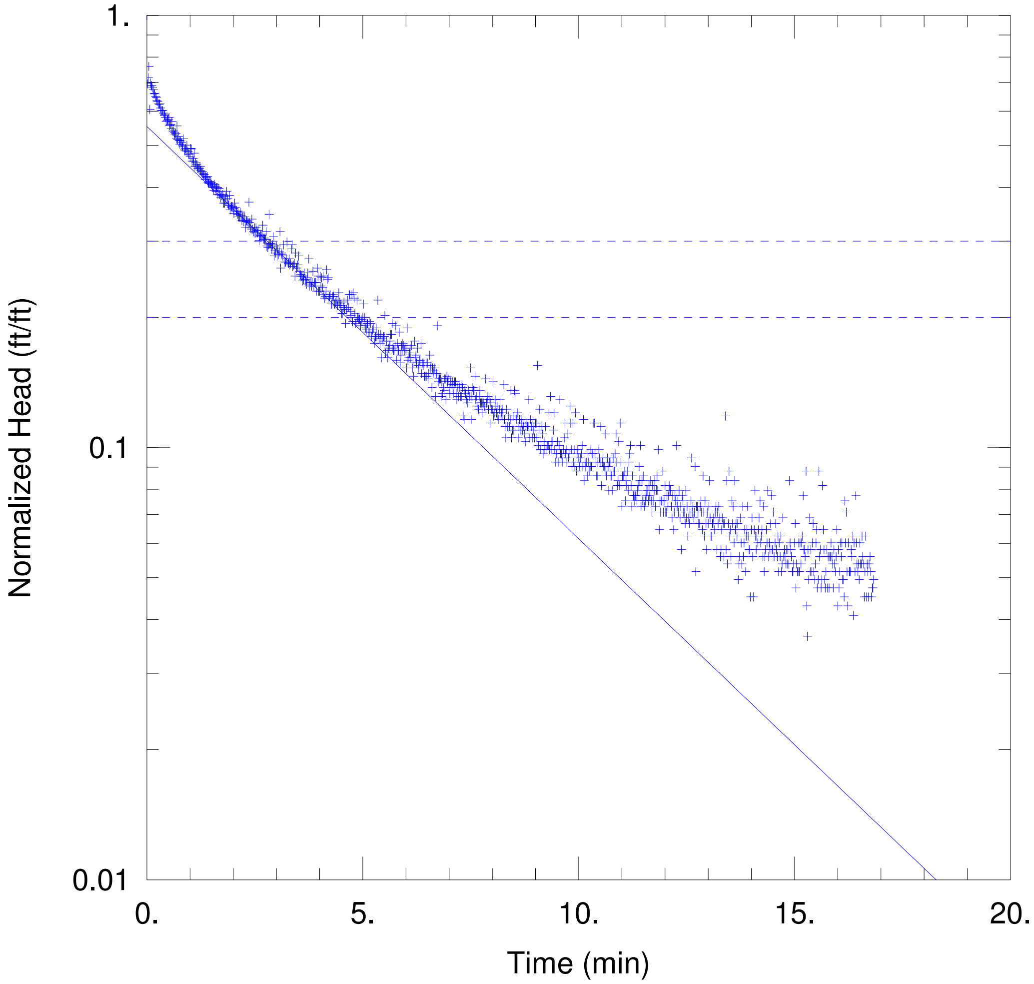
WELL DATA (UW-1)

Initial Displacement: 0.72 ft
Total Well Penetration Depth: 34.64 ft
Casing Radius: 0.167 ft
Static Water Column Height: 34.64 ft
Screen Length: 34.64 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.4704 ft/day
y0 = 0.4191 ft



UW-1 SLUG G FALLING HEAD

Data Set: S:\...\UW-1_SlugGFallingHead_Kz.aqt
Date: 01/13/15 Time: 11:29:48

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: UW-1
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 34.64 ft
Anisotropy Ratio (Kz/Kr): 0.1

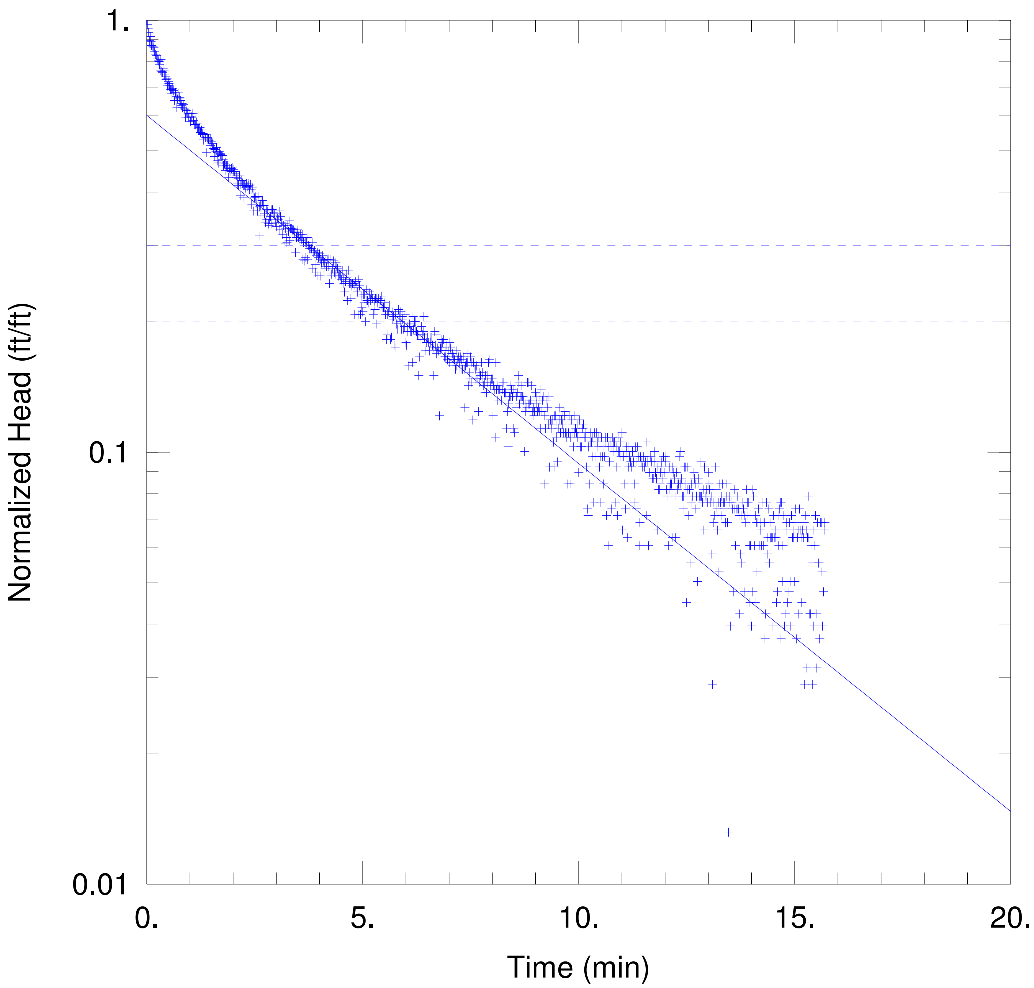
WELL DATA (UW-1)

Initial Displacement: 0.465 ft
Total Well Penetration Depth: 34.64 ft
Casing Radius: 0.167 ft
Static Water Column Height: 34.64 ft
Screen Length: 34.64 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.455 ft/day
y0 = 0.2572 ft



UW-1 SLUG G RISING HEAD

Data Set: S:\...\UW-1_SlugGRisingHead_Kz.aqt
Date: 01/13/15 Time: 11:30:27

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.14
Location: Lisbon
Test Well: UW-1
Test Date: 4 Nov 2012

AQUIFER DATA

Saturated Thickness: 34.64 ft
Anisotropy Ratio (Kz/Kr): 0.1

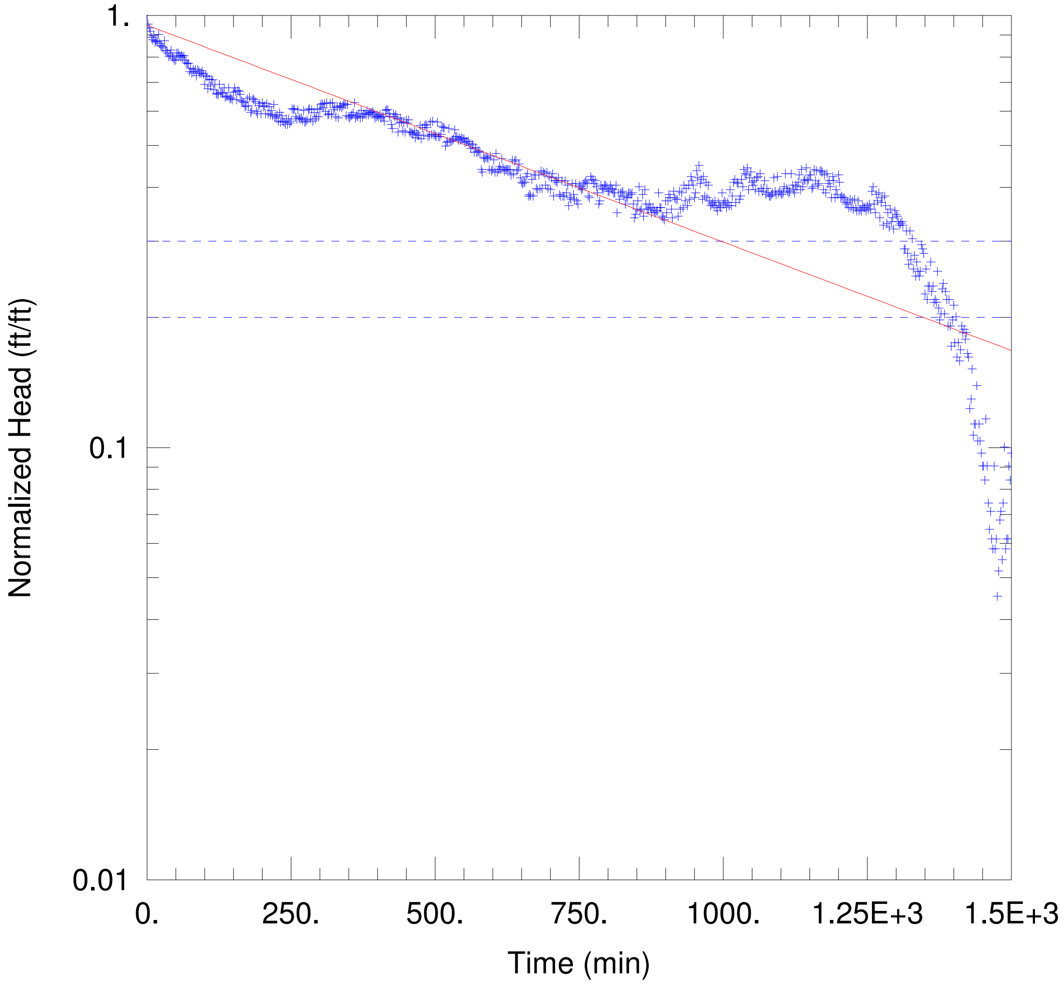
WELL DATA (UW-1)

Initial Displacement: 0.379 ft
Total Well Penetration Depth: 34.64 ft
Casing Radius: 0.167 ft
Static Water Column Height: 34.64 ft
Screen Length: 34.64 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3844 ft/day
y0 = 0.228 ft



MW-104 SLUG A FALLING HEAD

Data Set: S:\...\MW-104_SlugAFallingHead_Kz.aqt
Date: 01/14/15 Time: 09:04:45

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-104
Test Date: 11 Sep 2013

AQUIFER DATA

Saturated Thickness: 3.08 ft
Anisotropy Ratio (Kz/Kr): 0.1

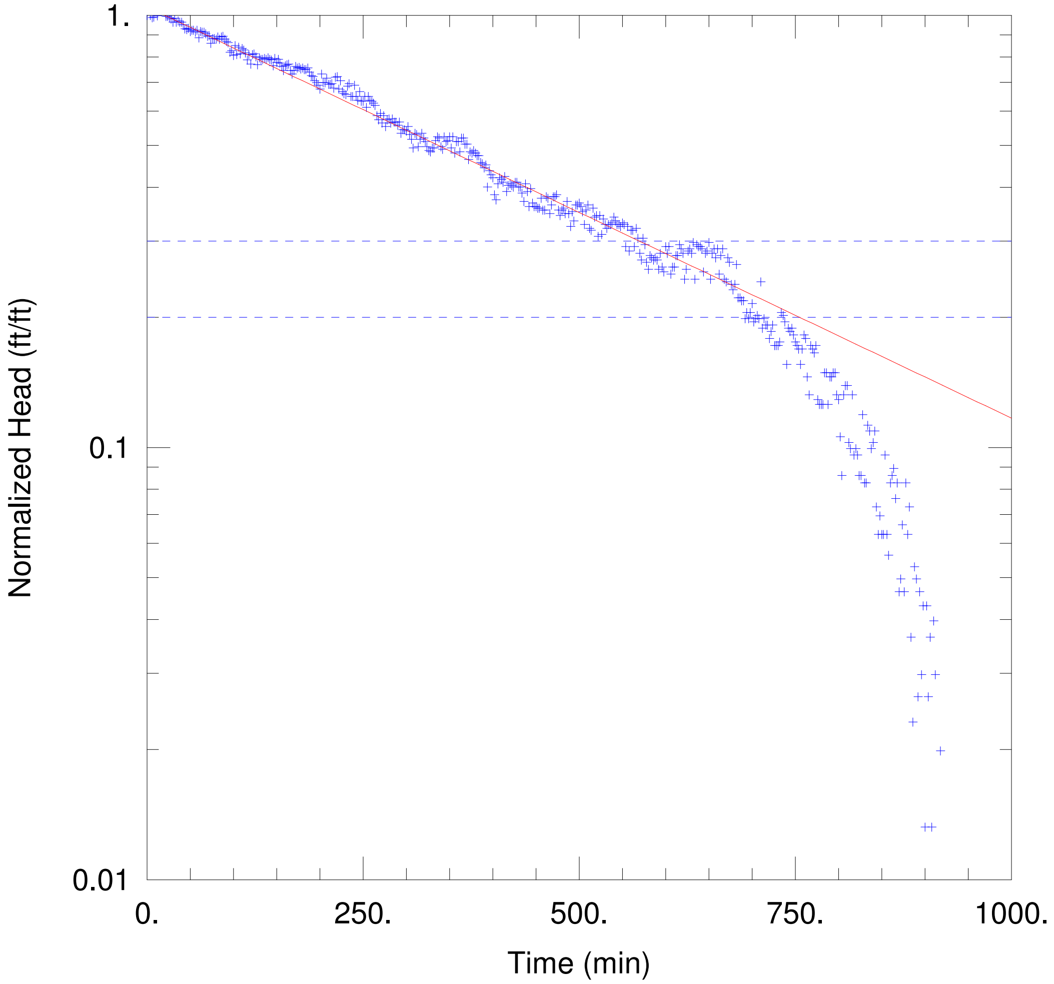
WELL DATA (MW-104)

Initial Displacement: 0.309 ft
Static Water Column Height: 3.08 ft
Total Well Penetration Depth: 3.08 ft
Screen Length: 3.08 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.01199 ft/day
y0 = 0.2931 ft



MW-104 SLUG A RISING HEAD

Data Set: S:\...\MW-104_SlugARisingHead_Kz.aqt
Date: 01/14/15
Time: 09:09:38

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-104
Test Date: 14 Sep 2013

AQUIFER DATA

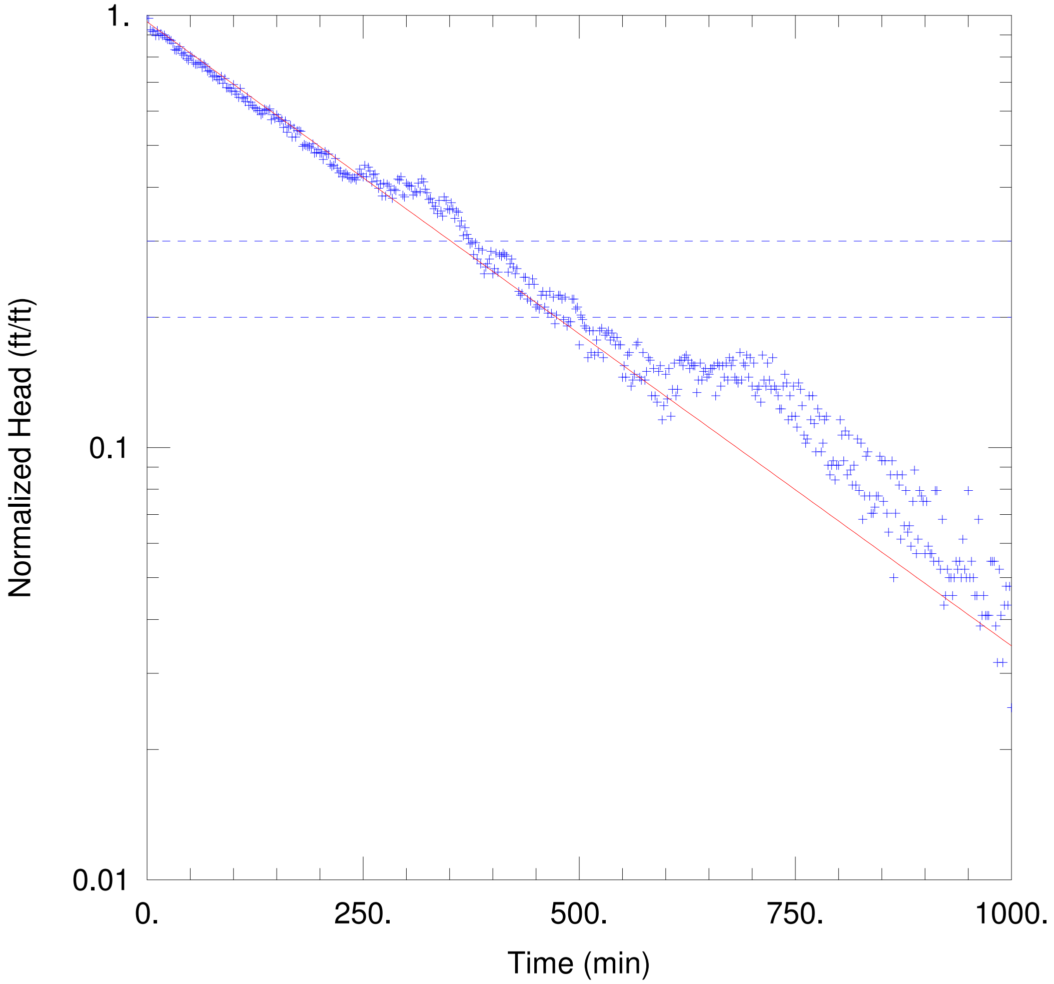
Saturated Thickness: 3.08 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-104)

Initial Displacement: 0.302 ft
Total Well Penetration Depth: 3.08 ft
Casing Radius: 0.167 ft
Static Water Column Height: 3.08 ft
Screen Length: 3.08 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.02273 ft/day
y0 = 0.3158 ft



MW-104 SLUG B FALLING HEAD

Data Set: S:\...\MW-104_SlugBFallingHead_Kz.aqt
Date: 01/14/15 Time: 09:11:33

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-104
Test Date: 27 Aug 2013

AQUIFER DATA

Saturated Thickness: 3.08 ft
Anisotropy Ratio (Kz/Kr): 0.1

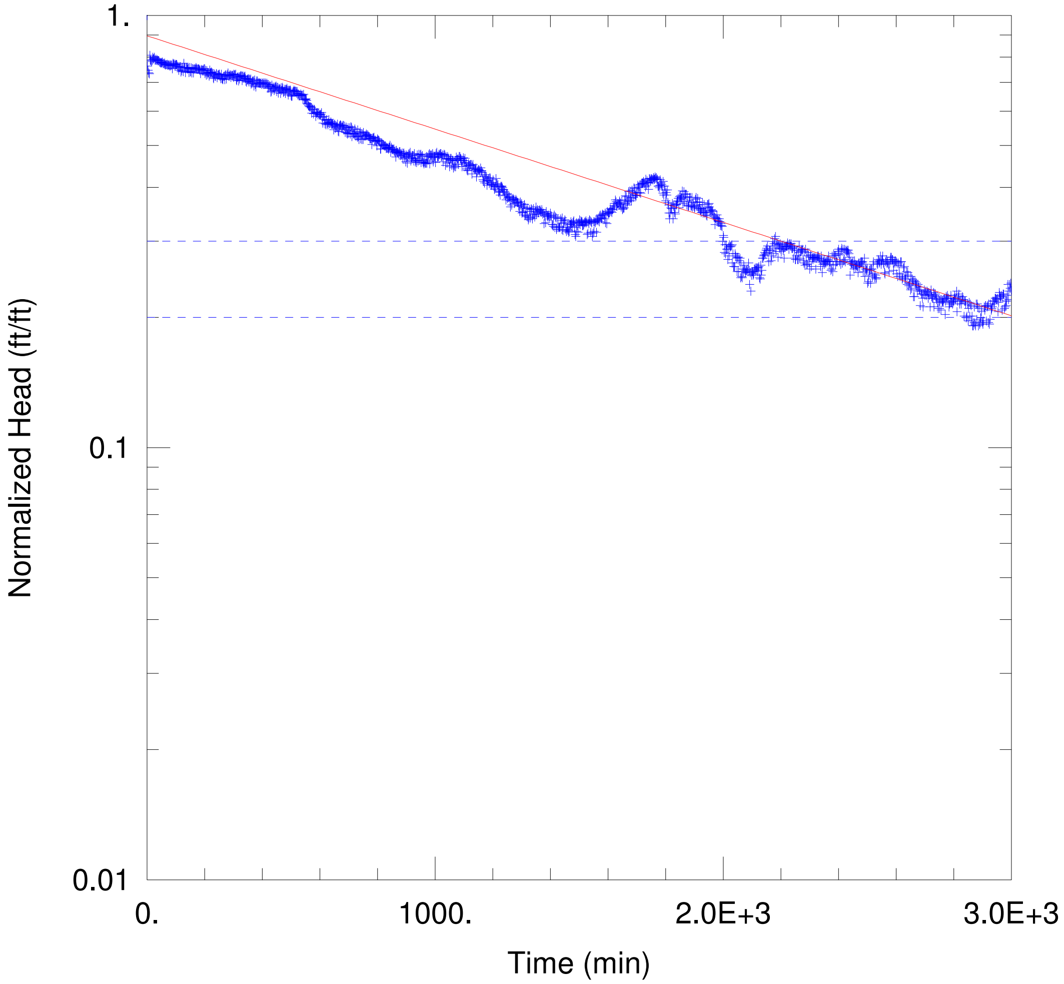
WELL DATA (MW-104)

Initial Displacement: 0.44 ft
Total Well Penetration Depth: 3.08 ft
Casing Radius: 0.167 ft
Static Water Column Height: 3.08 ft
Screen Length: 3.08 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.03449 ft/day
y0 = 0.4248 ft



MW-104 SLUG B RISING HEAD

Data Set: S:\...\MW-104_SlugBRisingHead_Kz.aqt
Date: 01/14/15 Time: 09:12:32

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-104
Test Date: 29 Aug 2013

AQUIFER DATA

Saturated Thickness: 3.08 ft
Anisotropy Ratio (Kz/Kr): 0.1

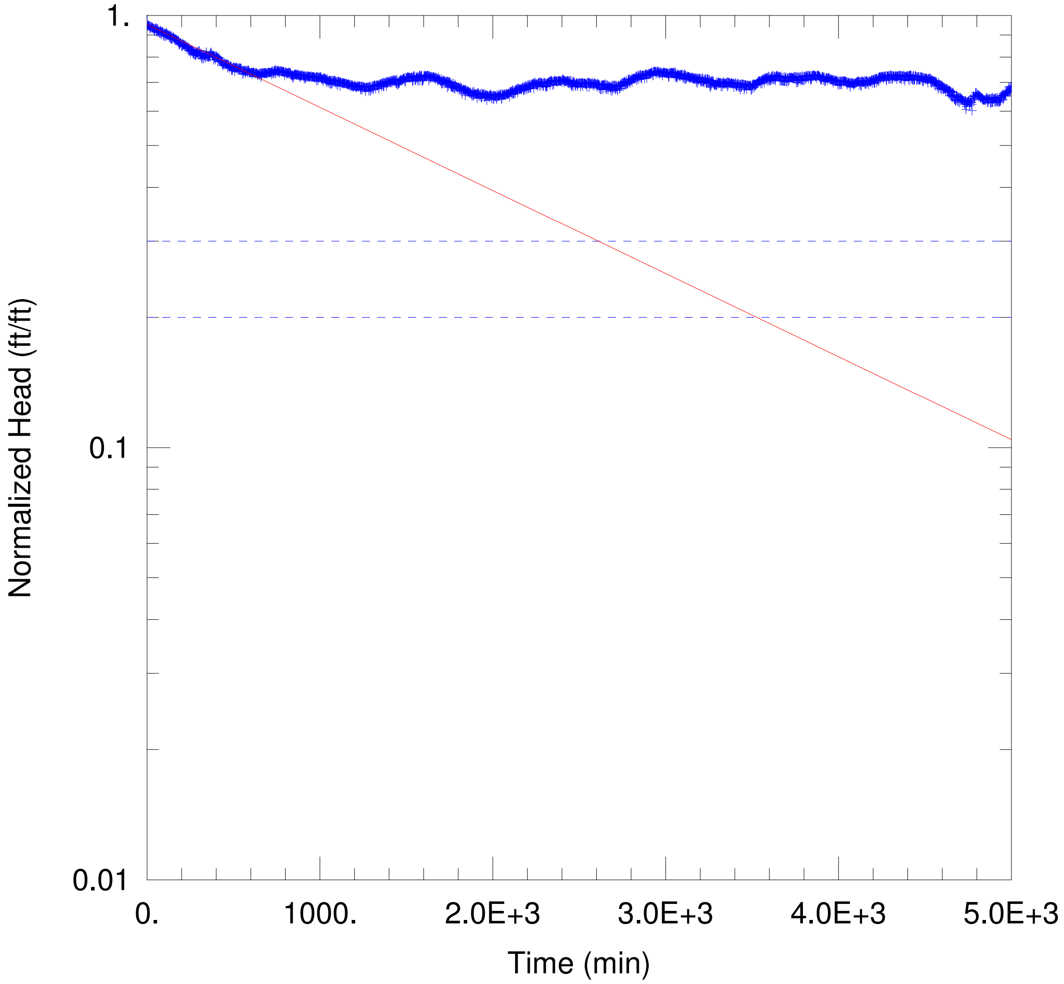
WELL DATA (MW-104)

Initial Displacement: 0.591 ft
Total Well Penetration Depth: 3.08 ft
Casing Radius: 0.167 ft
Static Water Column Height: 3.08 ft
Screen Length: 3.08 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.005158 ft/day
y0 = 0.5299 ft



MW-106 SLUG F FALLING HEAD

Data Set: S:\...\MW-106_SlugFFallingHead_Kz.aqt
Date: 01/14/15 Time: 09:13:43

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-106
Test Date: 19 Aug 2013

AQUIFER DATA

Saturated Thickness: 19.7 ft
Anisotropy Ratio (Kz/Kr): 0.1

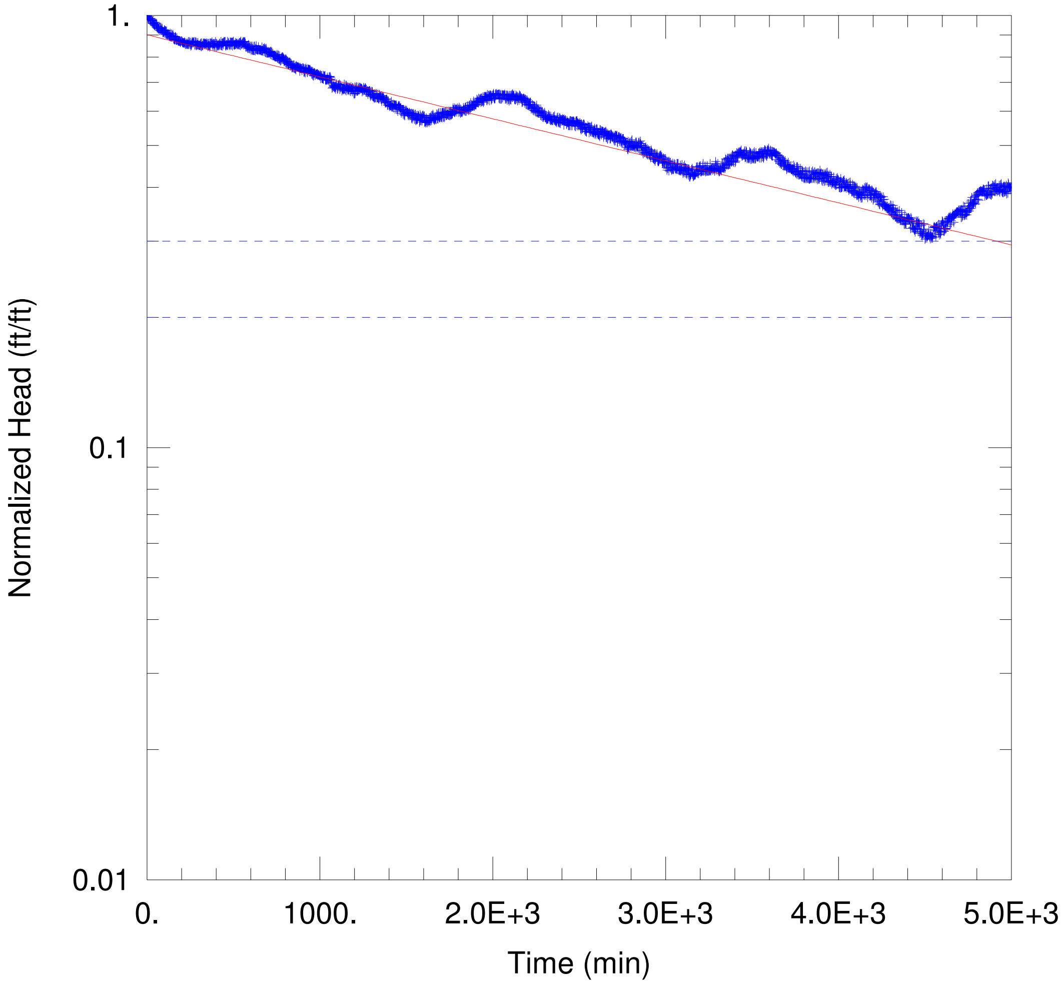
WELL DATA (MW-106)

Initial Displacement: 0.84 ft
Static Water Column Height: 30.59 ft
Total Well Penetration Depth: 19.7 ft
Screen Length: 19.7 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.001412 ft/day
y0 = 0.8007 ft



MW-106 SLUG F RISING HEAD

Data Set: S:\...\MW-106_SlugFRisingHead.aqt
Date: 01/14/15 Time: 09:15:17

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-106
Test Date: 1 Sept 2013

AQUIFER DATA

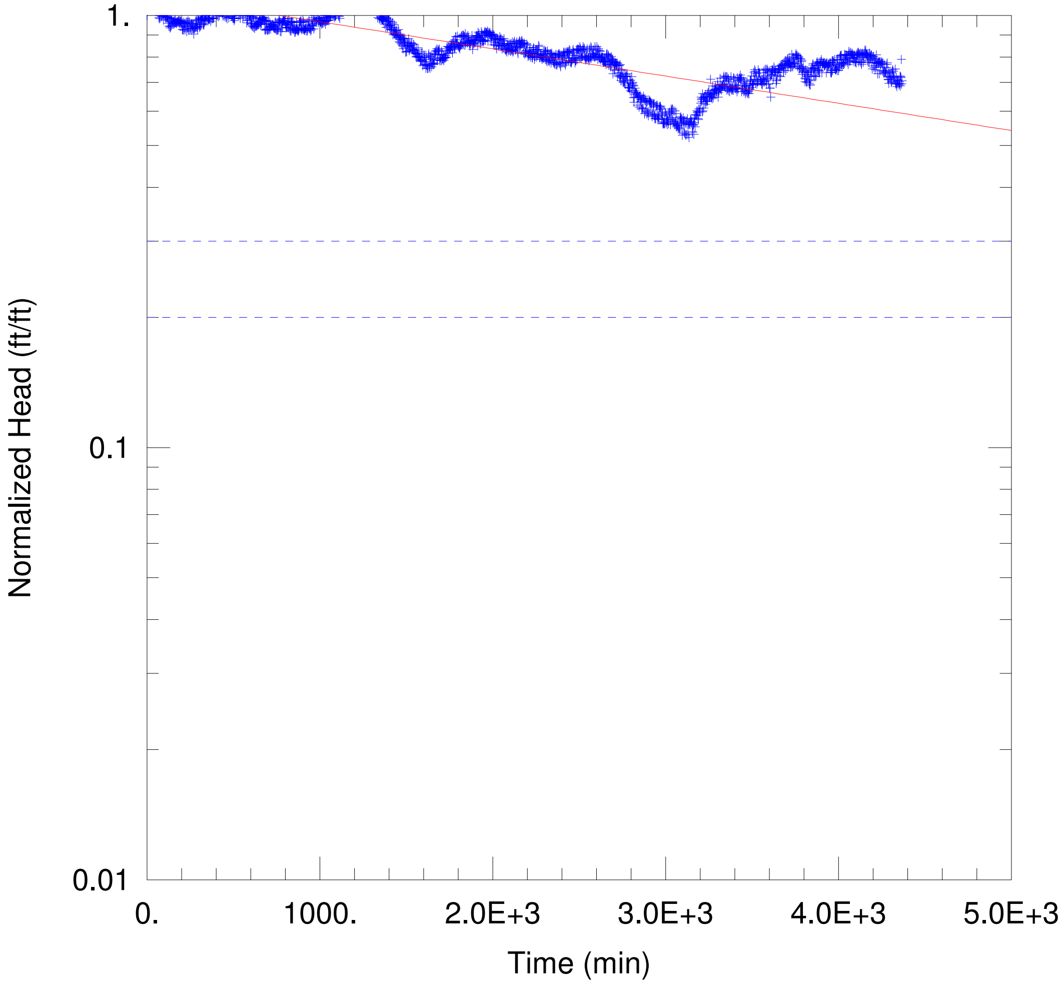
Saturated Thickness: 19.7 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-106)

Initial Displacement: 0.828 ft
Total Well Penetration Depth: 19.7 ft
Casing Radius: 0.167 ft
Static Water Column Height: 30.59 ft
Screen Length: 19.7 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0007136 ft/day
y0 = 0.7462 ft



MW-106 SLUG H FALLING HEAD

Data Set: S:\...\MW-106_SlugHFallingHead_Kz.aqt
Date: 01/14/15 Time: 09:16:16

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-106
Test Date: 11 Sept 2013

AQUIFER DATA

Saturated Thickness: 19.7 ft
Anisotropy Ratio (Kz/Kr): 0.1

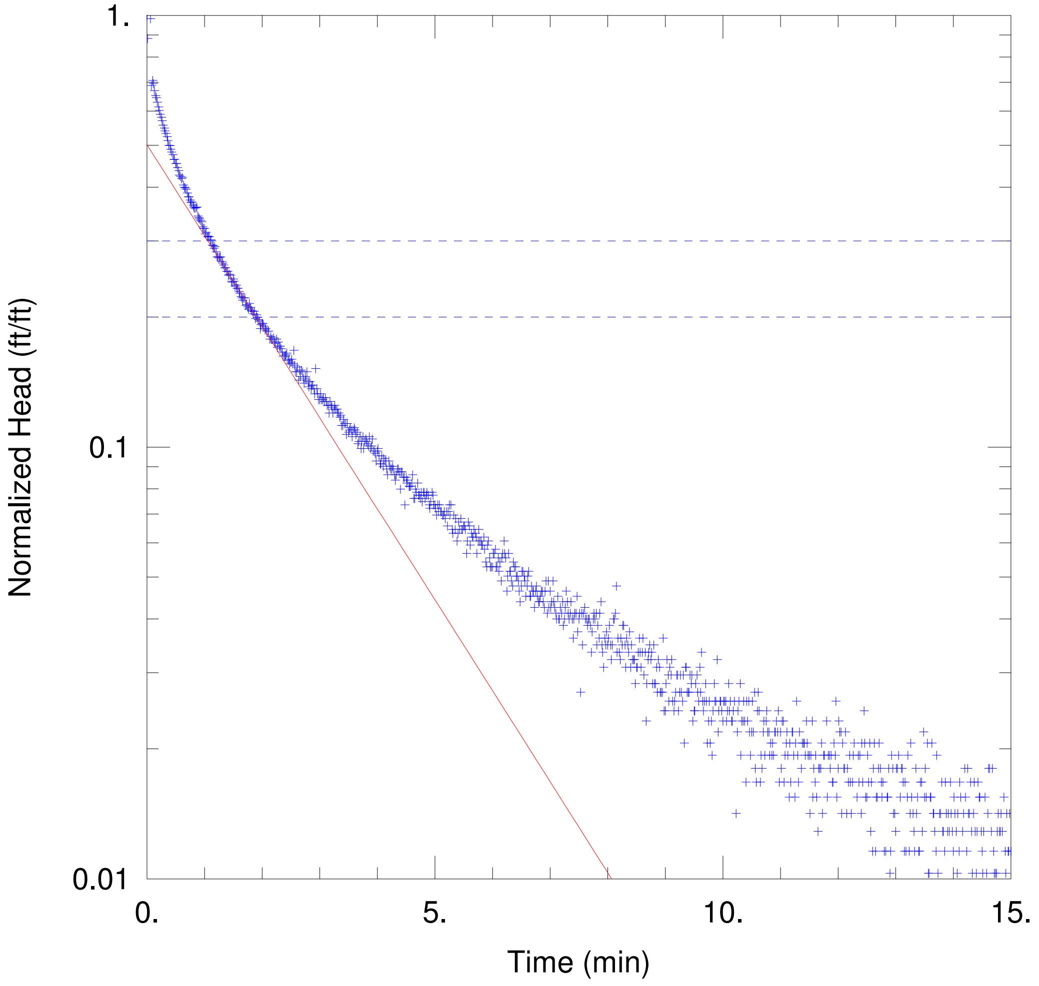
WELL DATA (MW-106)

Initial Displacement: 0.326 ft
Total Well Penetration Depth: 19.7 ft
Casing Radius: 0.167 ft
Static Water Column Height: 30.59 ft
Screen Length: 19.7 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0004622 ft/day
y0 = 0.3642 ft



MW-107D SLUG B FALLING HEAD

Data Set: S:\...\MW-107D_SlugBFallingHeadSlugHo_Kz.aqt
Date: 01/14/15
Time: 09:18:28

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107D
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 30.59 ft
Anisotropy Ratio (Kz/Kr): 0.1

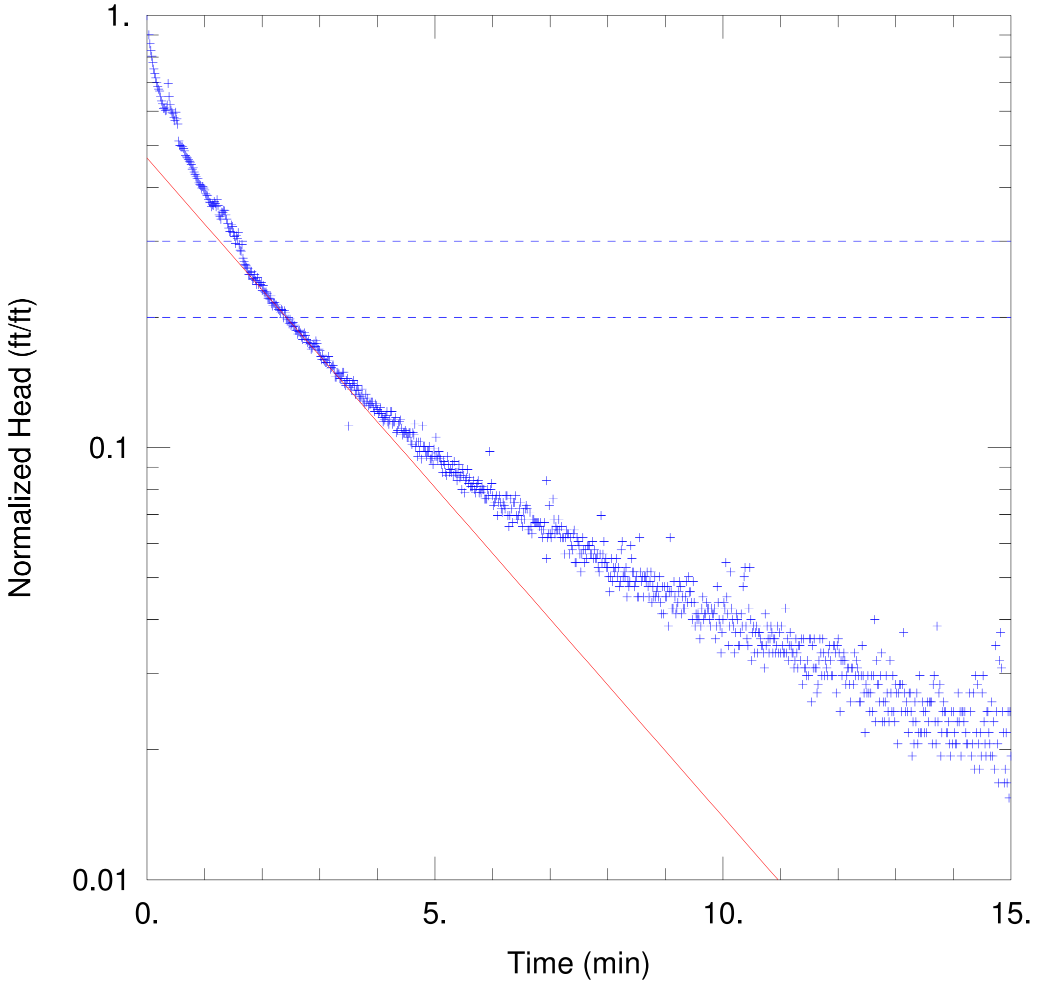
WELL DATA (MW-107D)

Initial Displacement: 0.776 ft
Total Well Penetration Depth: 30.59 ft
Casing Radius: 0.167 ft
Static Water Column Height: 30.59 ft
Screen Length: 20. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.126 ft/day
y0 = 0.3893 ft



MW-107D SLUG B RISING HEAD

Data Set: S:\...\MW-107D_SlugBRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:19:54

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107D
Test Date: 1 Oct 2013

AQUIFER DATA

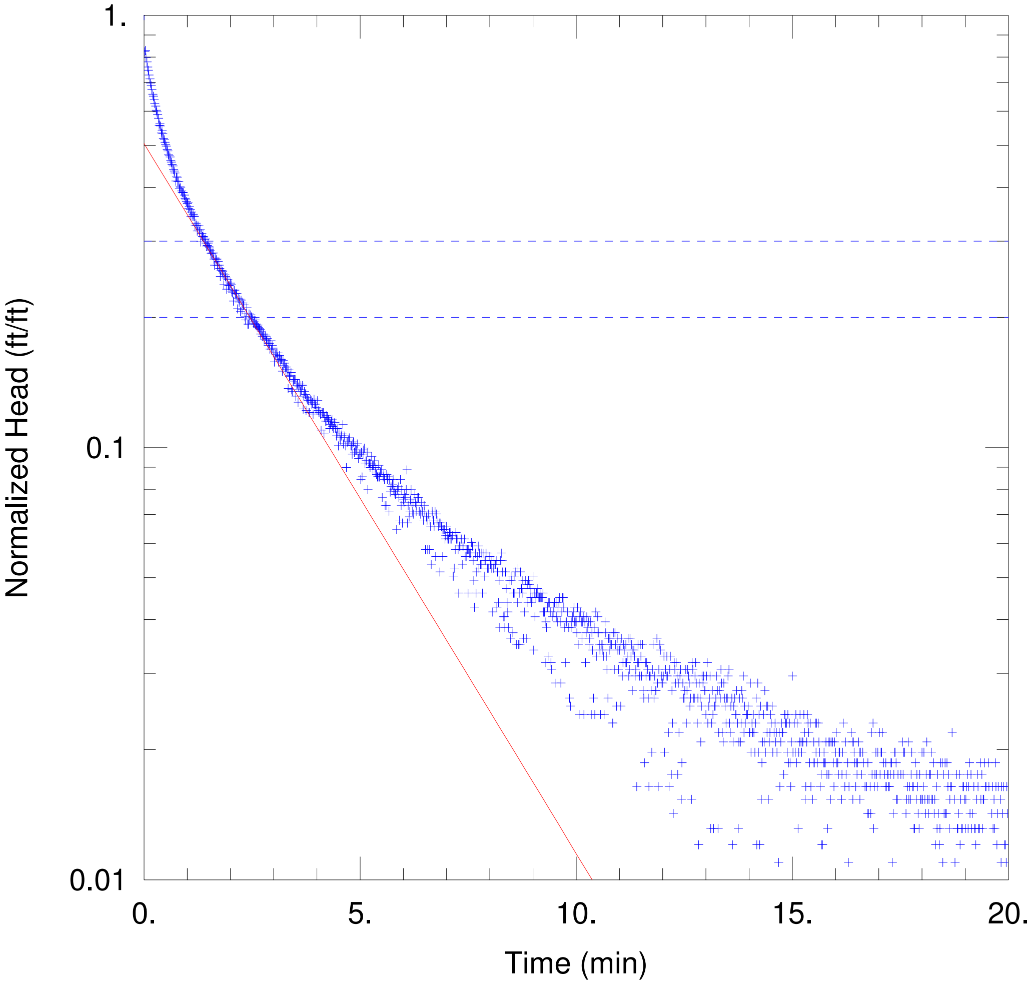
Saturated Thickness: 30.59 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-107D)

Initial Displacement: 0.776 ft
Static Water Column Height: 30.59 ft
Total Well Penetration Depth: 30.59 ft
Screen Length: 20. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.537 ft/day
y0 = 0.3627 ft



MW-107D SLUG C FALLING HEAD

Data Set: S:\...\MW-107D_SlugCFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 09:21:09

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107D
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 30.59 ft
Anisotropy Ratio (Kz/Kr): 0.1

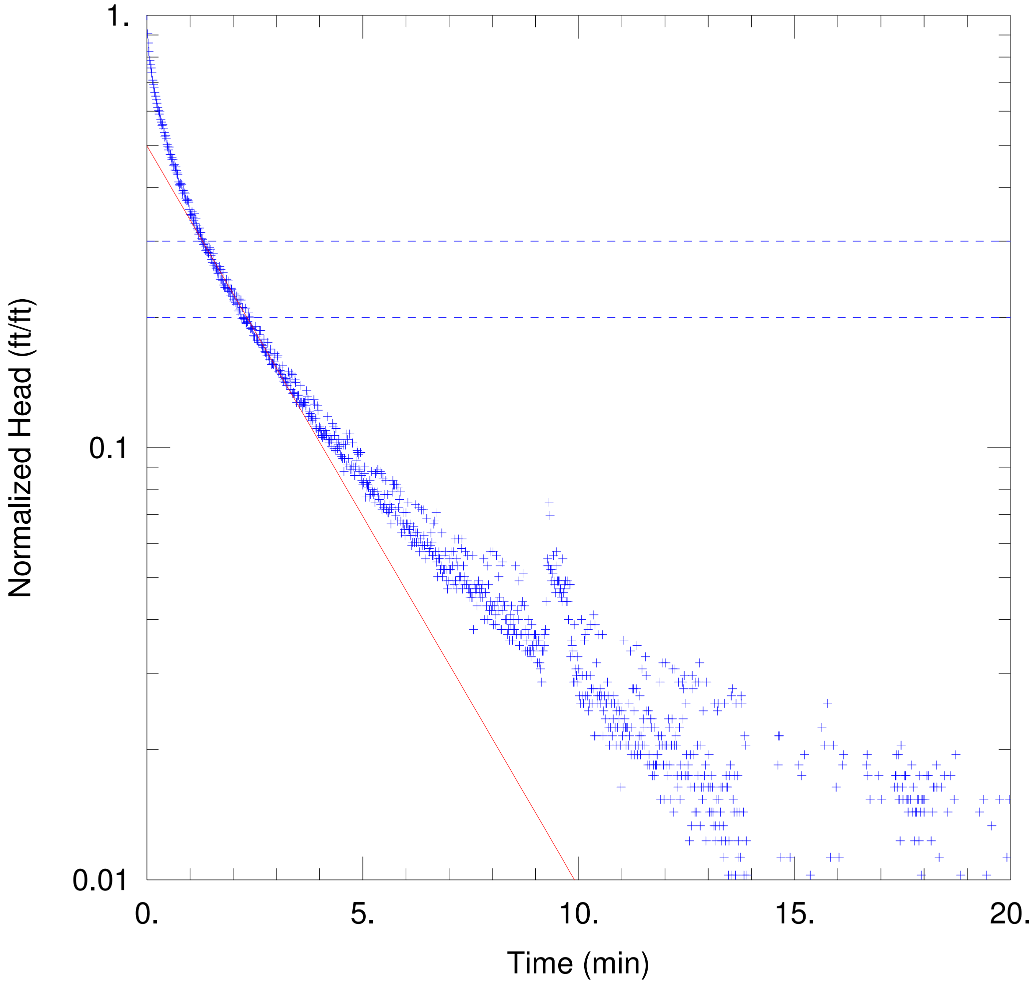
WELL DATA (MW-107D)

Initial Displacement: 0.912 ft
Total Well Penetration Depth: 30.59 ft
Casing Radius: 0.167 ft
Static Water Column Height: 30.59 ft
Screen Length: 20. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.656 ft/day
y0 = 0.4604 ft



MW-107D SLUG C RISING HEAD

Data Set: S:\...\MW-107D_SlugCRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 09:22:18

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107D
Test Date: 1 Oct 2013

AQUIFER DATA

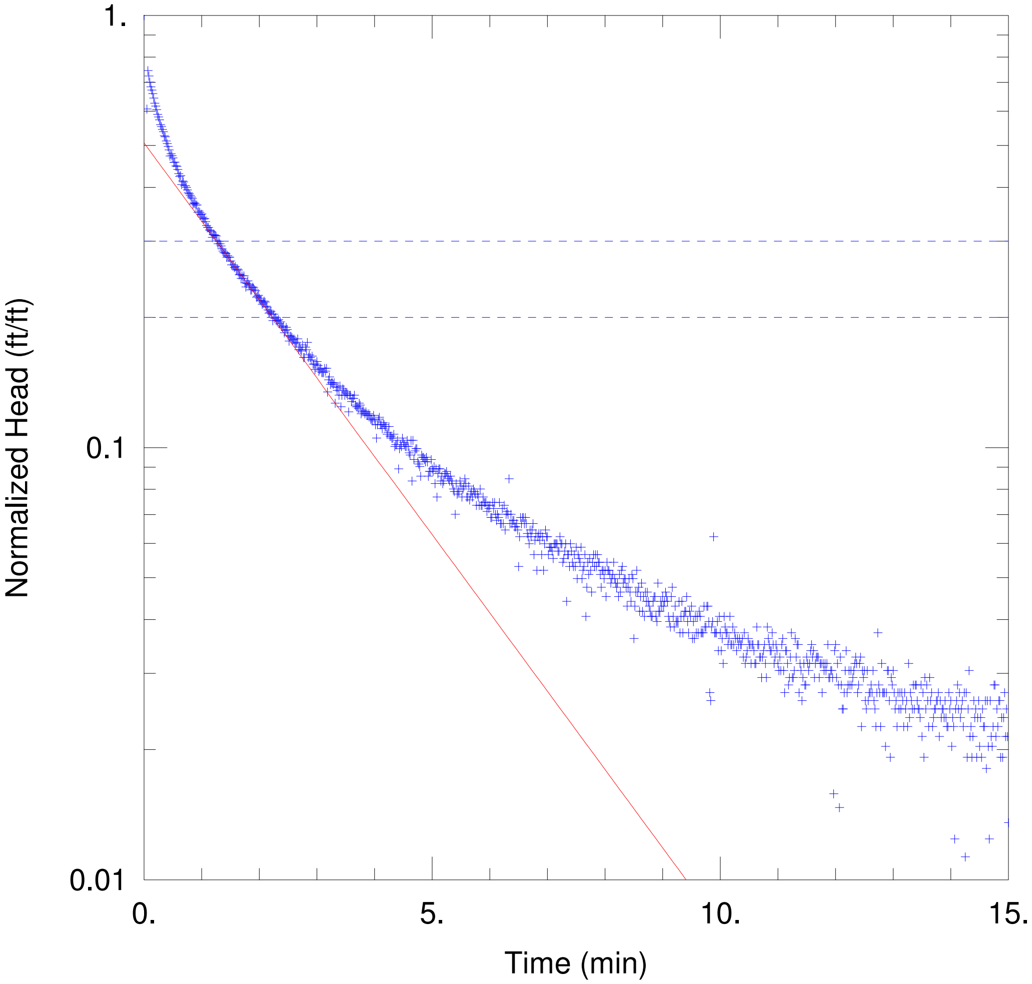
Saturated Thickness: 30.59 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-107D)

Initial Displacement: 0.976 ft
Total Well Penetration Depth: 30.59 ft
Casing Radius: 0.167 ft
Static Water Column Height: 30.59 ft
Screen Length: 20. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.73 ft/day
y0 = 0.4872 ft



MW-107D SLUG F FALLING HEAD

Data Set: S:\...\MW-107D_SlugFFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:24:10

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107D
Test Date: 1 Oct 2013

AQUIFER DATA

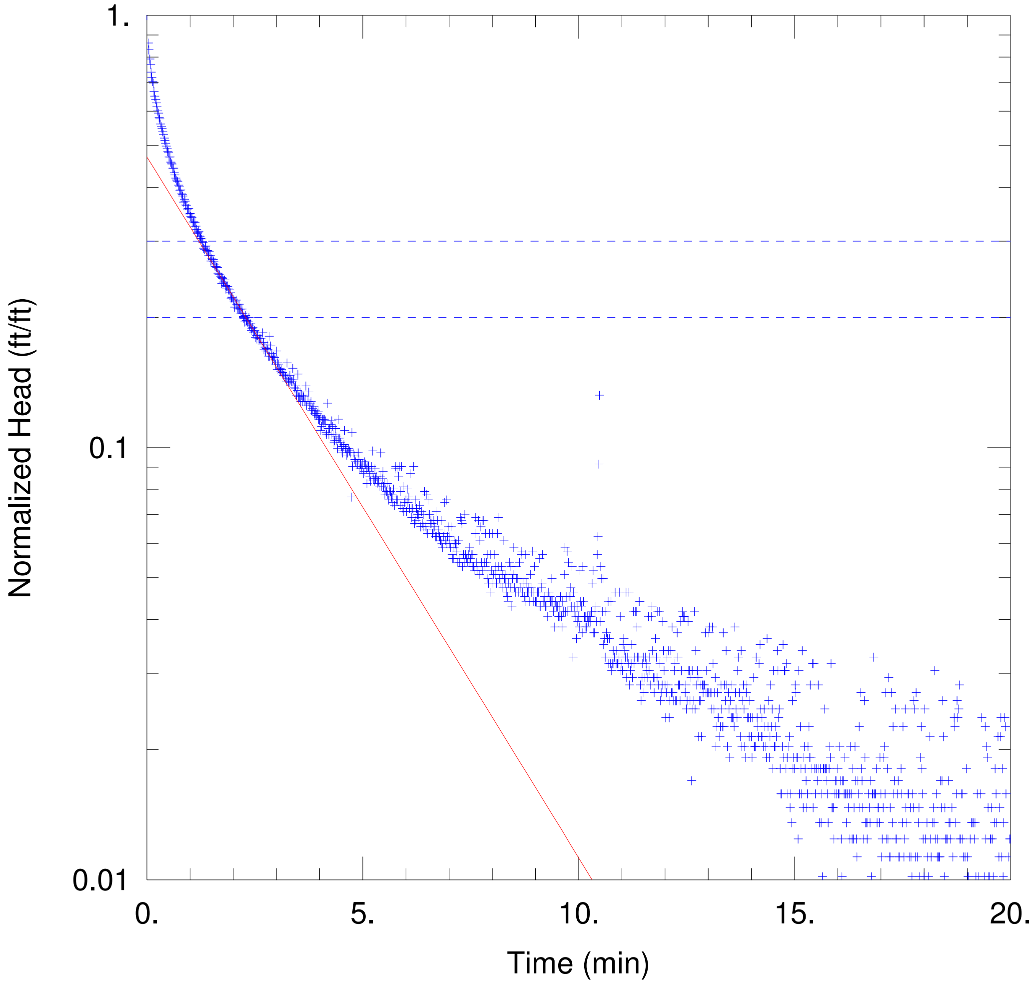
Saturated Thickness: 30.59 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-107D)

Initial Displacement: 0.885 ft
Static Water Column Height: 30.59 ft
Total Well Penetration Depth: 30.59 ft
Screen Length: 20. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.828 ft/day
y0 = 0.4484 ft



MW-107D SLUG F RISING HEAD

Data Set: S:\...\MW-107D_SlugFRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:25:23

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107D
Test Date: 1 Oct 2013

AQUIFER DATA

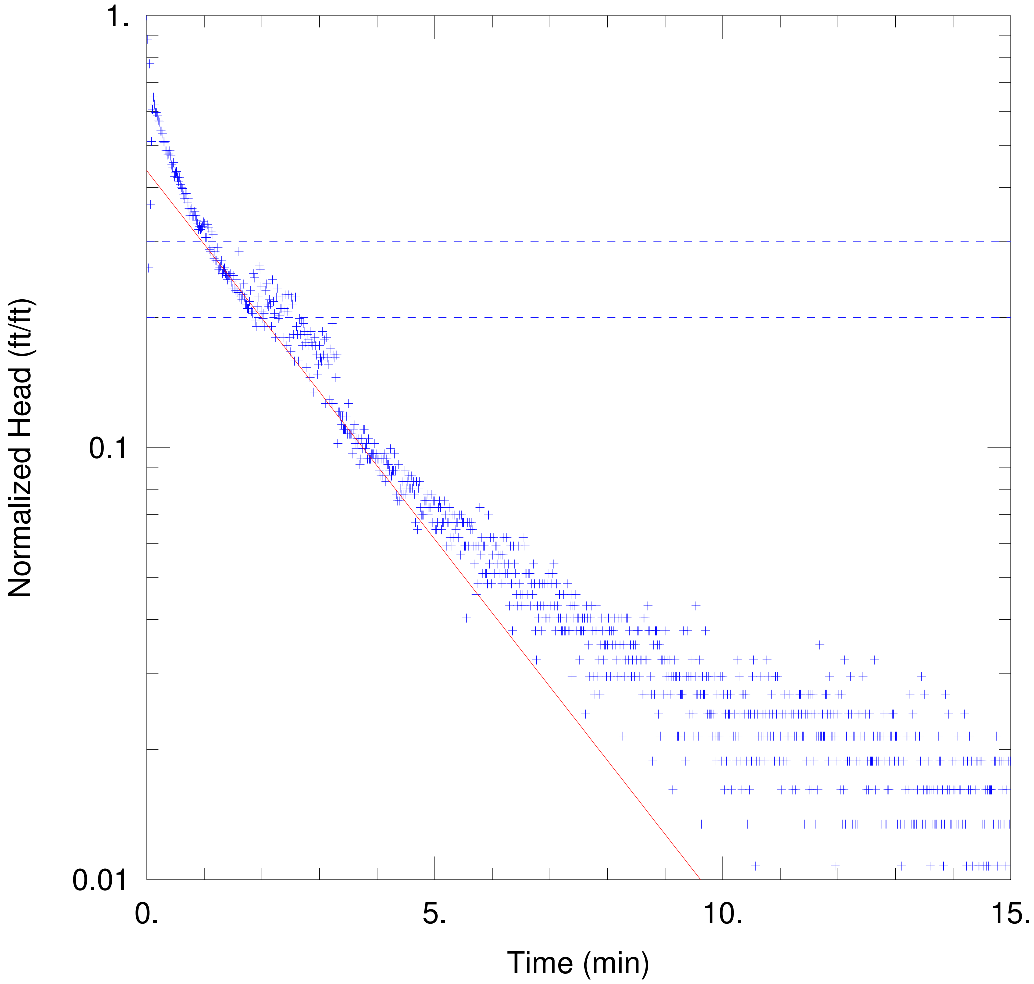
Saturated Thickness: 30.59 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-107D)

Initial Displacement: 0.885 ft
Static Water Column Height: 30.59 ft
Total Well Penetration Depth: 30.59 ft
Screen Length: 20. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.635 ft/day
y0 = 0.4164 ft



MW-107S SLUG A FALLING HEAD

Data Set: S:\...\MW-107S_SlugAFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 09:28:11

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107S
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 10.82 ft
Anisotropy Ratio (Kz/Kr): 0.1

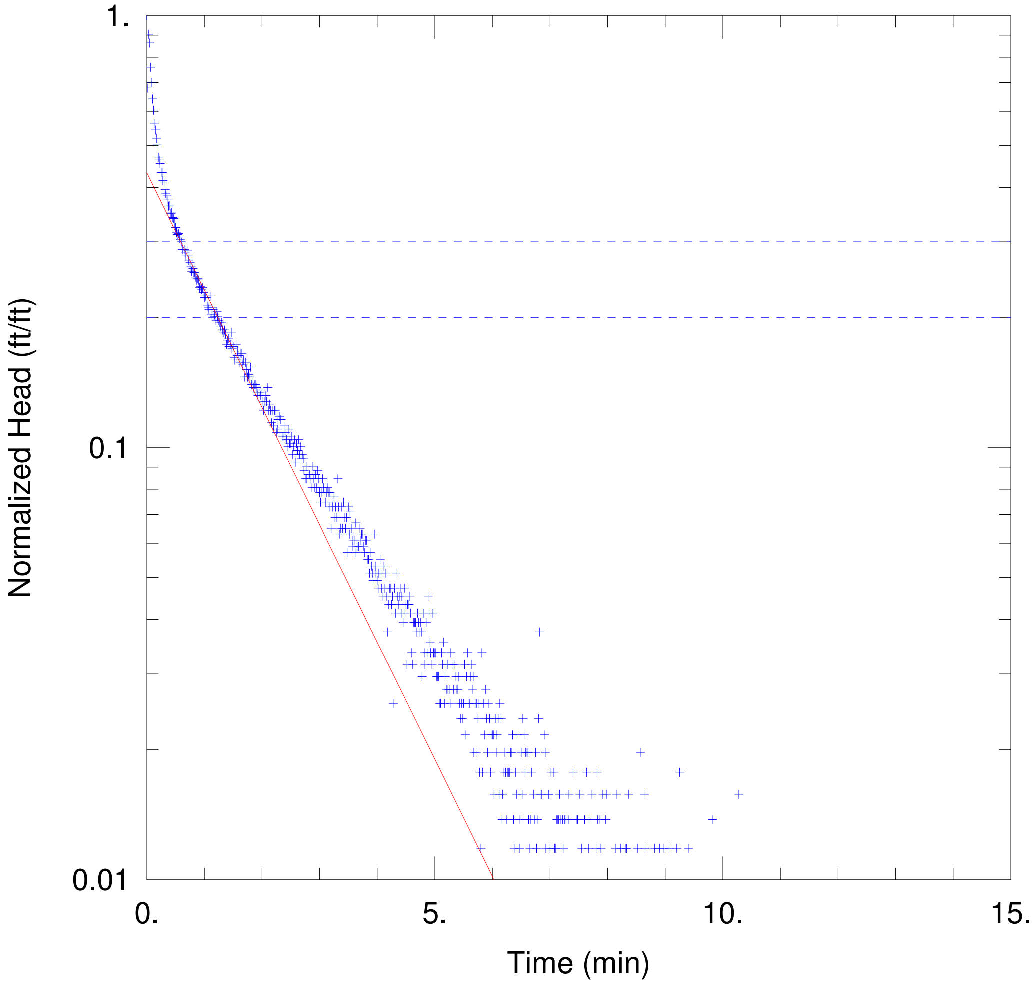
WELL DATA (MW-107S)

Initial Displacement: 0.372 ft
Total Well Penetration Depth: 10.82 ft
Casing Radius: 0.167 ft
Static Water Column Height: 10.82 ft
Screen Length: 10.82 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.924 ft/day
y0 = 0.1628 ft



MW-107S SLUG A RISING HEAD

Data Set: S:\...\MW-107S_SlugARisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:29:42

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107S
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 10.82 ft
Anisotropy Ratio (Kz/Kr): 0.1

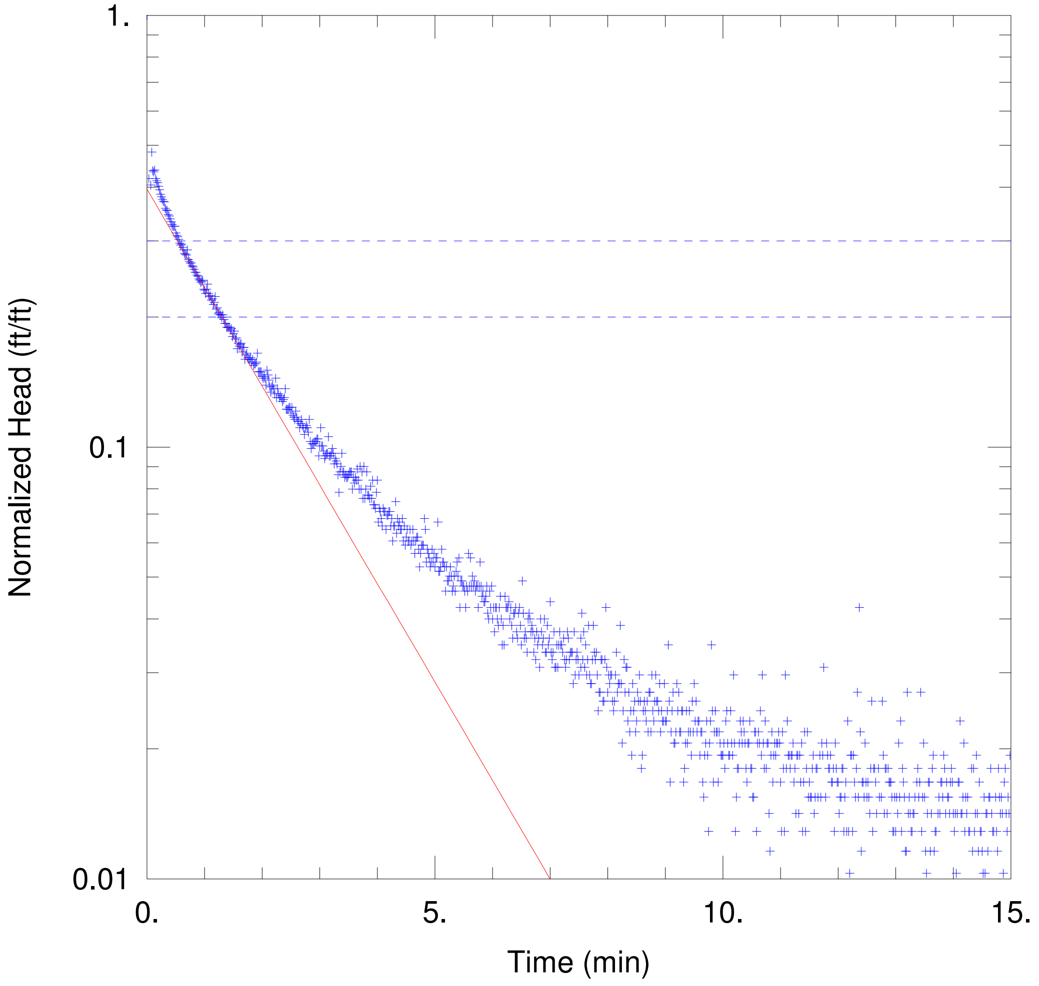
WELL DATA (MW-107S)

Initial Displacement: 0.508 ft
Total Well Penetration Depth: 10.82 ft
Casing Radius: 0.167 ft
Static Water Column Height: 10.82 ft
Screen Length: 10.82 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.061 ft/day
y0 = 0.2196 ft



MW-107S SLUG B FALLING HEAD

Data Set: S:\...\MW-107S_SlugBFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:31:03

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107S
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 10.82 ft
Anisotropy Ratio (Kz/Kr): 0.1

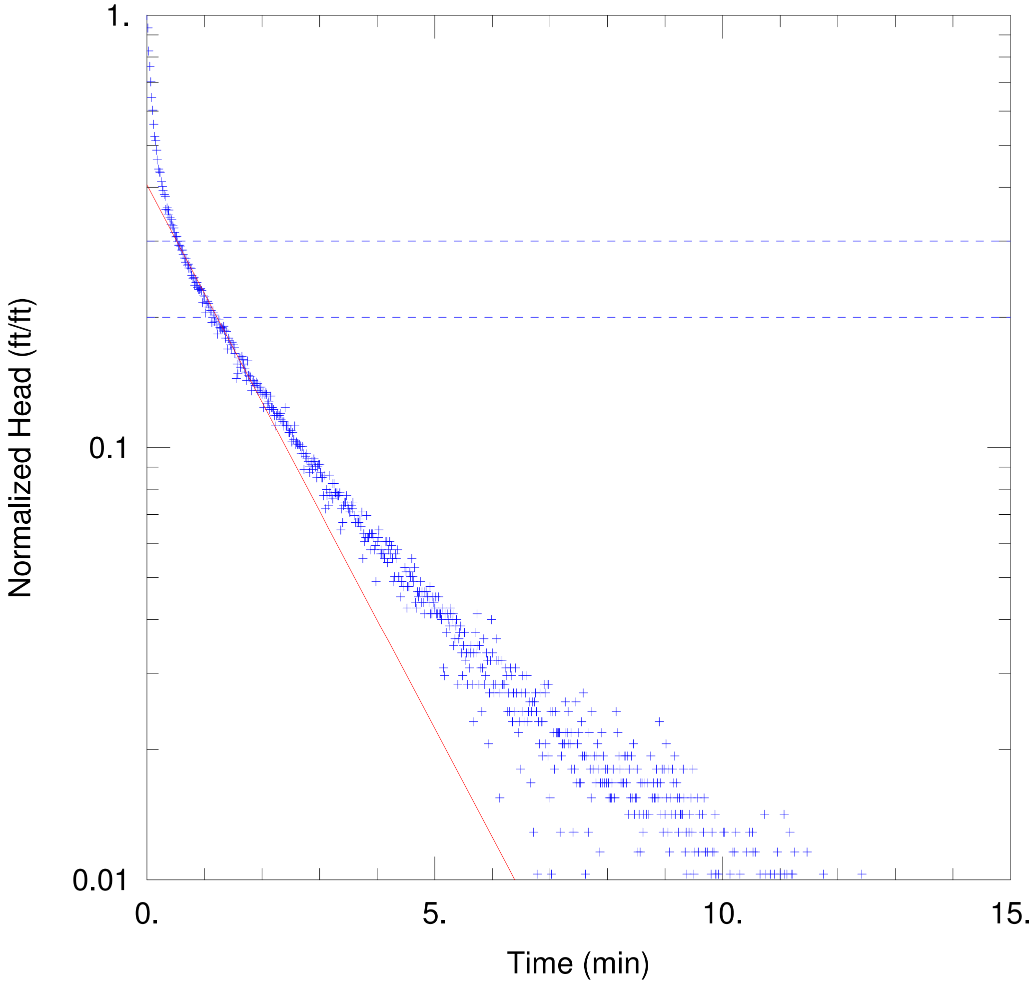
WELL DATA (MW-107S)

Initial Displacement: 0.776 ft
Static Water Column Height: 10.82 ft
Total Well Penetration Depth: 10.82 ft
Screen Length: 10.82 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.573 ft/day
y0 = 0.307 ft



MW-107S SLUG B RISING HEAD

Data Set: S:\...\MW-107S_SlugBRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:32:10

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107S
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 10.82 ft
Anisotropy Ratio (Kz/Kr): 0.1

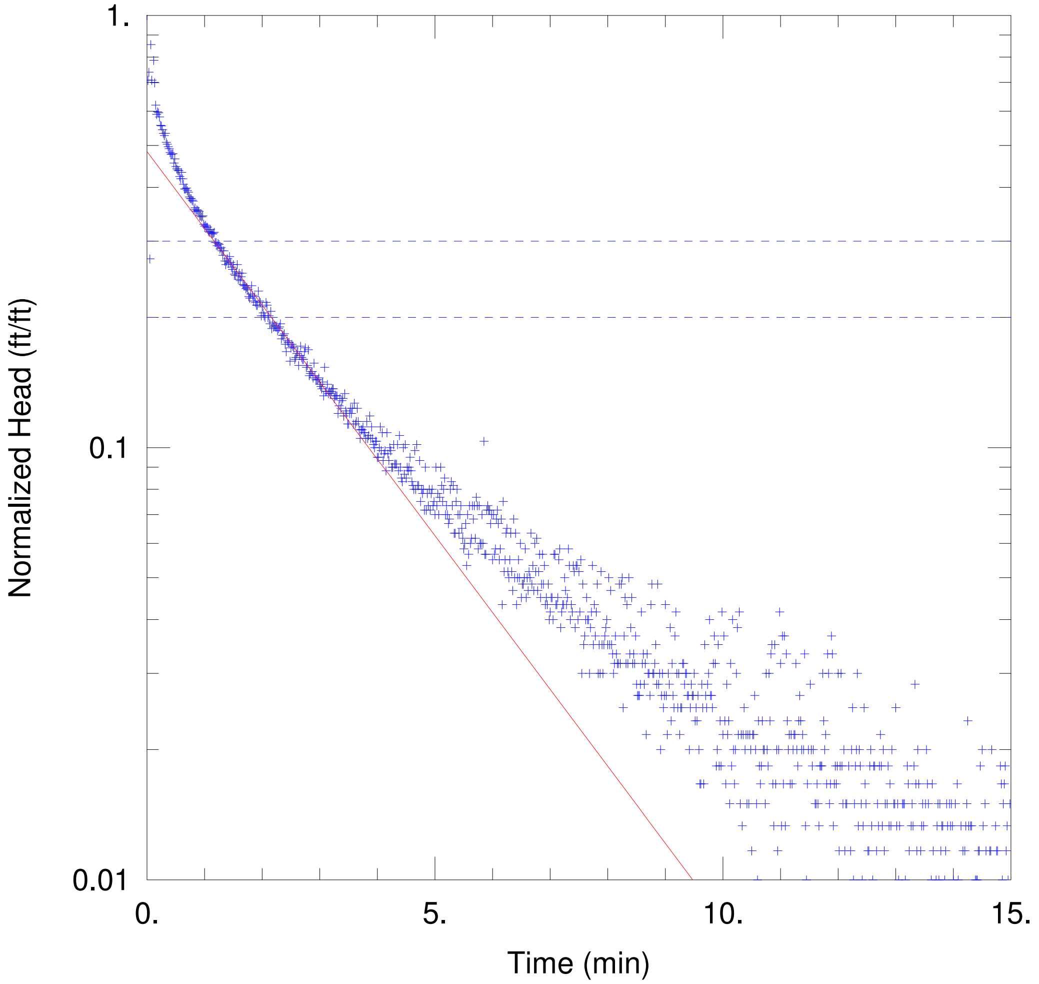
WELL DATA (MW-107S)

Initial Displacement: 0.776 ft
Total Well Penetration Depth: 10.82 ft
Casing Radius: 0.167 ft
Static Water Column Height: 10.82 ft
Screen Length: 10.82 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.836 ft/day
y0 = 0.3144 ft



MW-107S SLUG F FALLING HEAD

Data Set: S:\...\MW-107S_SlugFFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 09:33:46

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107S
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 10.82 ft
Anisotropy Ratio (Kz/Kr): 0.1

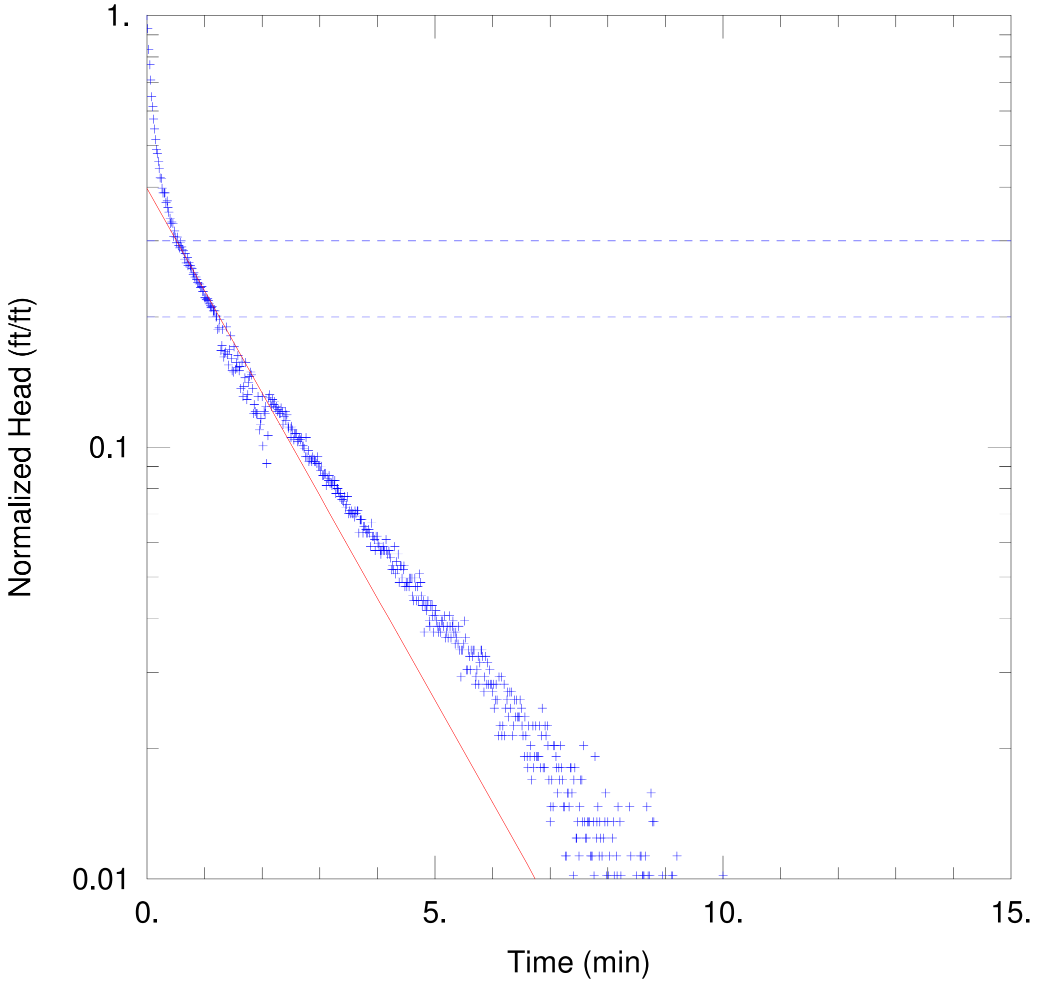
WELL DATA (MW-107S)

Initial Displacement: 0.6 ft
Total Well Penetration Depth: 10.82 ft
Casing Radius: 0.167 ft
Static Water Column Height: 10.82 ft
Screen Length: 10.82 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.005 ft/day
y0 = 0.2903 ft



MW-107S SLUG F RISING HEAD

Data Set: S:\...\MW-107S_SlugFRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:35:01

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-107S
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 10.82 ft
Anisotropy Ratio (Kz/Kr): 0.1

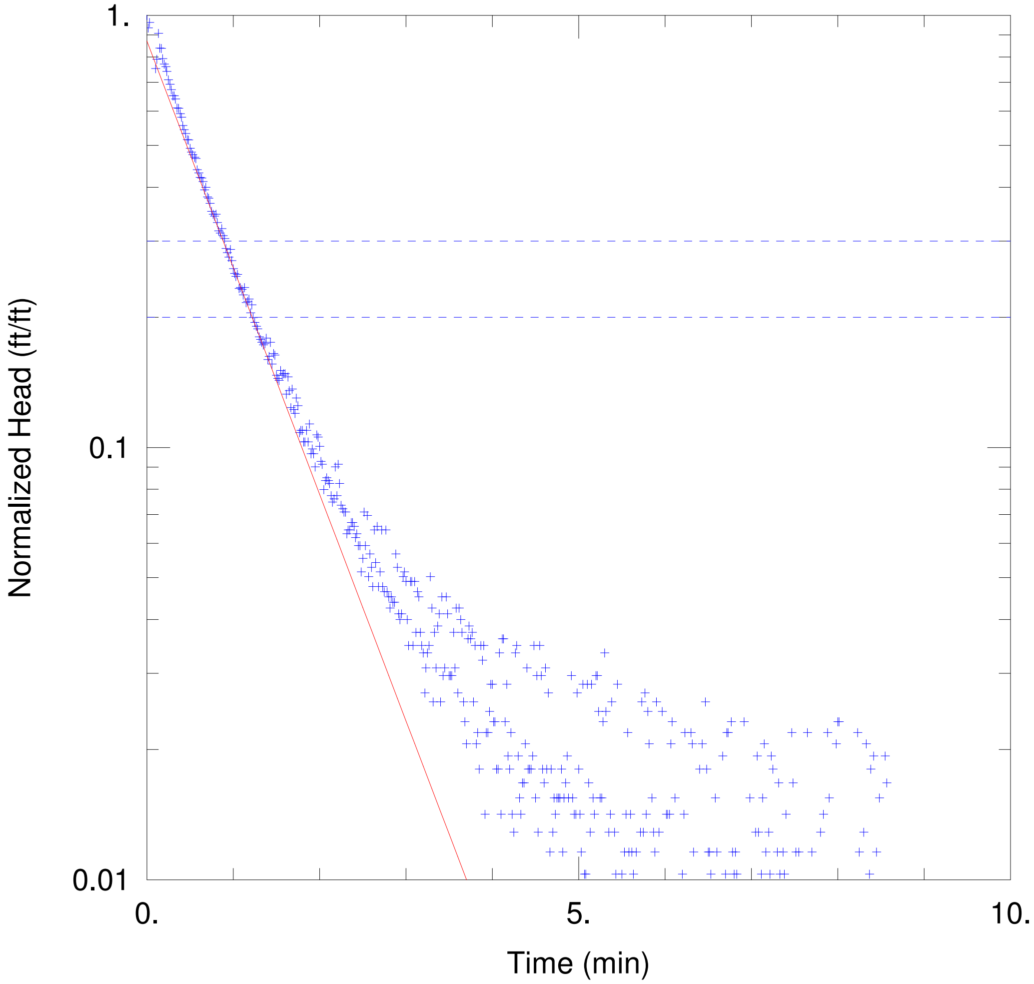
WELL DATA (MW-107S)

Initial Displacement: 0.885 ft
Static Water Column Height: 10.82 ft
Total Well Penetration Depth: 10.82 ft
Screen Length: 10.82 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.673 ft/day
y0 = 0.3514 ft



MW-108 SLUG B FALLING HEAD

Data Set: S:\...\MW-108_SlugBFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:36:42

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-10
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 83. ft
Anisotropy Ratio (Kz/Kr): 0.1

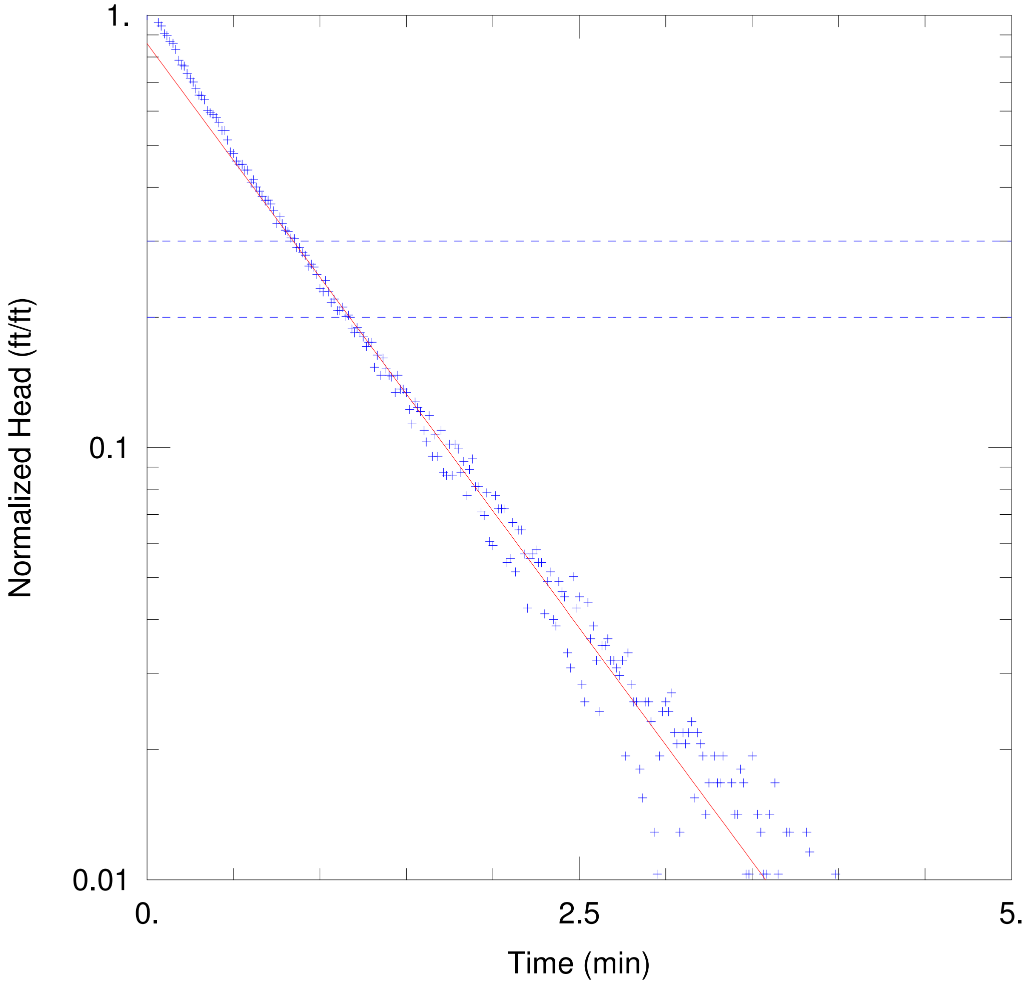
WELL DATA (MW-108)

Initial Displacement: 0.776 ft
Total Well Penetration Depth: 83. ft
Casing Radius: 0.167 ft
Static Water Column Height: 142.6 ft
Screen Length: 80. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.679 ft/day
y0 = 0.676 ft



MW-108 SLUG B RISING HEAD

Data Set: S:\...\MW-108_SlugBRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:38:03

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-108
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 83. ft
Anisotropy Ratio (Kz/Kr): 0.1

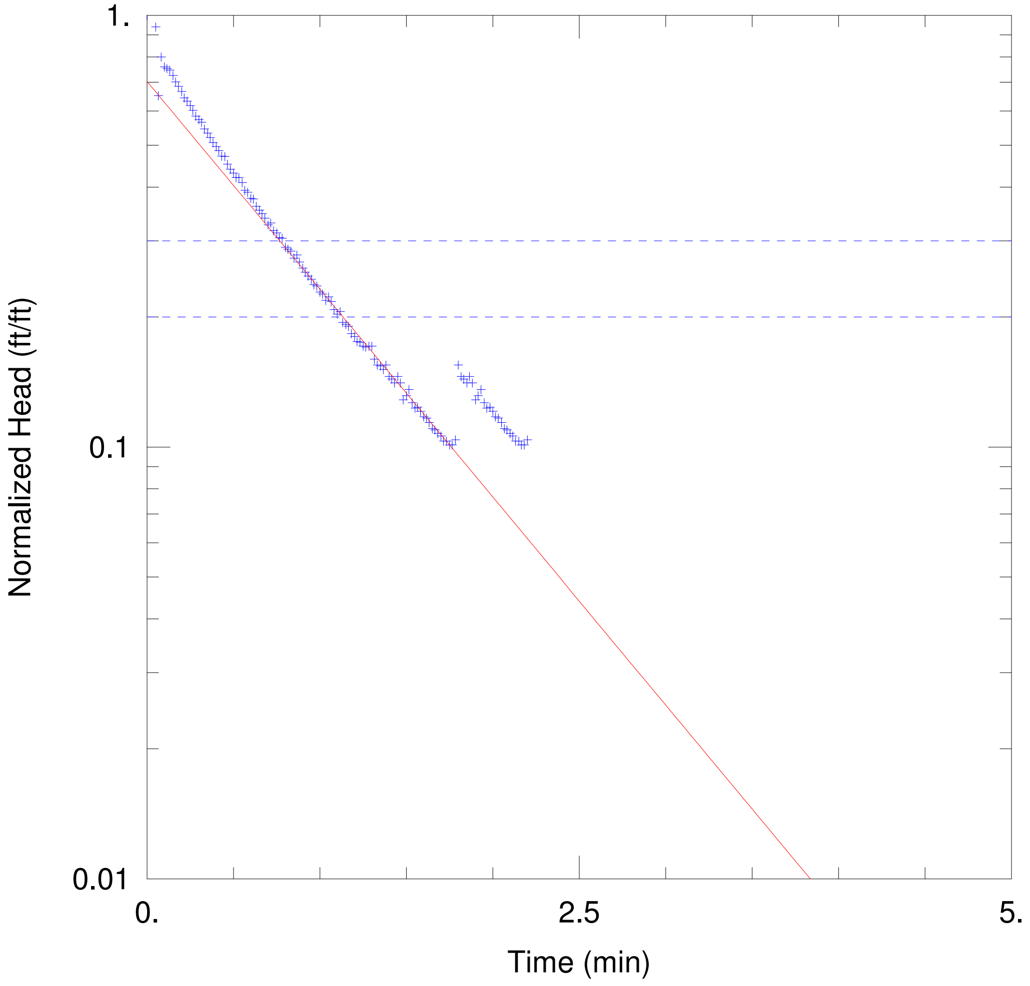
WELL DATA (MW-108)

Initial Displacement: 0.776 ft
Static Water Column Height: 142.6 ft
Total Well Penetration Depth: 83. ft
Screen Length: 80. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.73 ft/day
y0 = 0.6669 ft



MW-108 SLUG D FALLING HEAD

Data Set: S:\...\MW-108_SlugDFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:39:21

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-108
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 83. ft
Anisotropy Ratio (Kz/Kr): 0.1

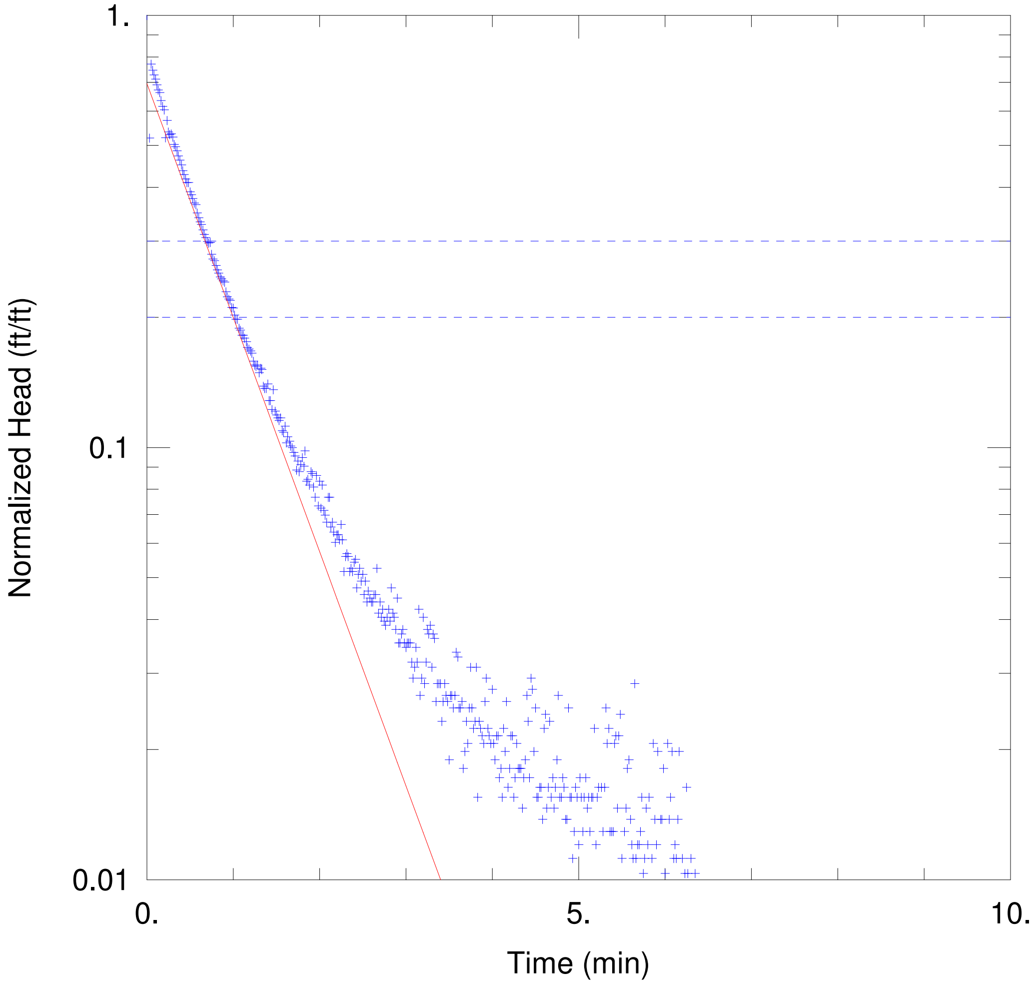
WELL DATA (MW-108)

Initial Displacement: 1.414 ft
Static Water Column Height: 142.6 ft
Total Well Penetration Depth: 83. ft
Screen Length: 80. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.541 ft/day
y0 = 0.993 ft



MW-108 SLUG J FALLING HEAD

Data Set: S:\...\MW-108_SlugJFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 15:07:54

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-108
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 83. ft
Anisotropy Ratio (Kz/Kr): 0.1

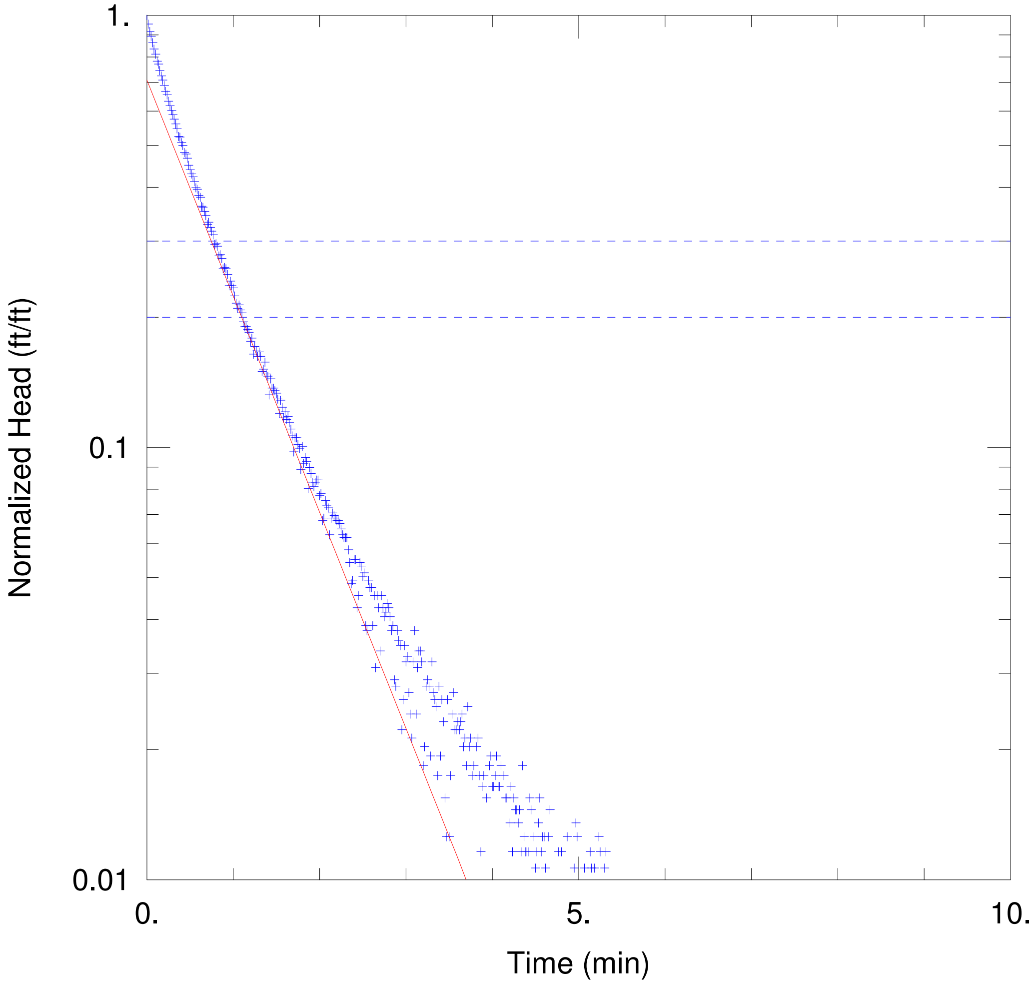
WELL DATA (MW-108)

Initial Displacement: 1.161 ft
Static Water Column Height: 142.6 ft
Total Well Penetration Depth: 83. ft
Screen Length: 80. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.735 ft/day
y0 = 0.8073 ft



MW-108 SLUG J RISING HEAD

Data Set: S:\...\MW-108_SlugJRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 09:43:37

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-108
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 83. ft
Anisotropy Ratio (Kz/Kr): 0.1

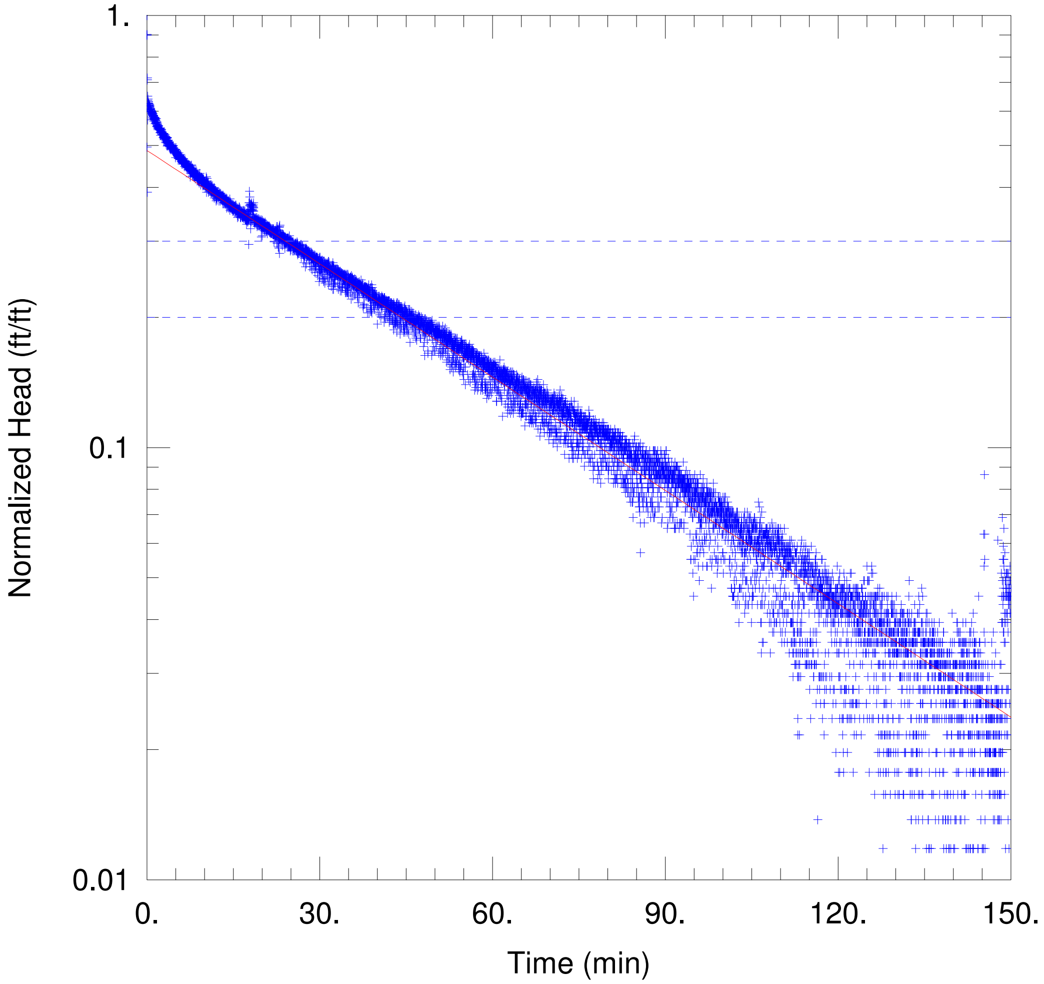
WELL DATA (MW-108)

Initial Displacement: 1.034 ft
Static Water Column Height: 142.6 ft
Total Well Penetration Depth: 83. ft
Screen Length: 80. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.601 ft/day
y0 = 0.732 ft



MW-109 SLUG A FALLING HEAD

Data Set: S:\...\MW-109_SlugAFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:45:44

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.22
Location: Lisbon
Test Well: MW-109
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 19.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

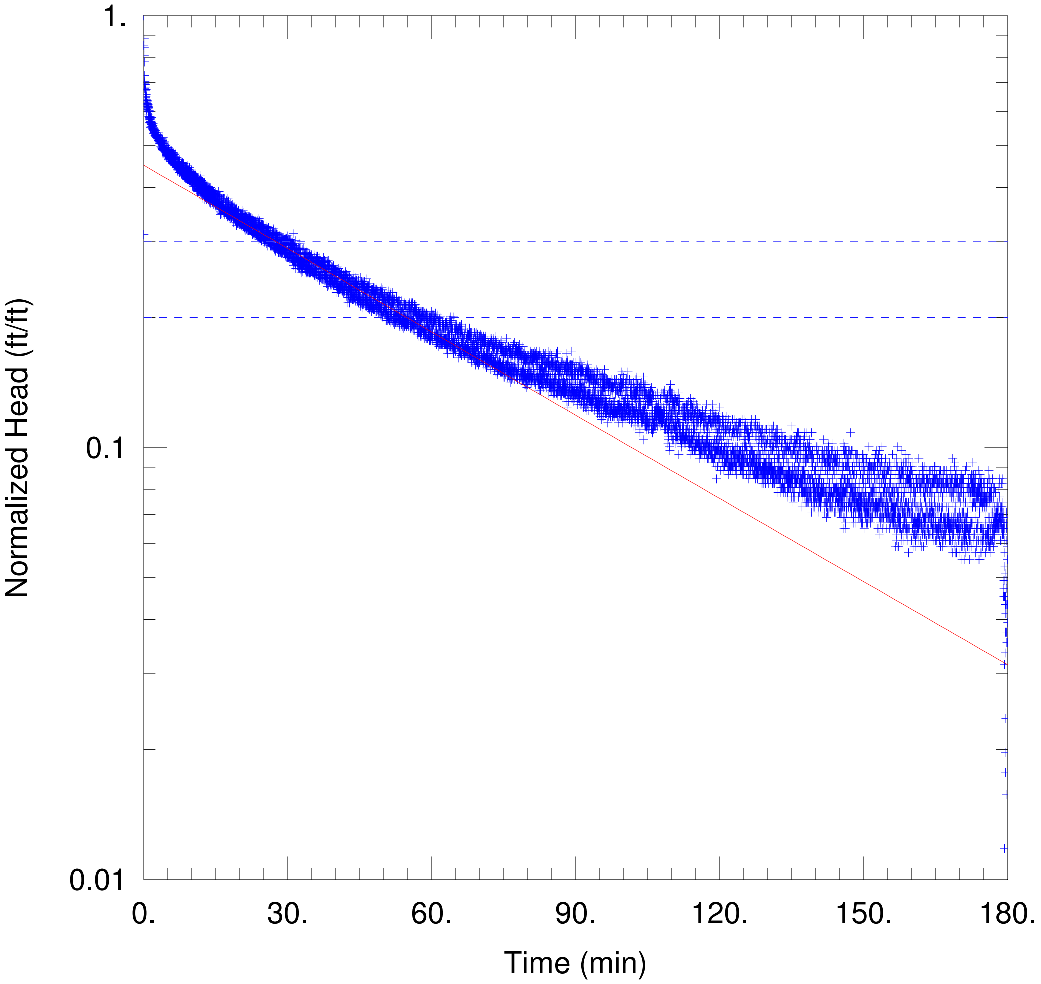
WELL DATA (MW-109)

Initial Displacement: 0.508 ft
Total Well Penetration Depth: 19.55 ft
Casing Radius: 0.167 ft
Static Water Column Height: 19.55 ft
Screen Length: 19.55 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.06456 ft/day
y0 = 0.2473 ft



MW-109 SLUG A RISING HEAD

Data Set: S:\...\MW-109_SlugARisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:46:39

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.22
Location: Lisbon
Test Well: MW-109
Test Date: 1 Oct 2013

AQUIFER DATA

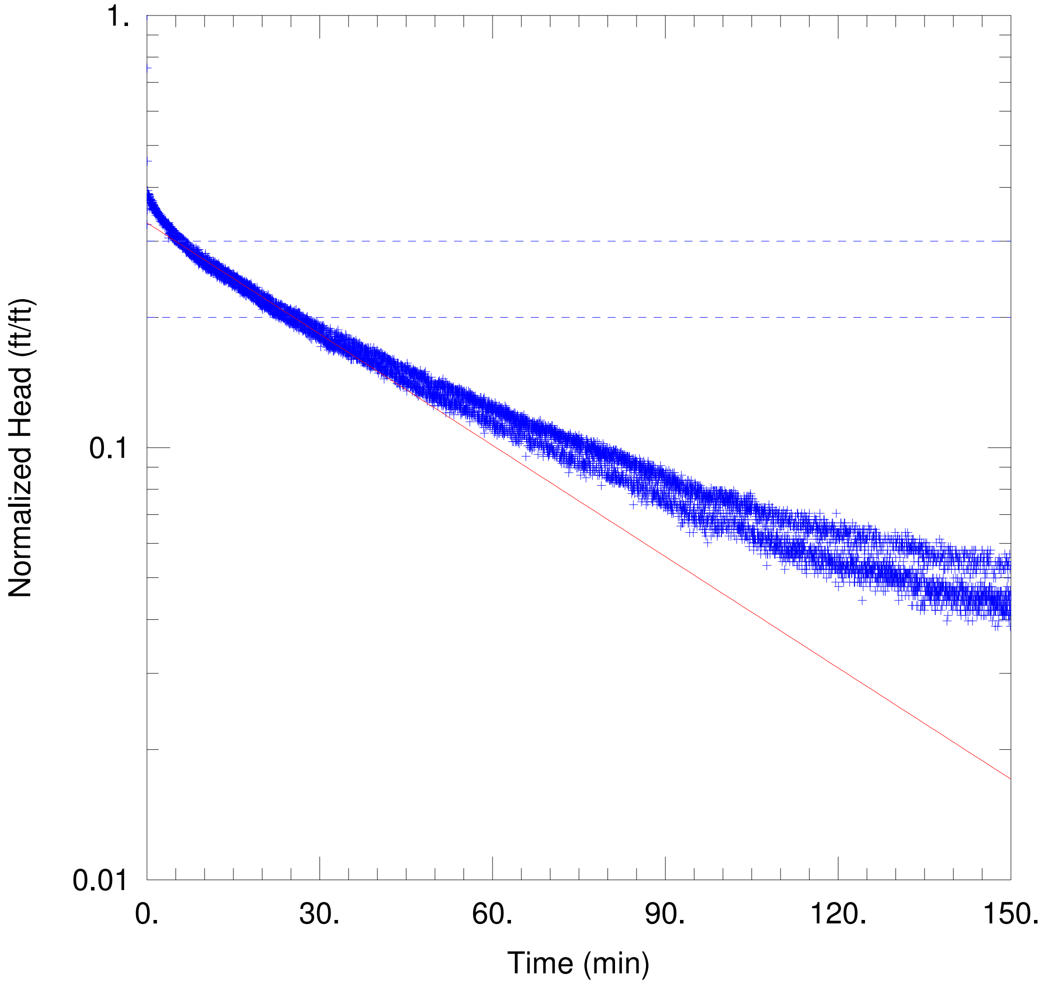
Saturated Thickness: 19.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-109)

Initial Displacement: 0.508 ft
Static Water Column Height: 19.55 ft
Total Well Penetration Depth: 19.55 ft
Screen Length: 19.55 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.04744 ft/day
y0 = 0.2287 ft



MW-109 SLUG G FALLING HEAD

Data Set: S:\...\MW-109_SlugGFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 09:48:46

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.22
Location: Lisbon
Test Well: MW-109
Test Date: 1 Oct 2013

AQUIFER DATA

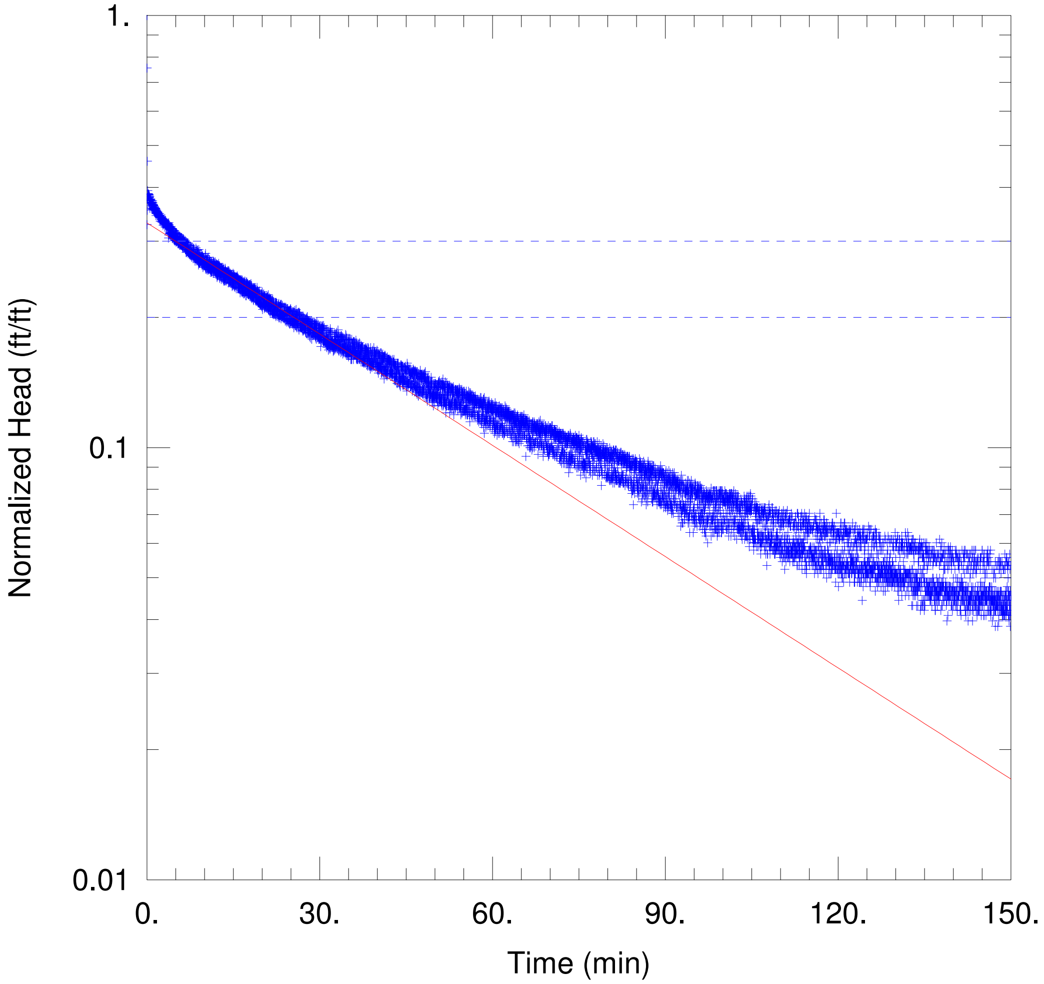
Saturated Thickness: 19.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-109)

Initial Displacement: 0.881 ft
Static Water Column Height: 19.55 ft
Total Well Penetration Depth: 19.55 ft
Screen Length: 19.55 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.06338 ft/day
y0 = 0.2917 ft



MW-109 SLUG G FALLING HEAD

Data Set: S:\...\MW-109_SlugGFallingHeadGraphHo.aqt
Date: 01/14/15 Time: 09:47:22

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.22
Location: Lisbon
Test Well: MW-109
Test Date: 1 Oct 2013

AQUIFER DATA

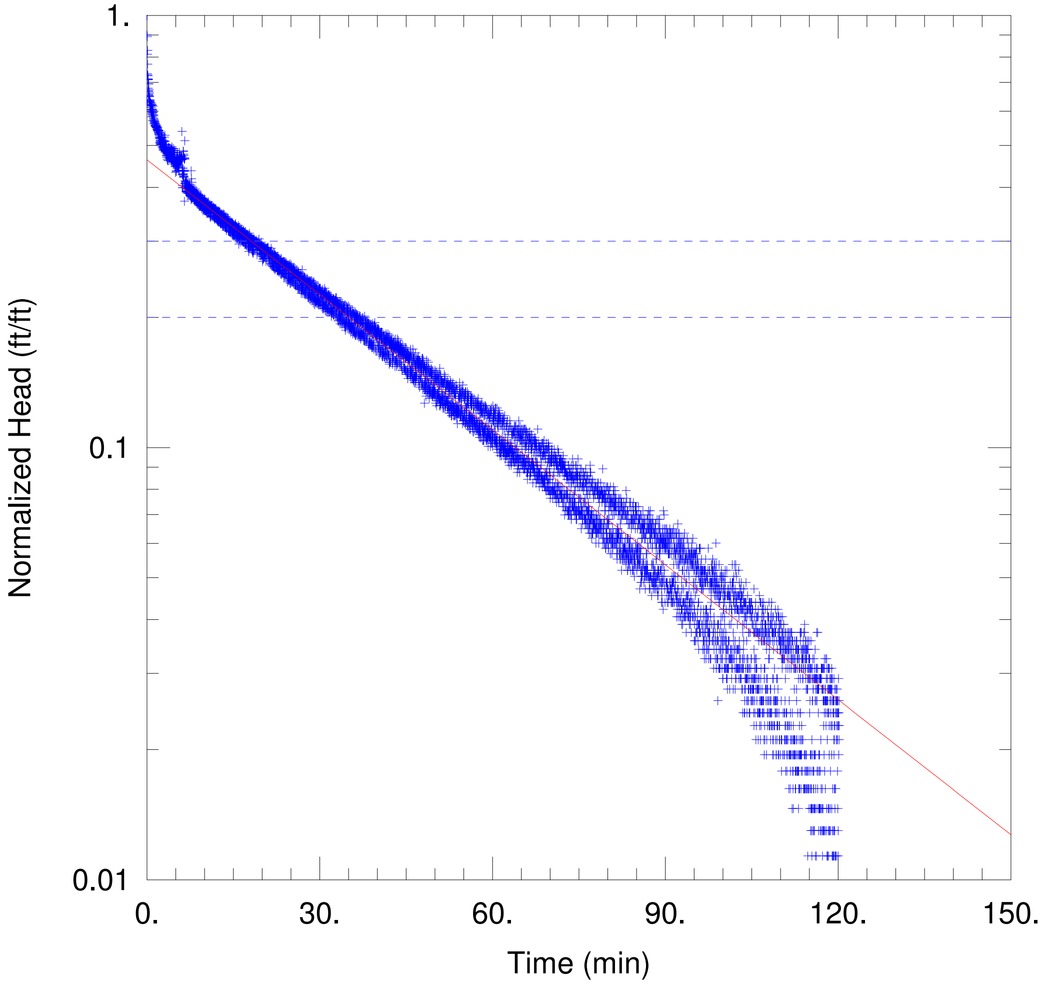
Saturated Thickness: 19.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-109)

Initial Displacement: 0.881 ft
Static Water Column Height: 19.55 ft
Total Well Penetration Depth: 19.55 ft
Screen Length: 19.55 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.06338 ft/day
y0 = 0.2917 ft



MW-109 SLUG G RISING HEAD

Data Set: S:\...\MW-109_SlugGRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 09:50:40

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.22
Location: Lisbon
Test Well: MW-109
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 19.55 ft
Anisotropy Ratio (Kz/Kr): 0.1

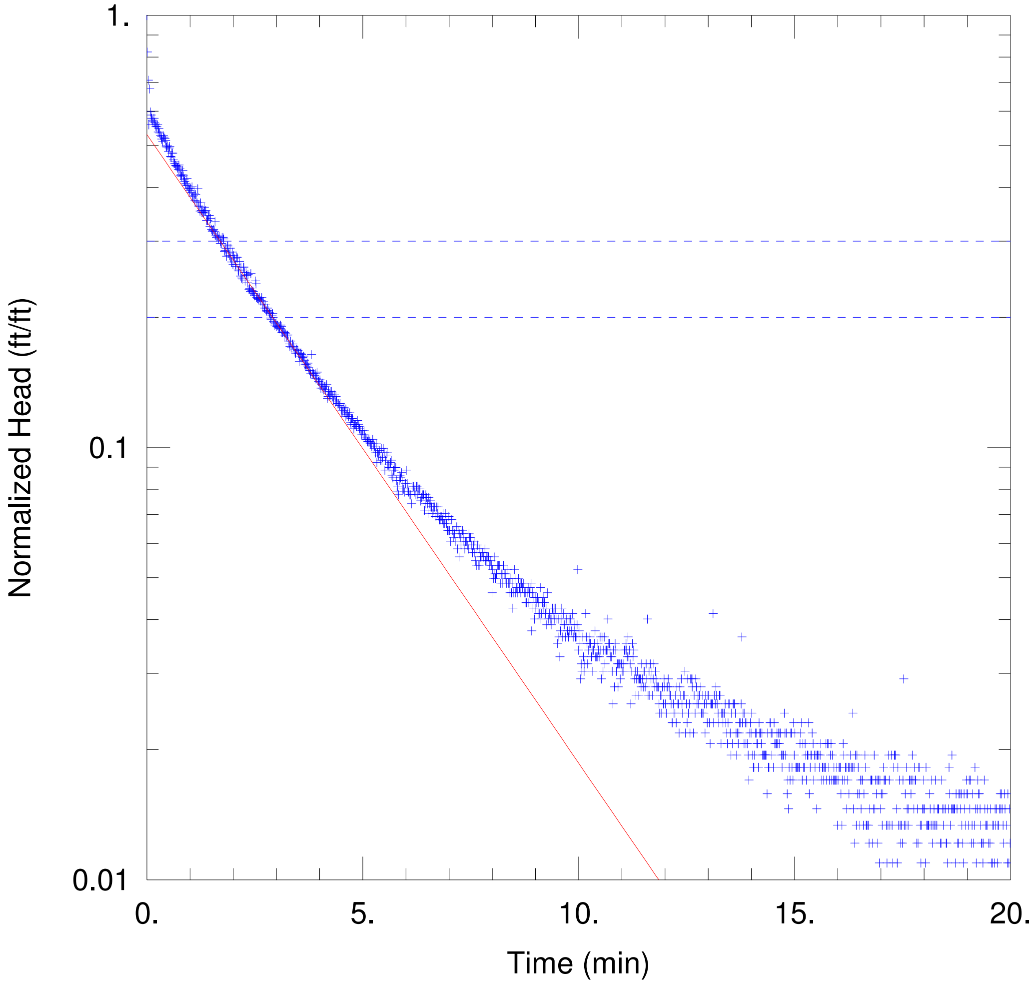
WELL DATA (MW-109)

Initial Displacement: 0.616 ft
Static Water Column Height: 19.55 ft
Total Well Penetration Depth: 19.55 ft
Screen Length: 19.55 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.0769 ft/day
y0 = 0.2854 ft



MW-112 SLUG C FALLING HEAD

Data Set: S:\...\MW-112_SlugCFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:00:49

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-112
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 96.17 ft
Anisotropy Ratio (Kz/Kr): 0.1

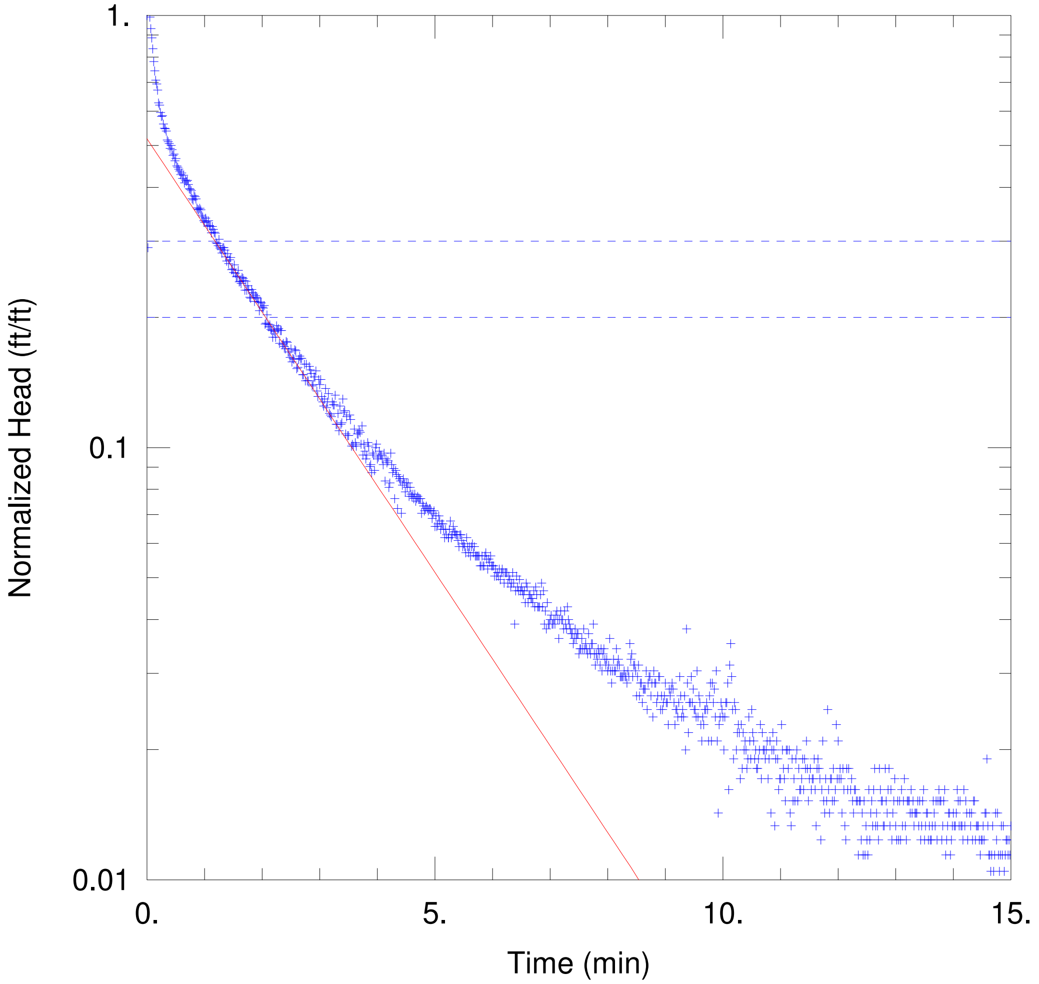
WELL DATA (MW-112)

Initial Displacement: 0.823 ft
Total Well Penetration Depth: 96.17 ft
Casing Radius: 0.167 ft
Static Water Column Height: 96.17 ft
Screen Length: 96.17 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3128 ft/day
y0 = 0.436 ft



MW-112 SLUG C RISING HEAD

Data Set: S:\...\MW-112_SlugCRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 10:01:49

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-112
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 96.17 ft
Anisotropy Ratio (Kz/Kr): 0.1

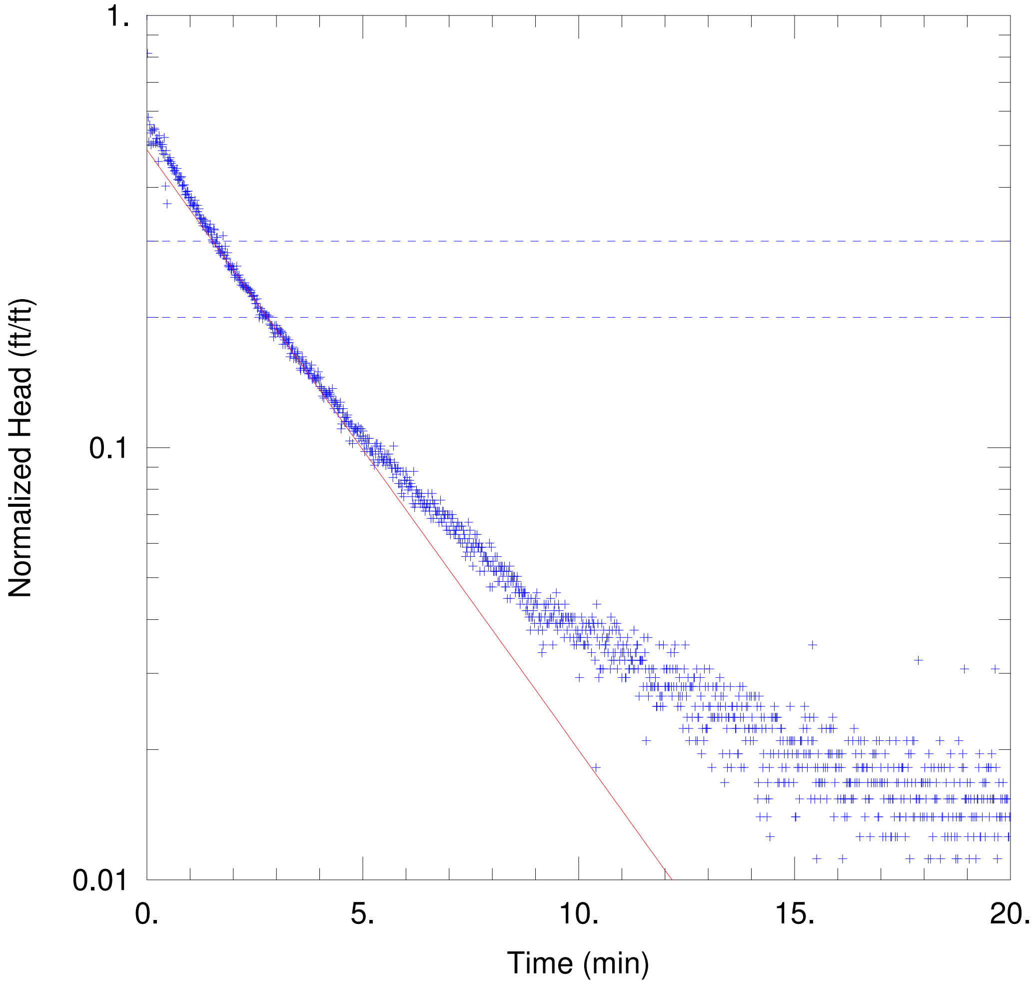
WELL DATA (MW-112)

Initial Displacement: 1.051 ft
Total Well Penetration Depth: 96.17 ft
Casing Radius: 0.167 ft
Static Water Column Height: 96.17 ft
Screen Length: 96.17 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.4318 ft/day
y0 = 0.5445 ft



MW-112 SLUG F FALLING HEAD

Data Set: S:\...\MW-112_SlugFFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:02:41

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-112
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 96.17 ft Anisotropy Ratio (Kz/Kr): 0.1

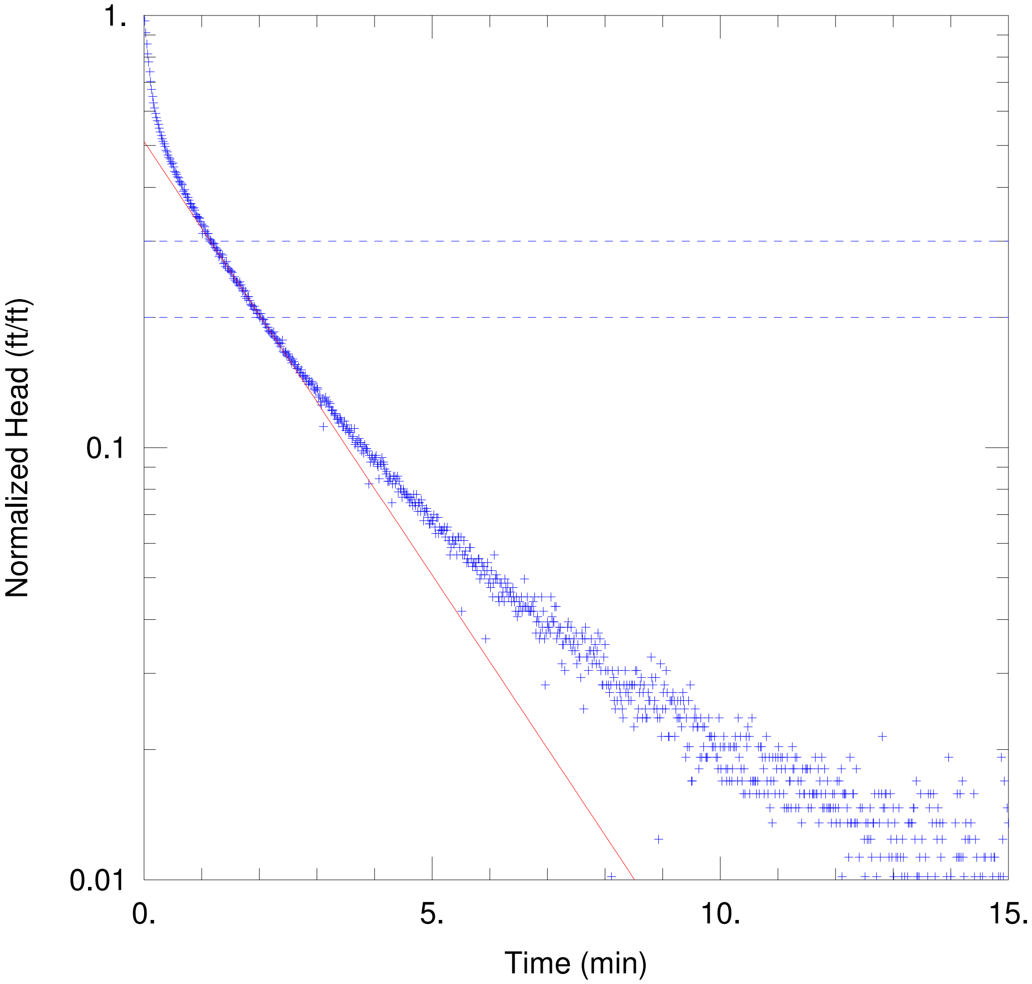
WELL DATA (MW-112)

Initial Displacement: 0.715 ft
Total Well Penetration Depth: 96.17 ft
Casing Radius: 0.167 ft
Static Water Column Height: 96.17 ft
Screen Length: 96.17 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.2987 ft/day y0 = 0.3491 ft



MW-112 SLUG F RISING HEAD

Data Set: S:\...\MW-112_SlugFRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:03:46

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-112
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 96.17 ft
Anisotropy Ratio (Kz/Kr): 0.1

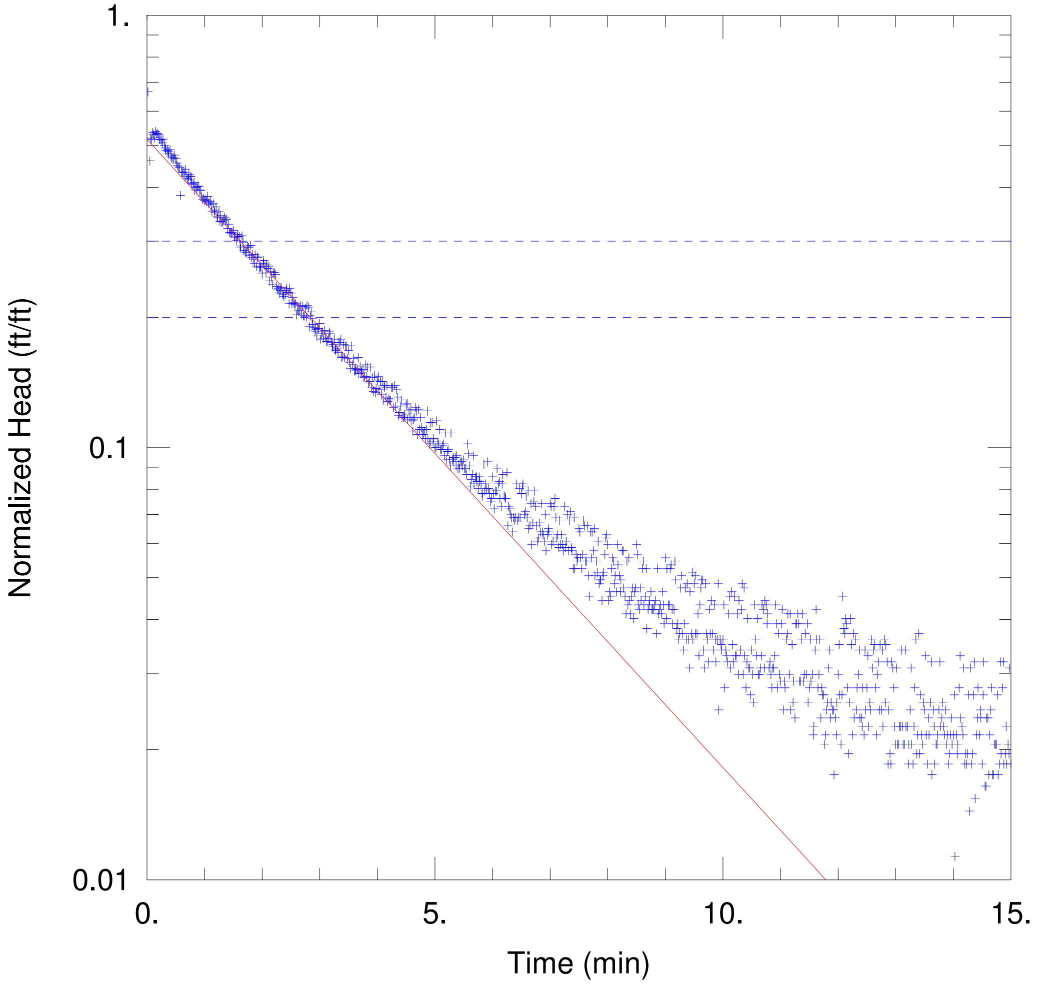
WELL DATA (MW-112)

Initial Displacement: 0.886 ft
Static Water Column Height: 96.17 ft
Total Well Penetration Depth: 96.17 ft
Screen Length: 96.17 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.4318 ft/day
y0 = 0.4524 ft



MW-112 SLUG K FALLING HEAD

Data Set: S:\...\MW-112_SlugKFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:04:50

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-112
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 96.17 ft
Anisotropy Ratio (Kz/Kr): 0.1

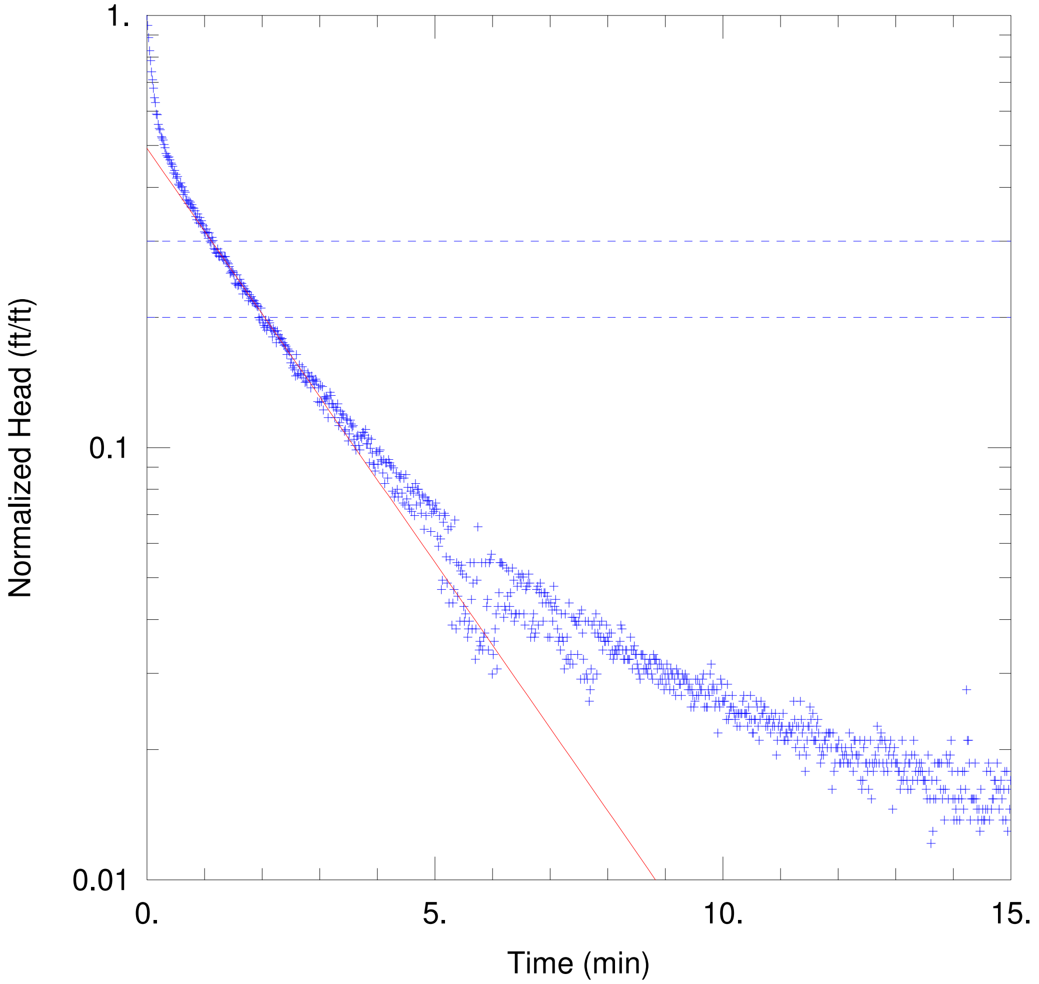
WELL DATA (MW-112)

Initial Displacement: 0.971 ft
Total Well Penetration Depth: 96.17 ft
Casing Radius: 0.167 ft
Static Water Column Height: 96.17 ft
Screen Length: 96.17 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3128 ft/day
y0 = 0.5016 ft



MW-112 SLUG K RISING HEAD

Data Set: S:\...\MW-112_SlugKRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:05:48

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-112
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 96.17 ft
Anisotropy Ratio (Kz/Kr): 0.1

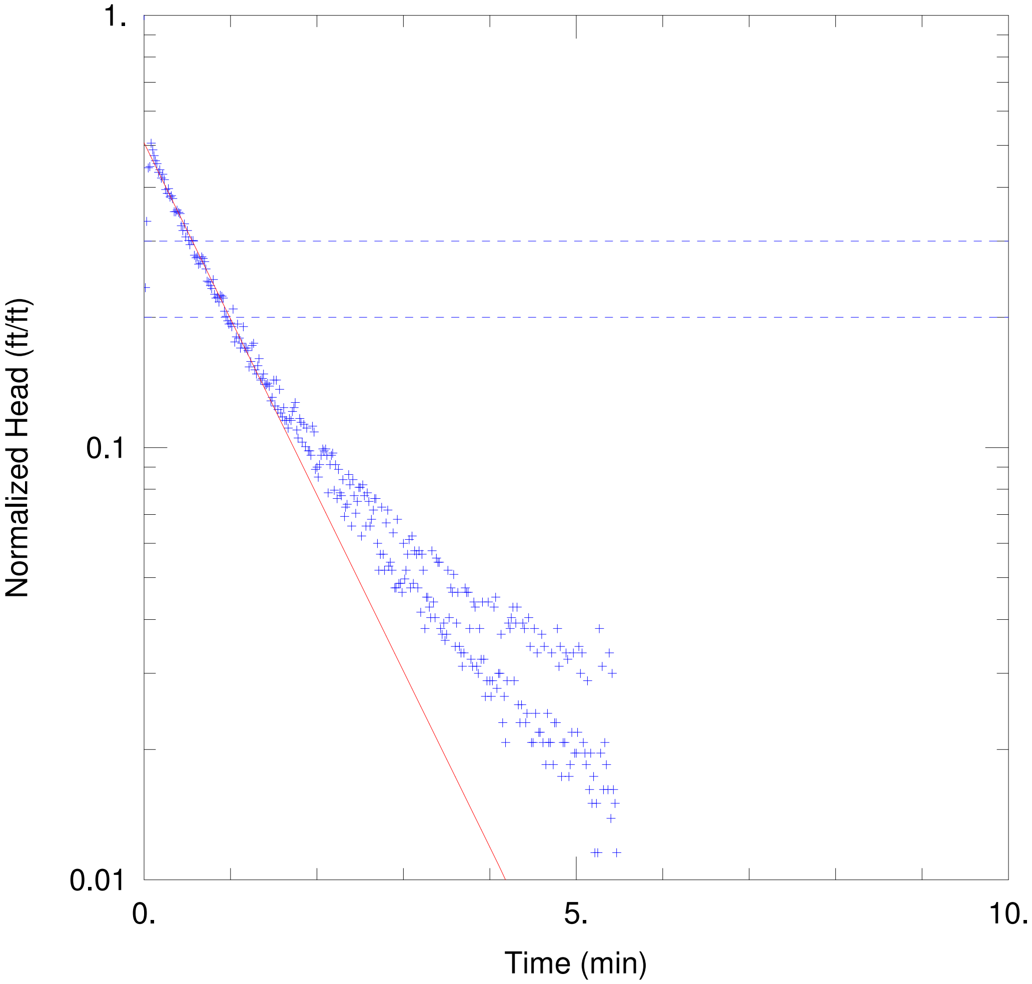
WELL DATA (MW-112)

Initial Displacement: 1.236 ft
Total Well Penetration Depth: 96.17 ft
Casing Radius: 0.167 ft
Static Water Column Height: 96.17 ft
Screen Length: 96.17 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.4124 ft/day
y0 = 0.6085 ft



MW-113 SLUG C FALLING HEAD

Data Set: S:\...\MW-113_SlugCFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:07:56

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-113
Test Date: 2 Oct 2013

AQUIFER DATA

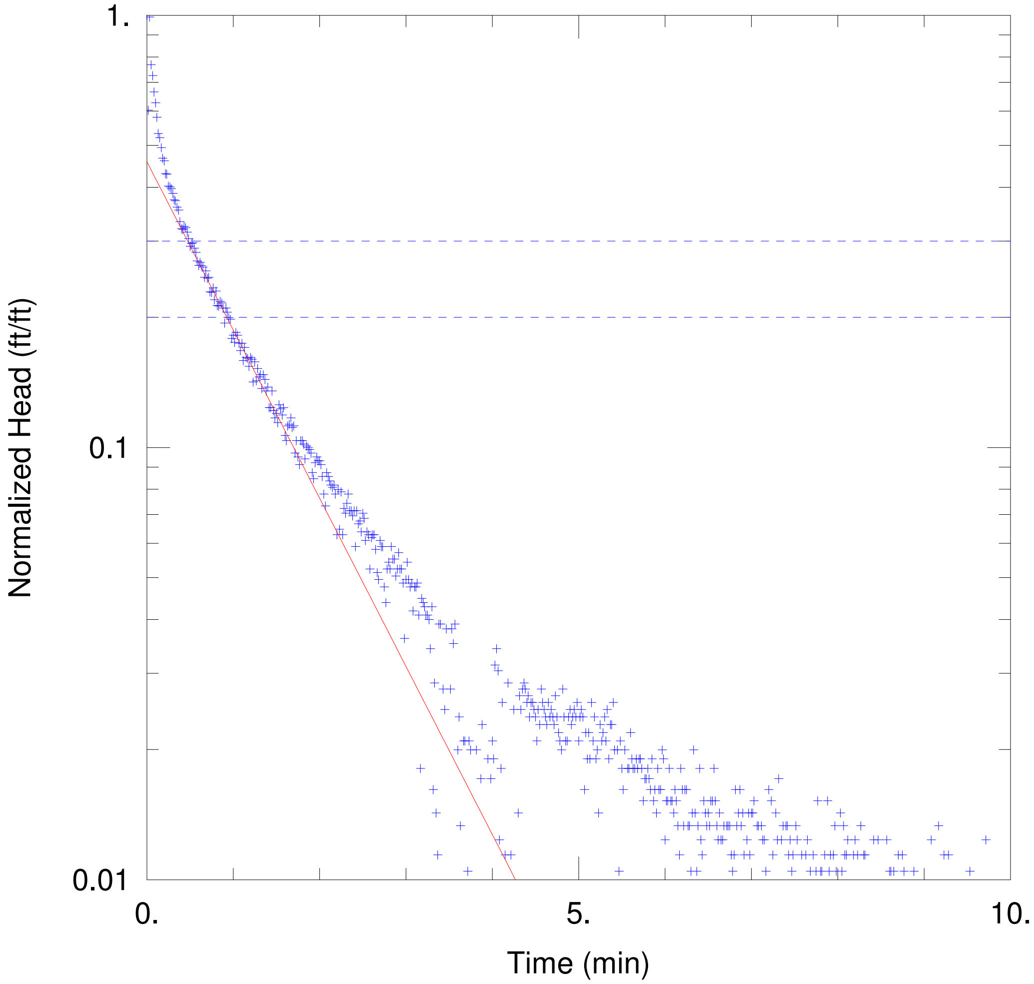
Saturated Thickness: 35.96 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-113)

Initial Displacement: 0.866 ft
Static Water Column Height: 35.96 ft
Total Well Penetration Depth: 35.96 ft
Screen Length: 35.96 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.89 ft/day
y0 = 0.4391 ft



MW-113 SLUG C RISING HEAD

Data Set: S:\...\MW-113_SlugCRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 10:09:10

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-113
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 35.96 ft
Anisotropy Ratio (Kz/Kr): 0.1

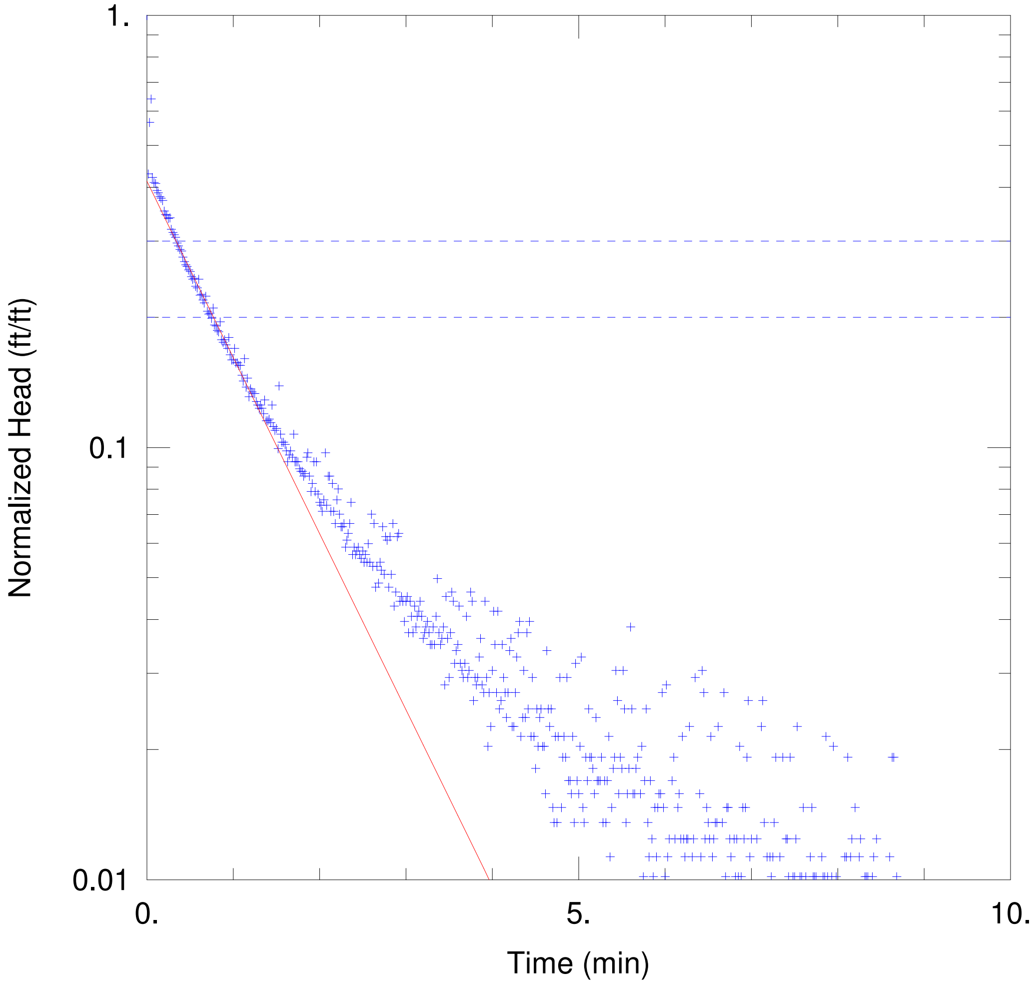
WELL DATA (MW-113)

Initial Displacement: 1.051 ft
Total Well Penetration Depth: 35.96 ft
Casing Radius: 0.167 ft
Static Water Column Height: 35.96 ft
Screen Length: 35.96 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.804 ft/day
y0 = 0.4814 ft



MW-113 SLUG F FALLING HEAD

Data Set: S:\...\MW-113_SlugFFallingHeadSlugHo_Kz.aqt
Date: 01/14/15
Time: 10:10:20

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-113
Test Date: 2 Oct 2013

AQUIFER DATA

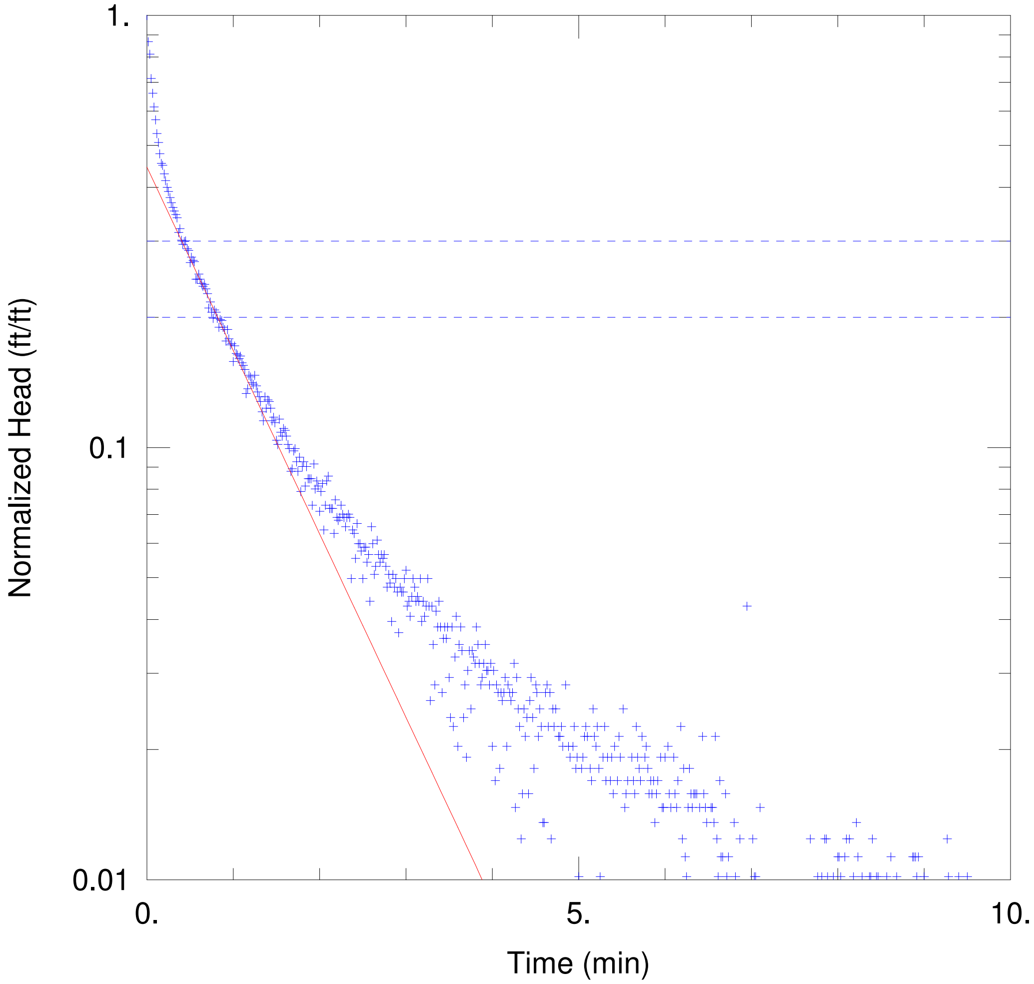
Saturated Thickness: 35.96 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-113)

Initial Displacement: 0.885 ft
Static Water Column Height: 35.96 ft
Total Well Penetration Depth: 35.96 ft
Screen Length: 35.96 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.89 ft/day
y0 = 0.3652 ft



MW-113 SLUG F RISING HEAD

Data Set: S:\...\MW-113_SlugFRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 10:11:35

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-113
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 35.96 ft
Anisotropy Ratio (Kz/Kr): 0.1

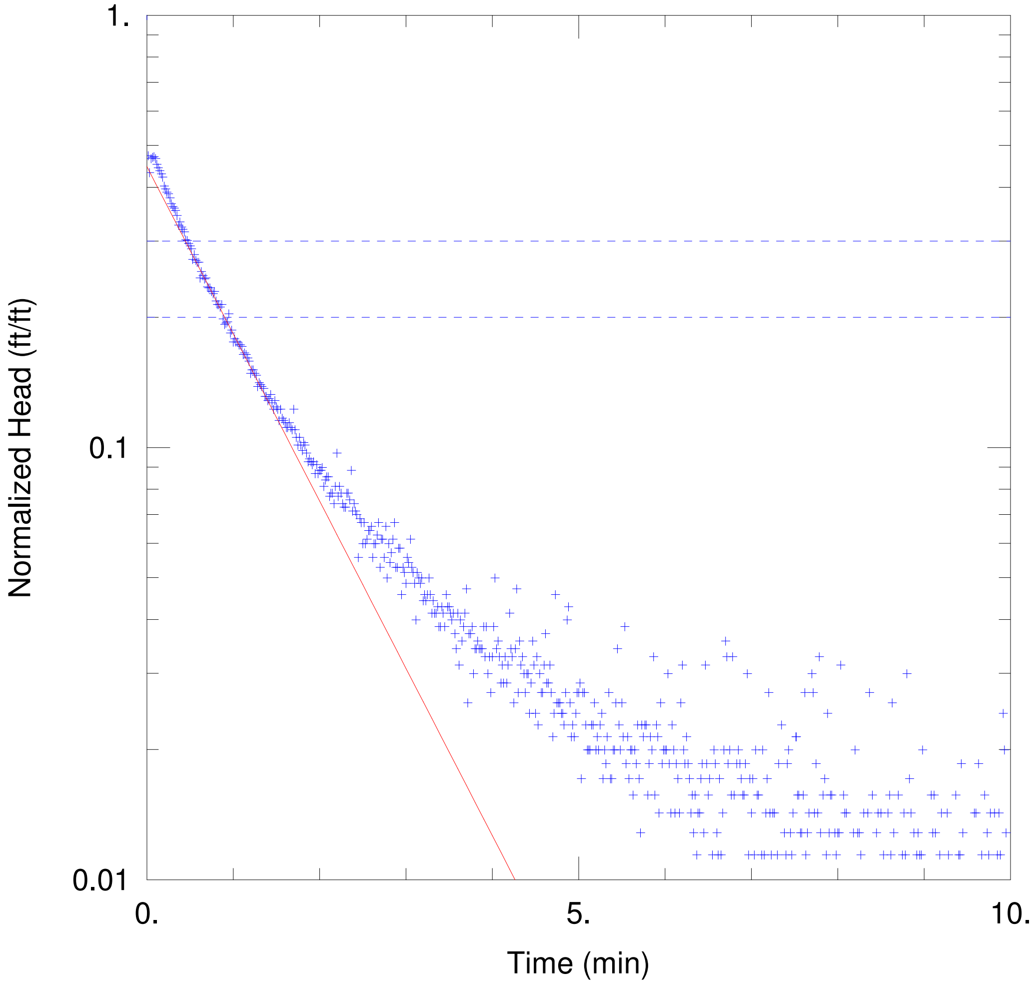
WELL DATA (MW-113)

Initial Displacement: 0.885 ft
Total Well Penetration Depth: 35.96 ft
Casing Radius: 0.167 ft
Static Water Column Height: 35.96 ft
Screen Length: 35.96 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.967 ft/day
y0 = 0.3939 ft



MW-113 SLUG I FALLING HEAD

Data Set: S:\...\MW-113_SlugIFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:12:45

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-113
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 35.96 ft
Anisotropy Ratio (Kz/Kr): 0.1

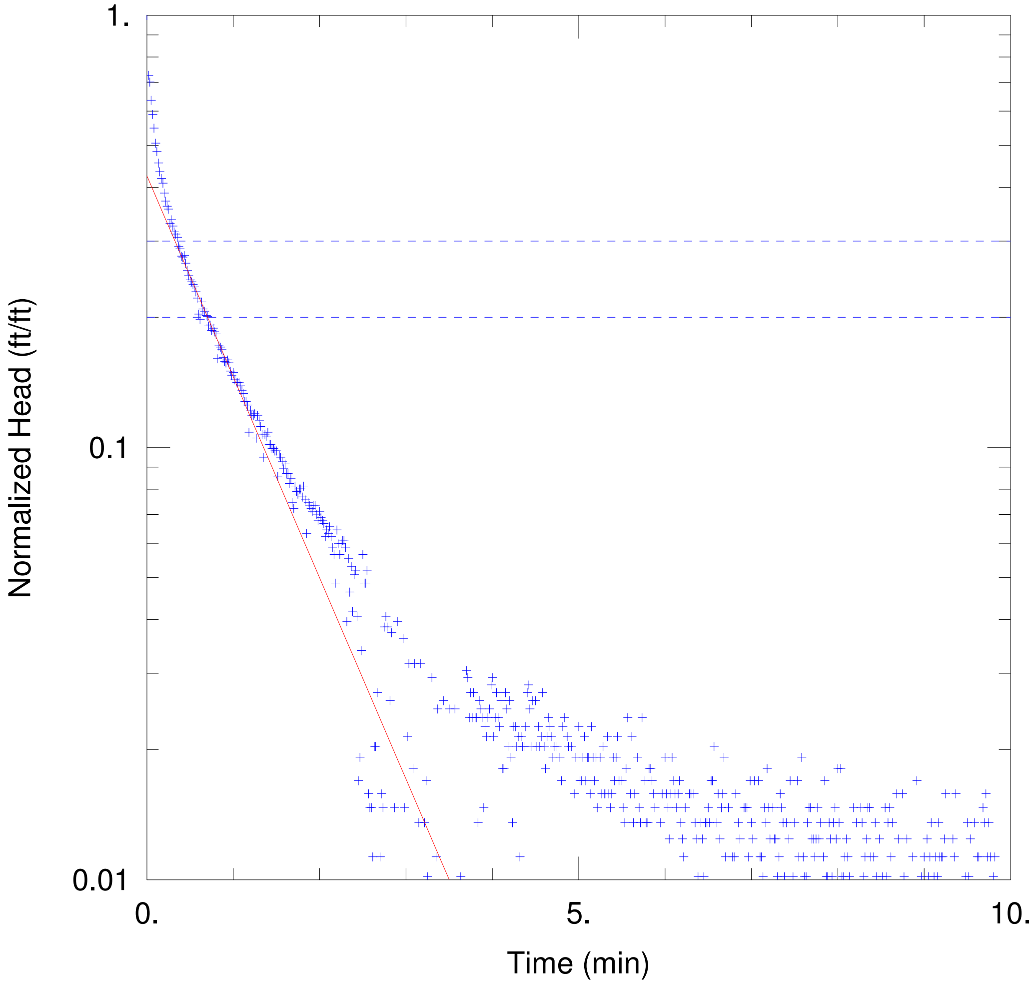
WELL DATA (MW-113)

Initial Displacement: 0.701 ft
Total Well Penetration Depth: 35.96 ft
Casing Radius: 0.167 ft
Static Water Column Height: 35.96 ft
Screen Length: 35.96 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.794 ft/day
y0 = 0.3129 ft



MW-113 SLUG I RISING HEAD

Data Set: S:\...\MW-113_SlugIRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 10:14:41

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-113
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 35.96 ft
Anisotropy Ratio (Kz/Kr): 0.1

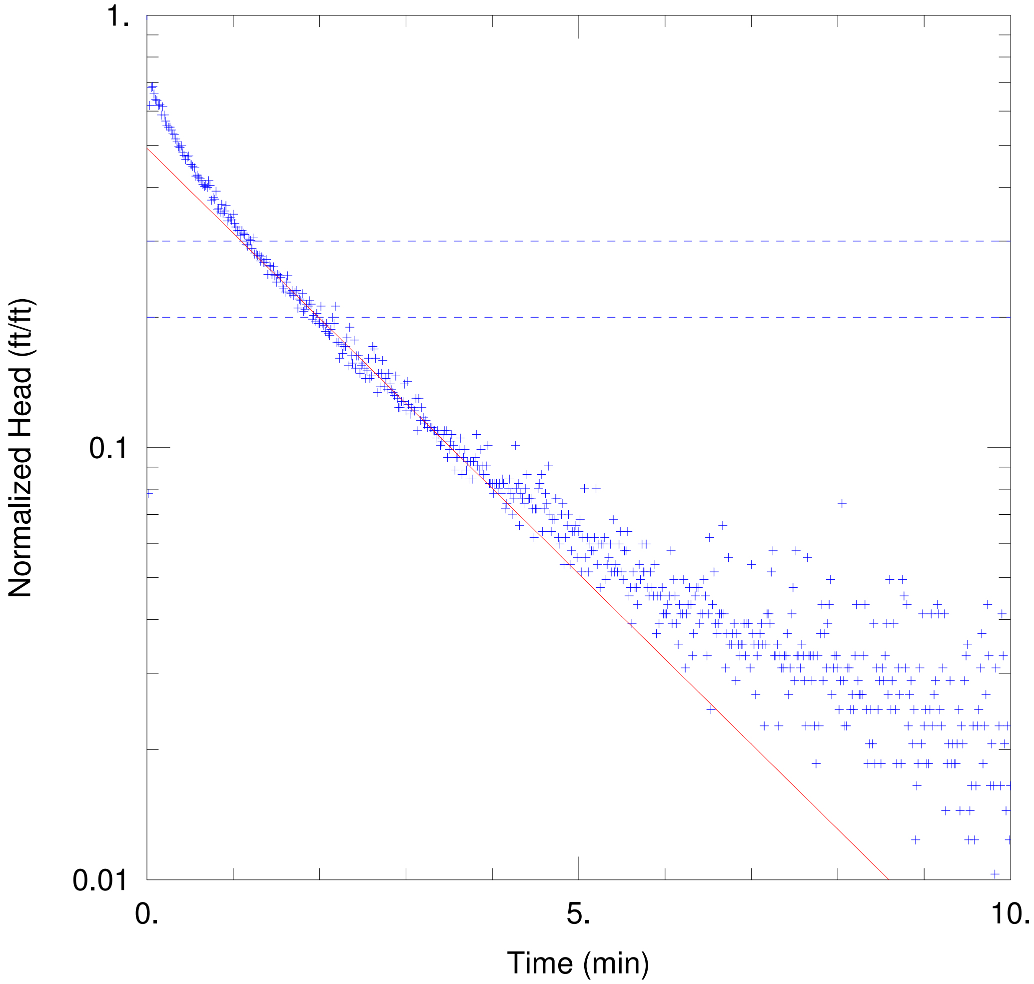
WELL DATA (MW-113)

Initial Displacement: 0.885 ft
Static Water Column Height: 35.96 ft
Total Well Penetration Depth: 35.96 ft
Screen Length: 35.96 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.157 ft/day
y0 = 0.3762 ft



MW-114 SLUG D FALLING HEAD

Data Set: S:\...\MW-114_SlugDFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:32:05

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-114
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 141.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

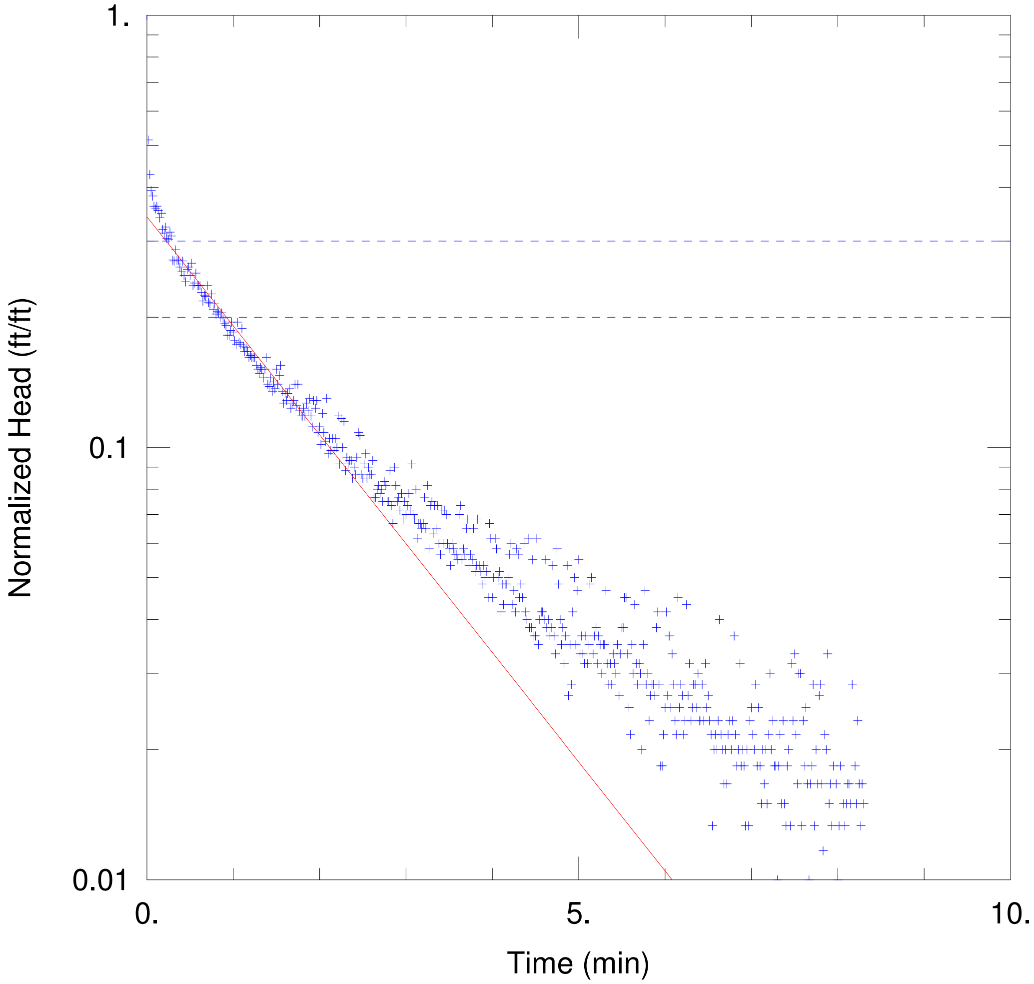
WELL DATA (MW-114)

Initial Displacement: 0.485 ft
Total Well Penetration Depth: 141.1 ft
Casing Radius: 0.167 ft
Static Water Column Height: 141.1 ft
Screen Length: 141.1 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3142 ft/day
y0 = 0.2389 ft



MW-114 SLUG J FALLING HEAD

Data Set: S:\...\MW-114_SlugJFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:36:16

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-114
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 141.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

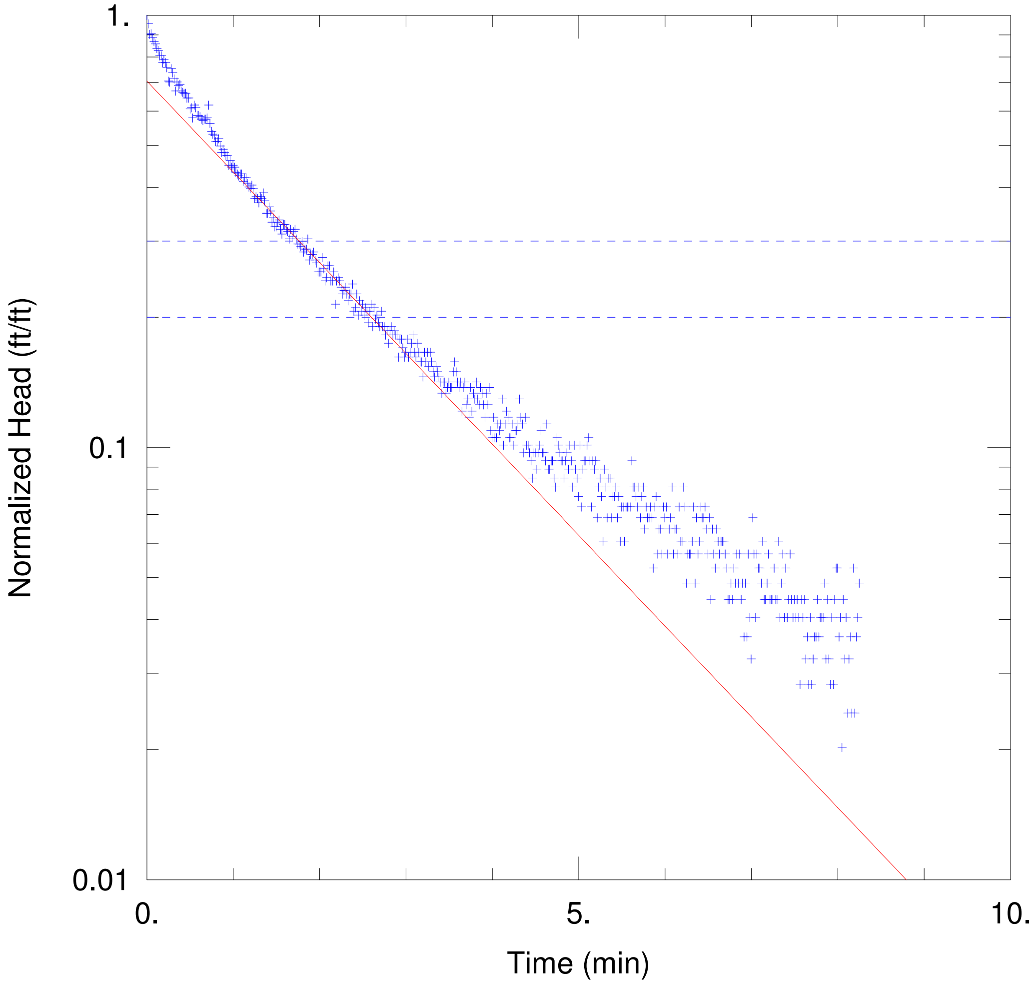
WELL DATA (MW-114)

Initial Displacement: 0.6 ft
Total Well Penetration Depth: 141.1 ft
Casing Radius: 0.167 ft
Static Water Column Height: 141.1 ft
Screen Length: 141.1 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.4021 ft/day
y0 = 0.2049 ft



MW-114 SLUG J RISING HEAD

Data Set: S:\...\MW-114_SlugJRisingHeadHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:37:17

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-114
Test Date: 2 Oct 2013

AQUIFER DATA

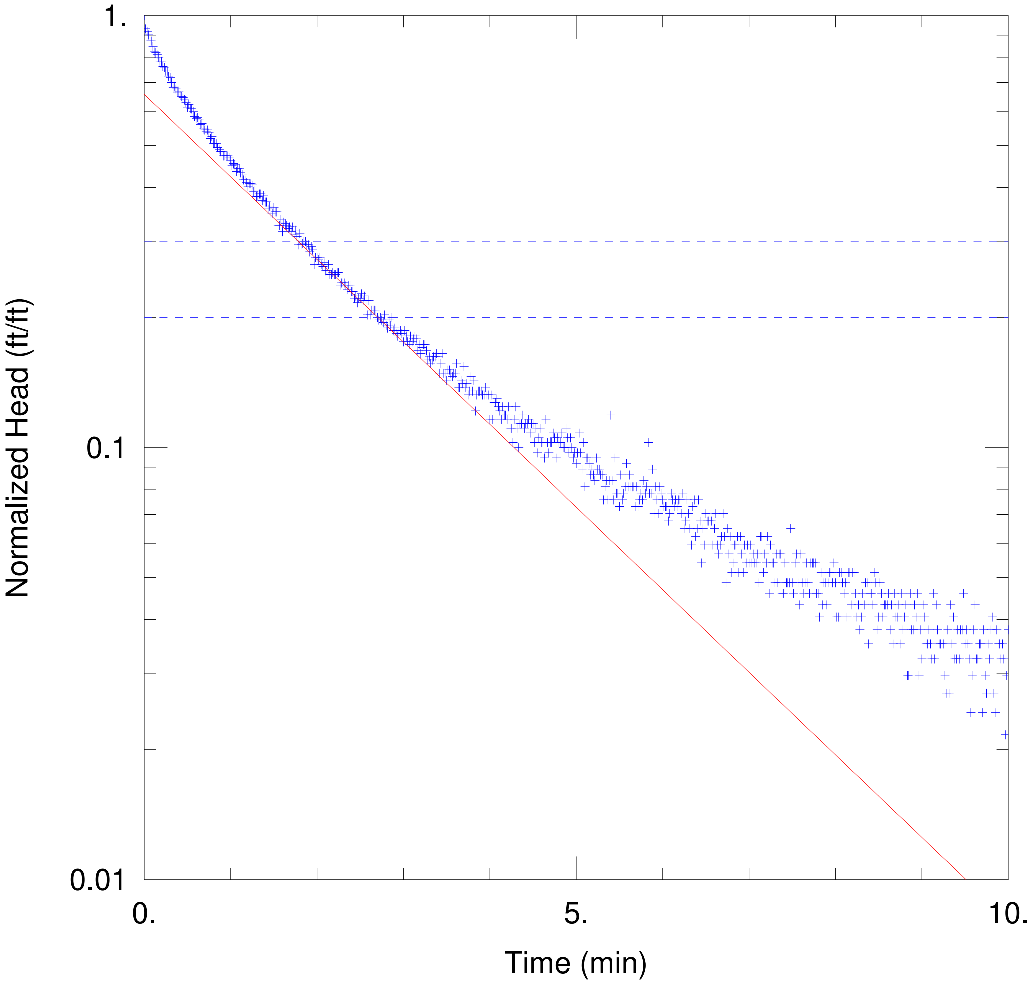
Saturated Thickness: 141.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-114)

Initial Displacement: 0.247 ft
Static Water Column Height: 141.1 ft
Total Well Penetration Depth: 141.1 ft
Screen Length: 141.1 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.3351 ft/day
y0 = 0.1739 ft



MW-114 SLUG L FALLING HEAD

Data Set: S:\...\MW-114_SlugLFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:38:18

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-114
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 141.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

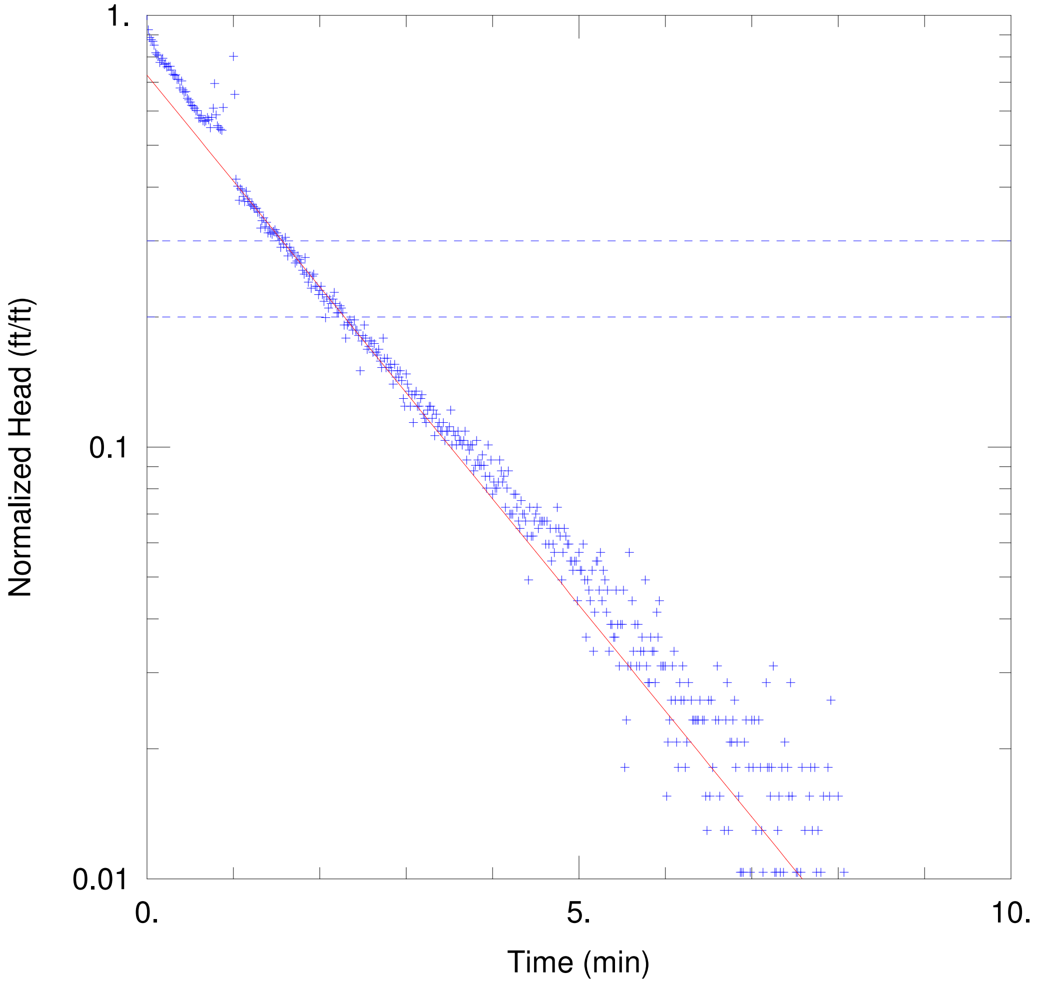
WELL DATA (MW-114)

Initial Displacement: 0.37 ft
Total Well Penetration Depth: 141.1 ft
Casing Radius: 0.167 ft
Static Water Column Height: 141.1 ft
Screen Length: 141.1 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3048 ft/day
y0 = 0.2431 ft



MW-114 SLUG L RISING HEAD

Data Set: S:\...\MW-114_SlugLRisingHeadHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 16:06:10

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-114
Test Date: 2 Oct 2013

AQUIFER DATA

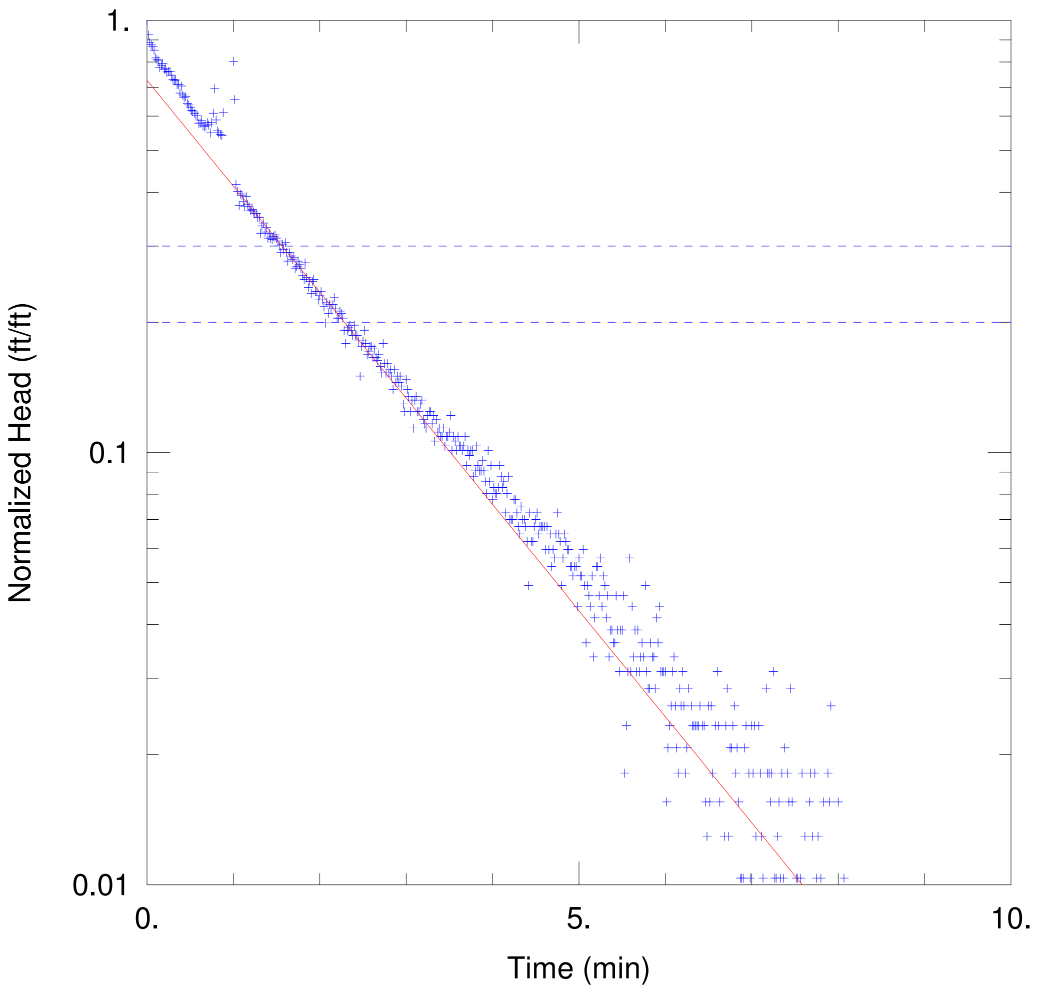
Saturated Thickness: 141.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-114)

Initial Displacement: 0.386 ft
Static Water Column Height: 141.1 ft
Total Well Penetration Depth: 141.1 ft
Screen Length: 141.1 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.3914 ft/day
y0 = 0.2805 ft



MW-114 SLUG L RISING HEAD

Data Set: S:\...\MW-114_SlugLRisingHeadHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 10:39:22

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-114
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 141.1 ft Anisotropy Ratio (Kz/Kr): 1.

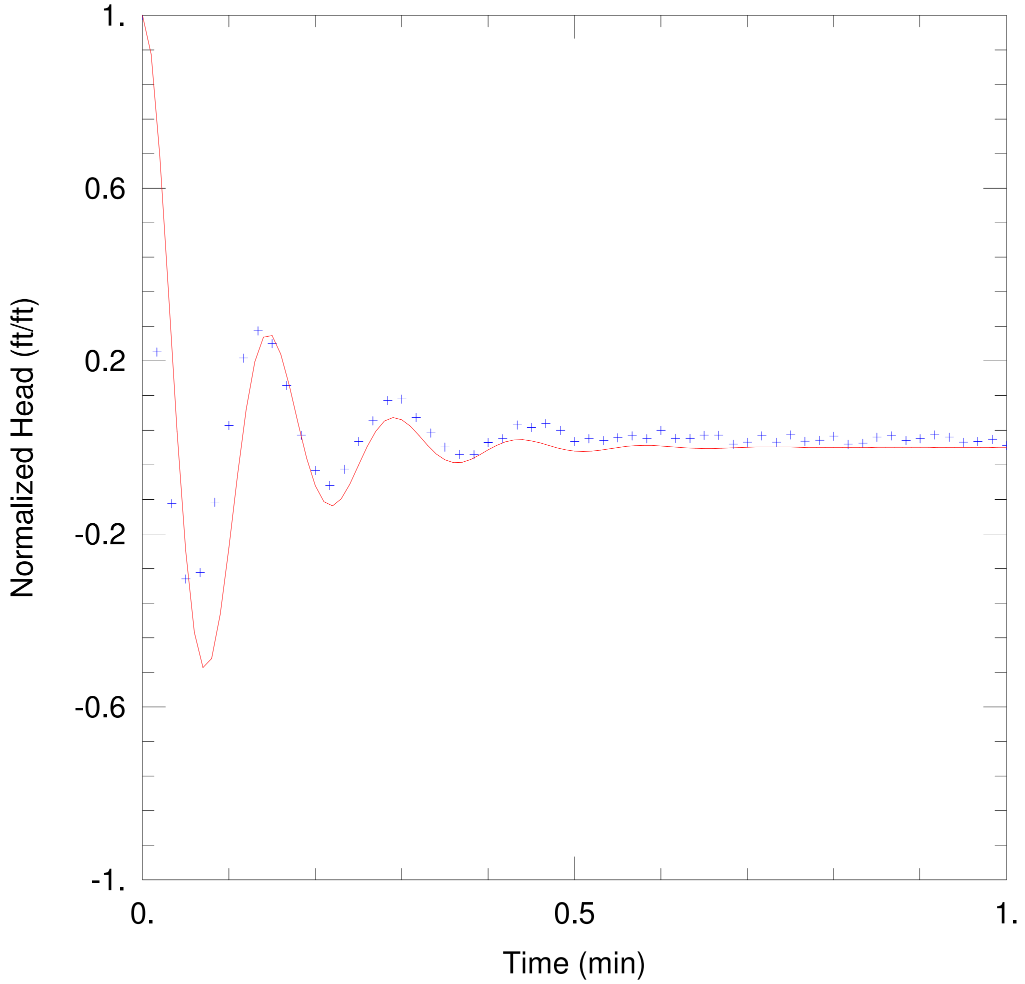
WELL DATA (MW-114)

Initial Displacement: 0.386 ft Static Water Column Height: 141.1 ft
Total Well Penetration Depth: 141.1 ft Screen Length: 141.1 ft
Casing Radius: 0.167 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.3914 ft/day y0 = 0.2805 ft



MW-115M SLUG C FALLING HEAD

Data Set: S:\...\MW-115M_SlugCFallingHeadButler_Kz.aqt

Date: 01/14/15 Time: 10:42:29

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115M
Test Date: 11 Oct 2013

AQUIFER DATA

Saturated Thickness: 125. ft
Anisotropy Ratio (Kz/Kr): 0.1

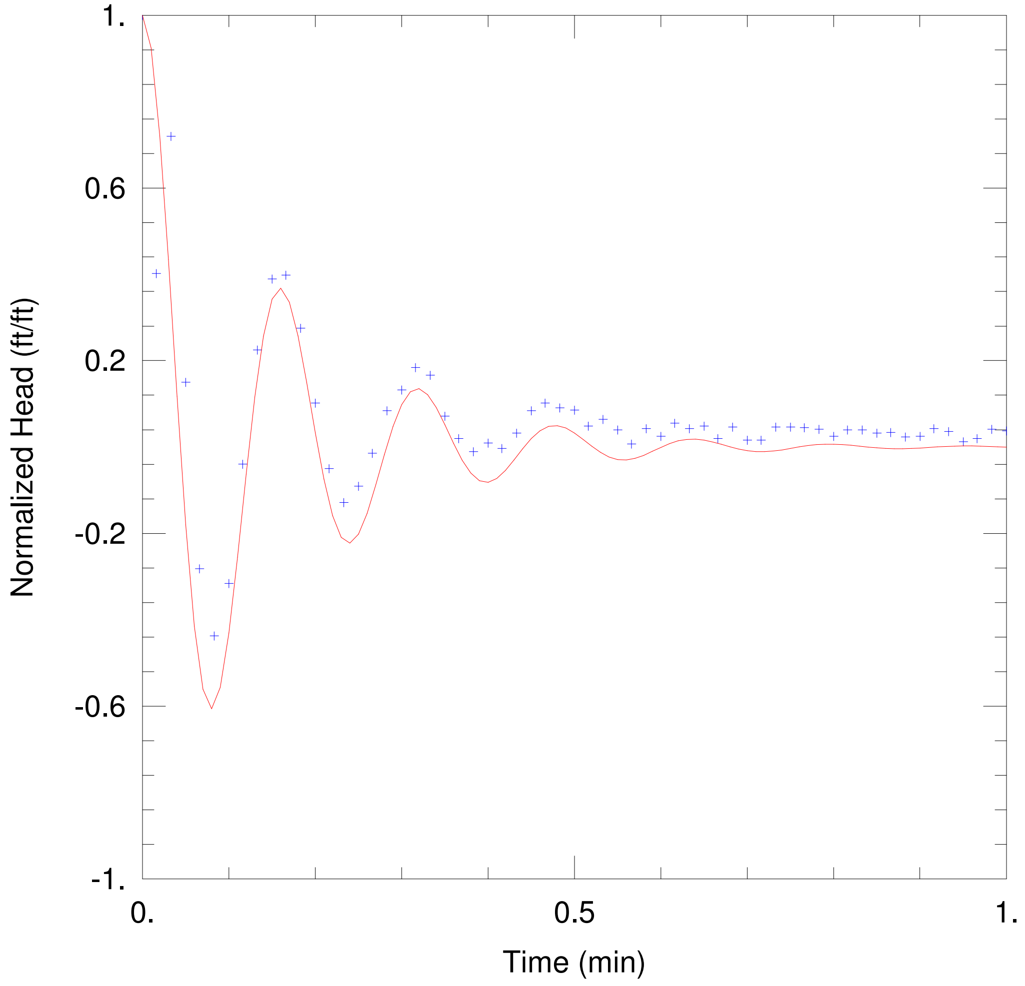
WELL DATA (MW-115M)

Initial Displacement: 0.885 ft
Total Well Penetration Depth: 125. ft
Casing Radius: 0.167 ft
Static Water Column Height: 141.3 ft
Screen Length: 90. ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler

K = 171.2 ft/day
Le = 59.45 ft



MW-115M SLUG C RISING HEAD

Data Set: S:\...\MW-115M_SlugCRisingHeadButler_Kz.aqt
Date: 01/14/15 Time: 10:44:38

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115M
Test Date: 11 Oct 2013

AQUIFER DATA

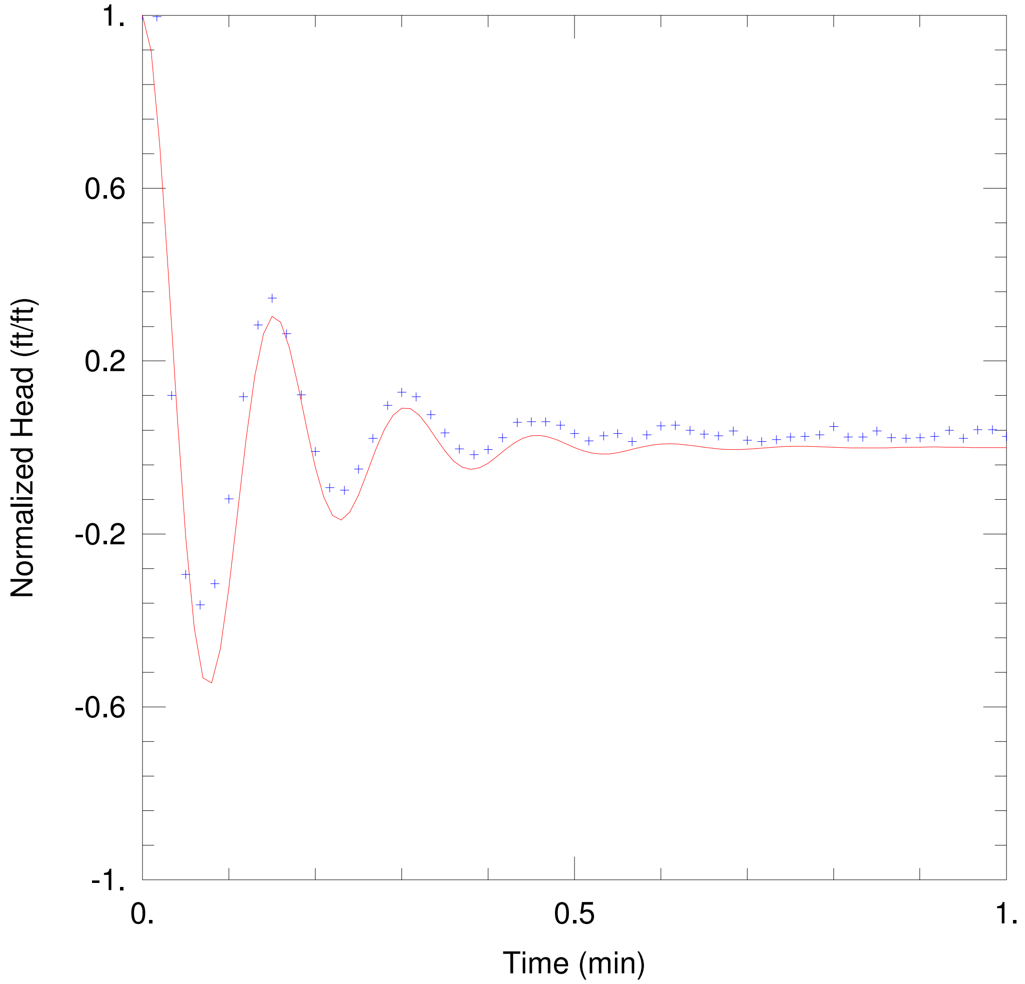
Saturated Thickness: 125. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-115M)

Initial Displacement: 0.56 ft
Total Well Penetration Depth: 125. ft
Casing Radius: 0.167 ft
Static Water Column Height: 141.3 ft
Screen Length: 90. ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler
K = 204.8 ft/day
Le = 72.47 ft



MW-115M SLUG F FALLING HEAD

Data Set: S:\...\MW-115M_SlugFFallingHeadButler_Kz.aqt
Date: 01/14/15 Time: 10:46:29

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115M
Test Date: 11 Oct 2013

AQUIFER DATA

Saturated Thickness: 125. ft
Anisotropy Ratio (Kz/Kr): 0.1

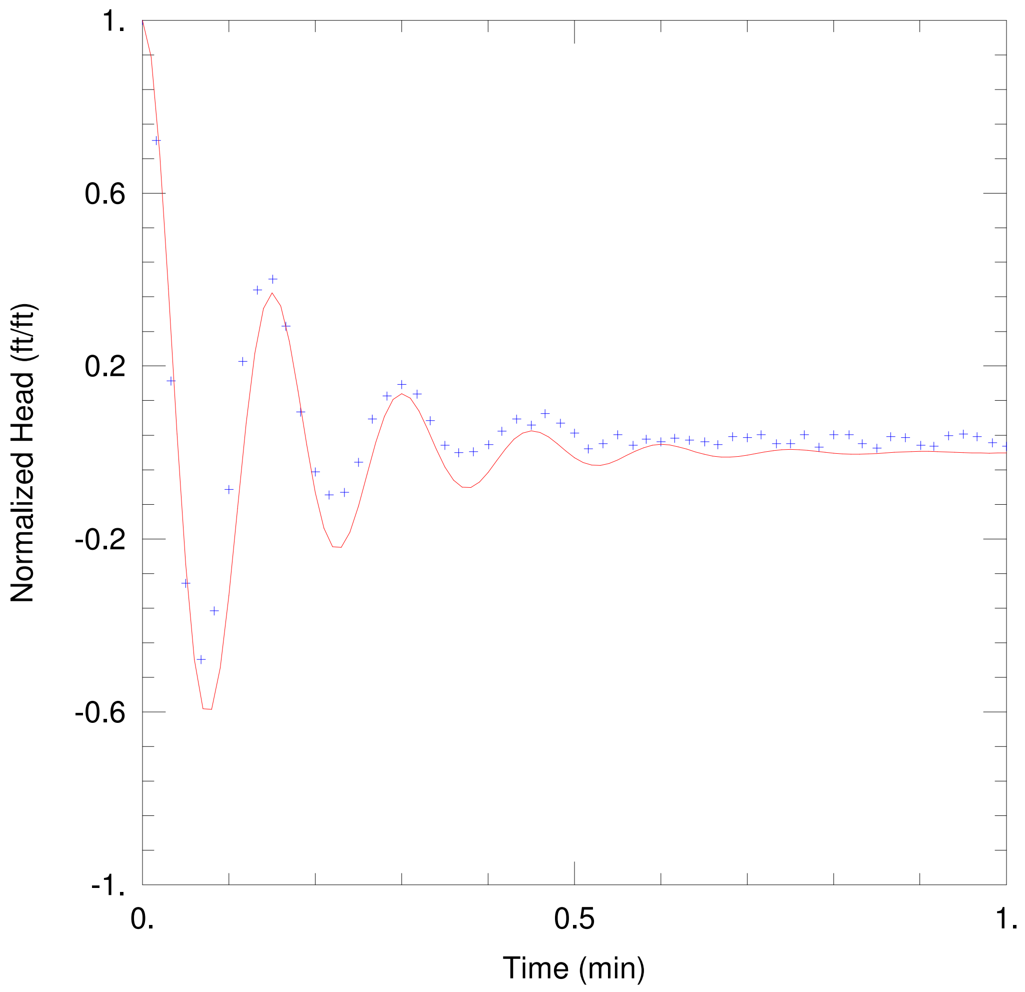
WELL DATA (MW-115M)

Initial Displacement: 0.657 ft
Total Well Penetration Depth: 125. ft
Casing Radius: 0.167 ft
Static Water Column Height: 141.3 ft
Screen Length: 90. ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler

K = 181.9 ft/day
Le = 65.64 ft



MW-115M SLUG F RISING HEAD

Data Set: S:\...\MW-115M_SlugFRisingHeadButler_Kz.aqt
Date: 01/14/15 Time: 10:48:28

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115M
Test Date: 11 Oct 2013

AQUIFER DATA

Saturated Thickness: 125. ft
Anisotropy Ratio (Kz/Kr): 0.1

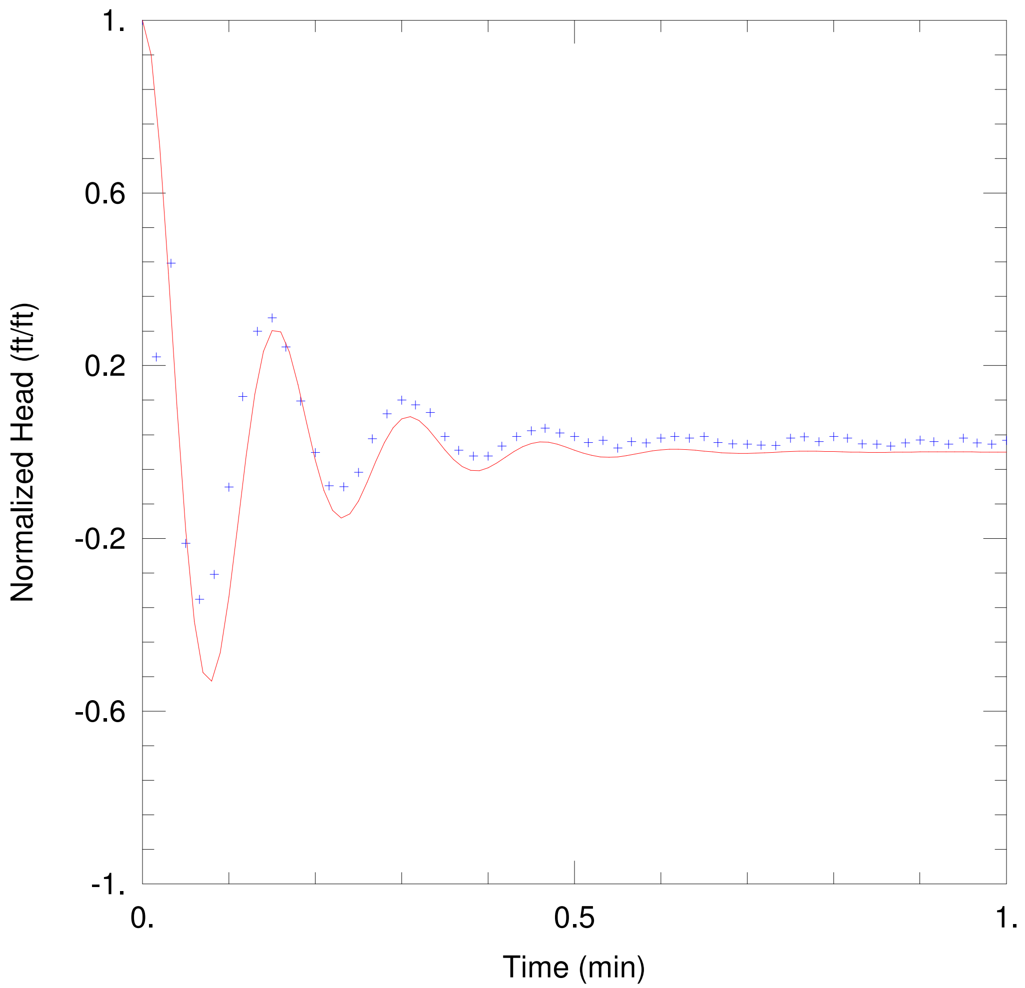
WELL DATA (MW-115M)

Initial Displacement: 0.489 ft
Total Well Penetration Depth: 125. ft
Casing Radius: 0.167 ft
Static Water Column Height: 141.3 ft
Screen Length: 90. ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler

K = 217.6 ft/day
Le = 64.59 ft



MW-115M SLUG L FALLING HEAD

Data Set: S:\...\MW-115M_SlugLFallingHeadGraphHoButler_Kz.aqt
Date: 01/14/15 Time: 10:56:31

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115M
Test Date: 11 Oct 2013

AQUIFER DATA

Saturated Thickness: 125. ft
Anisotropy Ratio (Kz/Kr): 0.1

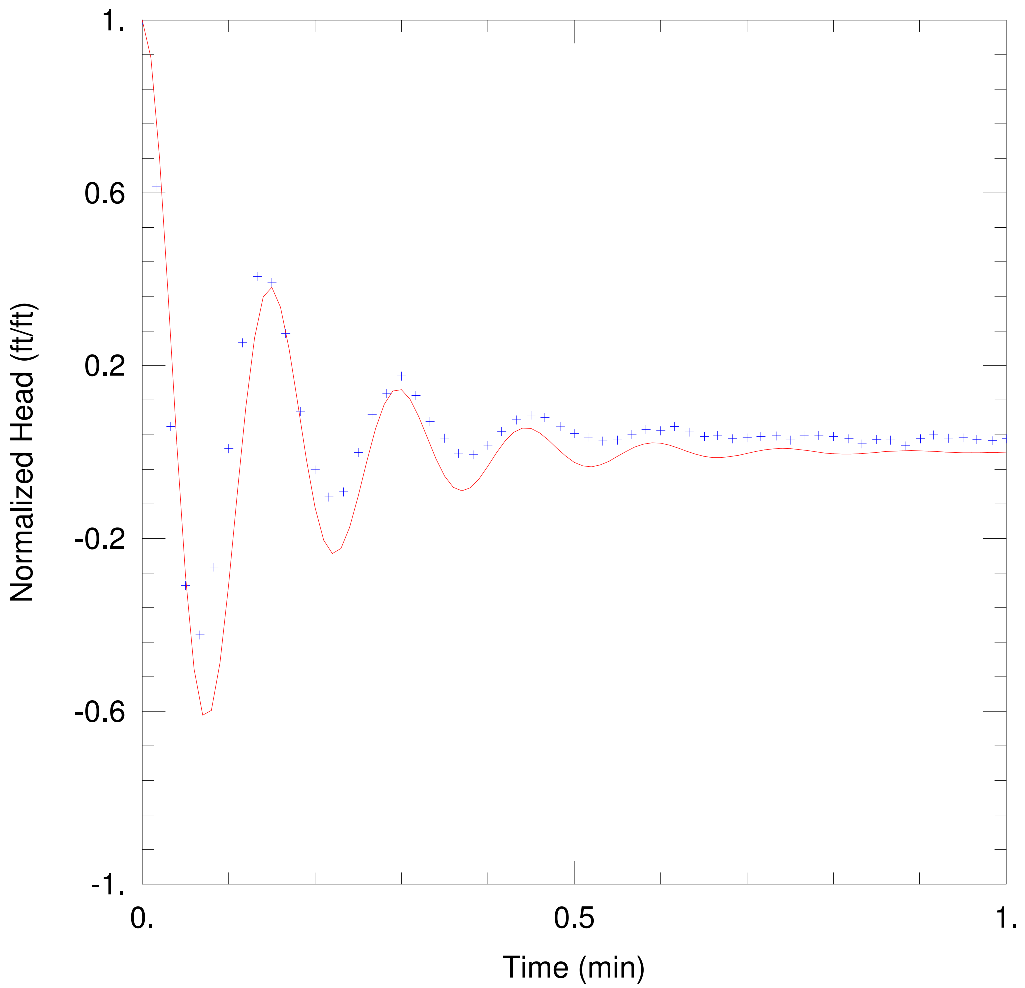
WELL DATA (MW-115M)

Initial Displacement: 1.049 ft
Static Water Column Height: 141.3 ft
Total Well Penetration Depth: 125. ft
Screen Length: 90. ft
Casing Radius: 0.167 ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler

K = 171.2 ft/day
Le = 67.15 ft



MW-115M SLUG L RISING HEAD

Data Set: S:\...\MW-115M_SlugLRisingHeadButler_Kz.aqt
Date: 01/14/15 Time: 10:58:37

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115M
Test Date: 11 Oct 2013

AQUIFER DATA

Saturated Thickness: 125. ft
Anisotropy Ratio (Kz/Kr): 0.1

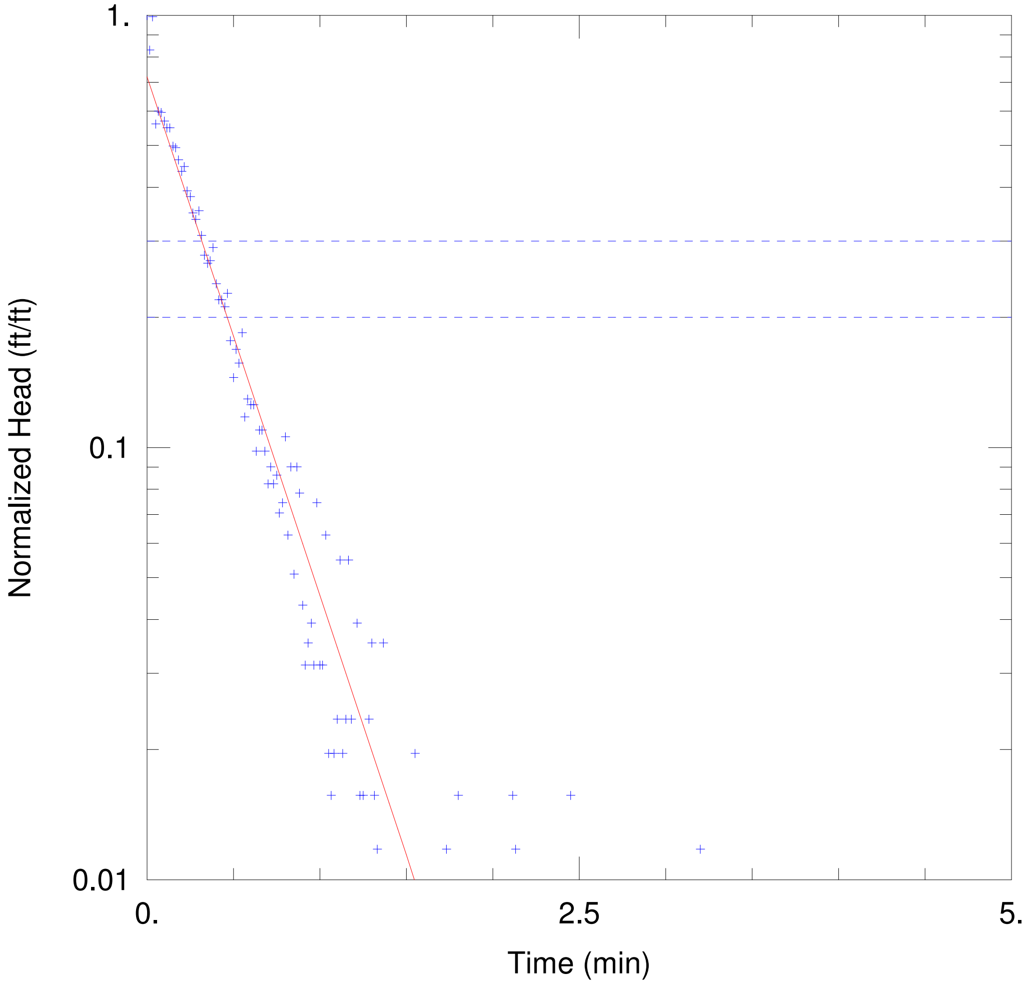
WELL DATA (MW-115M)

Initial Displacement: 0.751 ft
Static Water Column Height: 141.3 ft
Total Well Penetration Depth: 125. ft
Screen Length: 90. ft
Casing Radius: 0.167 ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Butler

K = 228.6 ft/day
Le = 62.82 ft



MW-115S SLUG J FALLING HEAD

Data Set: S:\...\MW-115S_SlugJFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:01:18

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115S
Test Date: 2 Oct 2013

AQUIFER DATA

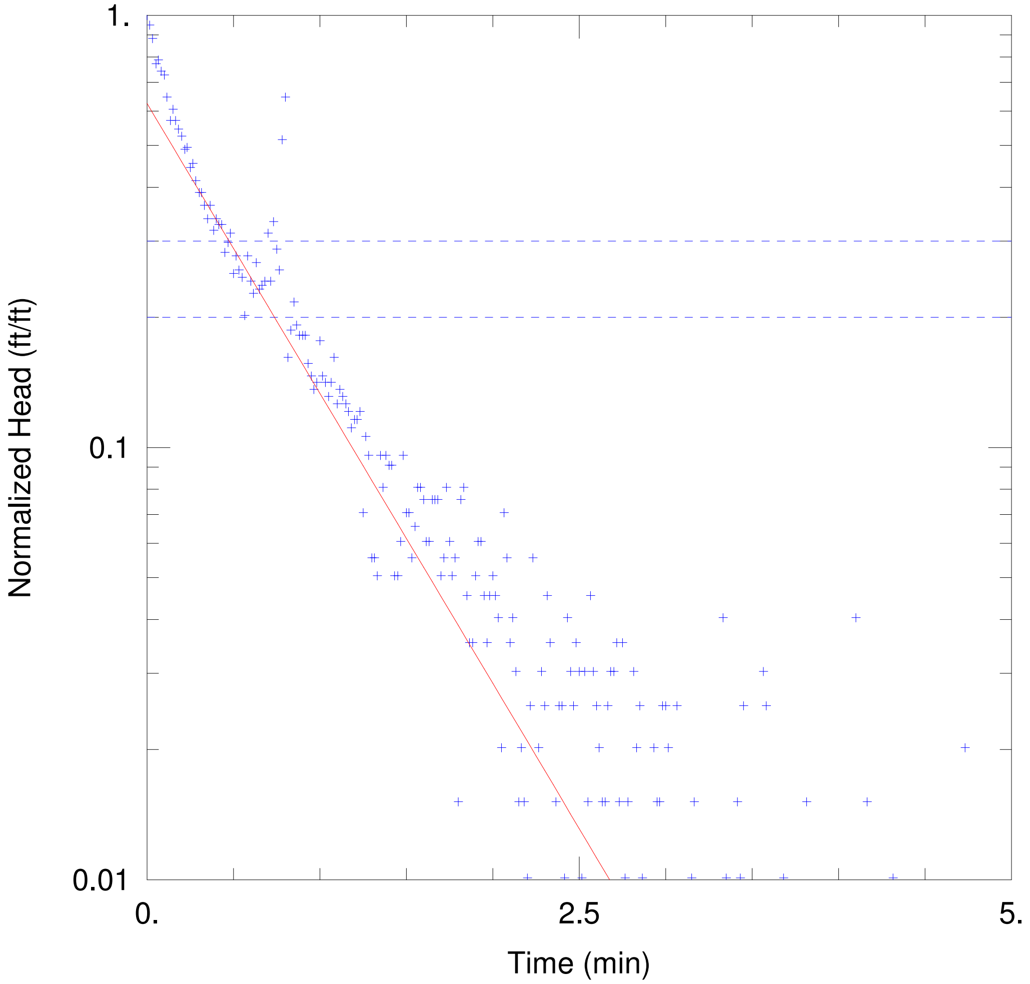
Saturated Thickness: 51.29 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-115)

Initial Displacement: 0.255 ft
Static Water Column Height: 51.29 ft
Total Well Penetration Depth: 51.29 ft
Screen Length: 51.29 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 4.22 ft/day
y0 = 0.1838 ft



MW-115S SLUG J RISING HEAD

Data Set: S:\...\MW-115S_SlugJRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:02:55

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115S
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 51.29 ft Anisotropy Ratio (Kz/Kr): 0.1

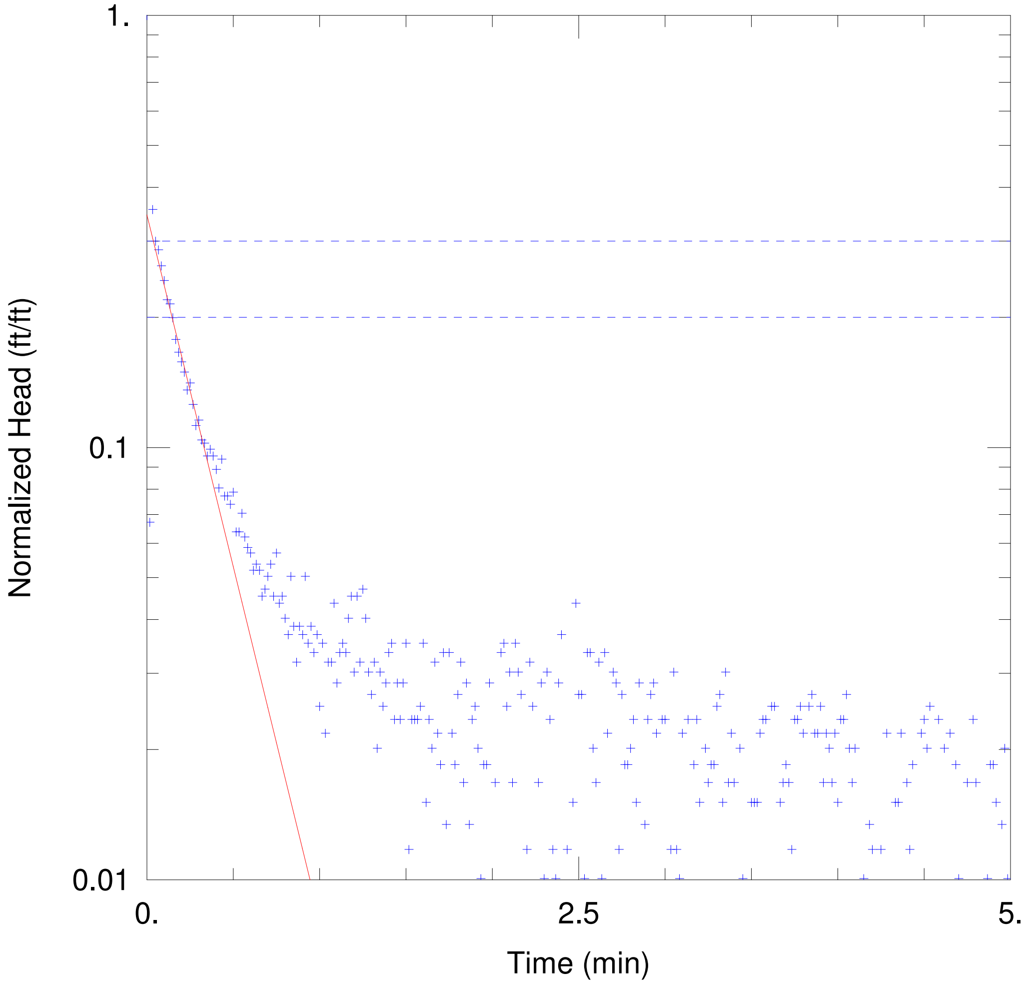
WELL DATA (MW-115)

Initial Displacement: 0.198 ft
Total Well Penetration Depth: 51.29 ft
Casing Radius: 0.167 ft
Static Water Column Height: 51.29 ft
Screen Length: 51.29 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.358 ft/day y0 = 0.1237 ft



MW-115S SLUG K FALLING HEAD

Data Set: S:\...\MW-115S_SlugKFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:04:23

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115S
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 51.29 ft
Anisotropy Ratio (Kz/Kr): 0.1

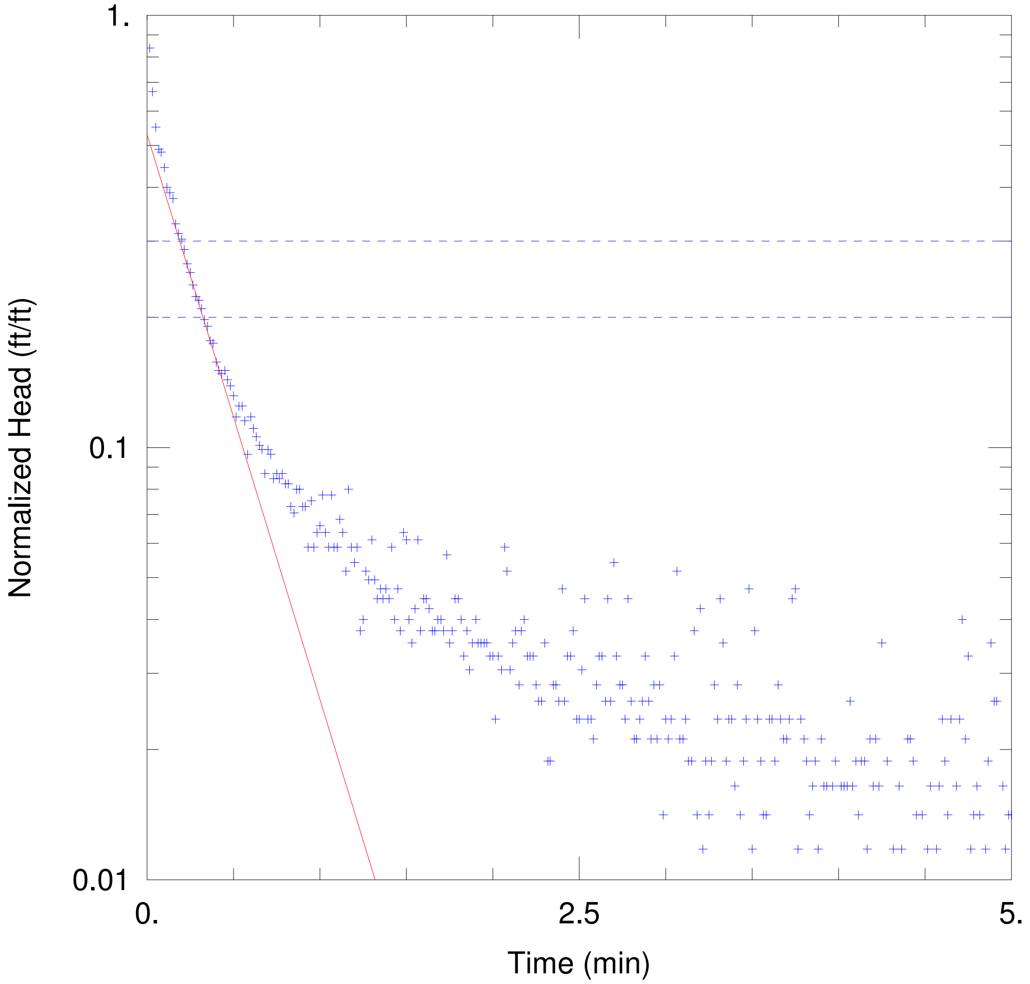
WELL DATA (MW-115)

Initial Displacement: 0.596 ft
Total Well Penetration Depth: 51.29 ft
Casing Radius: 0.167 ft
Static Water Column Height: 51.29 ft
Screen Length: 51.29 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.727 ft/day
y0 = 0.2059 ft



MW-115S SLUG L FALLING HEAD

Data Set: S:\...\MW-115S_SlugLFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:05:46

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-115S
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 51.29 ft
Anisotropy Ratio (Kz/Kr): 0.1

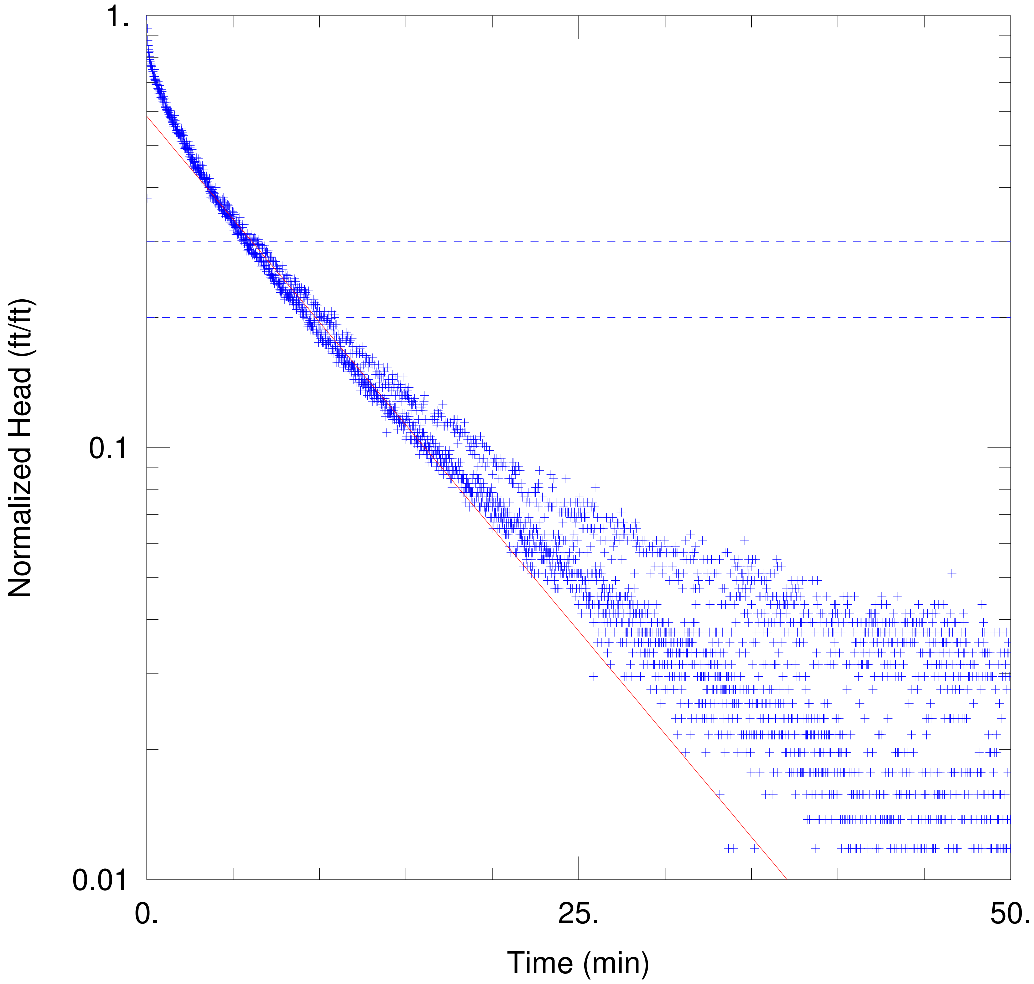
WELL DATA (MW-115)

Initial Displacement: 0.425 ft
Static Water Column Height: 51.29 ft
Total Well Penetration Depth: 51.29 ft
Screen Length: 51.29 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.595 ft/day
y0 = 0.225 ft



MW-116 SLUG A FALLING HEAD

Data Set: S:\...\MW-116_SlugAFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 11:09:20

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-116
Test Date: 3 Oct 2013

AQUIFER DATA

Saturated Thickness: 38.75 ft
Anisotropy Ratio (Kz/Kr): 0.1

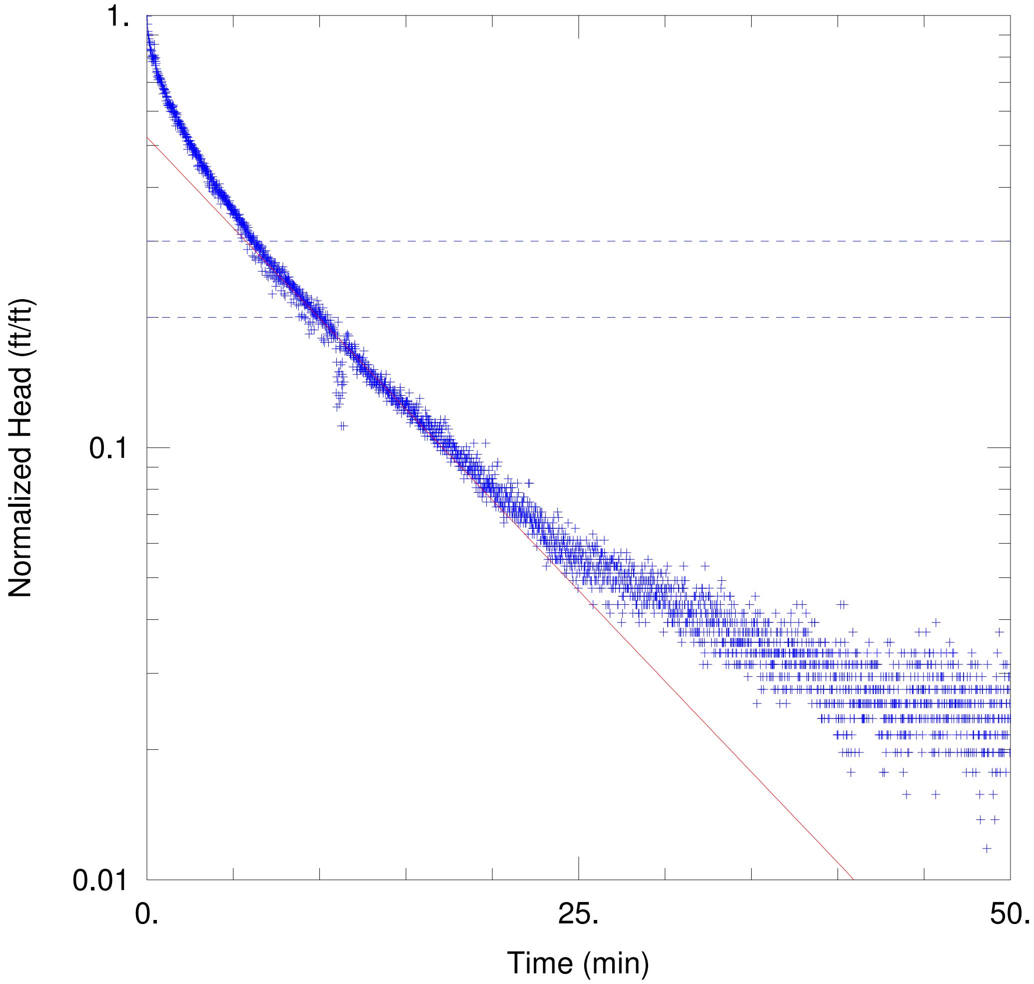
WELL DATA (MW-116)

Initial Displacement: 0.508 ft
Static Water Column Height: 38.75 ft
Total Well Penetration Depth: 38.75 ft
Screen Length: 20. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.4978 ft/day
y0 = 0.2971 ft



MW-116 SLUG A RISING HEAD

Data Set: S:\...\MW-116_SlugARisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 11:10:53

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-116
Test Date: 3 Oct 2013

AQUIFER DATA

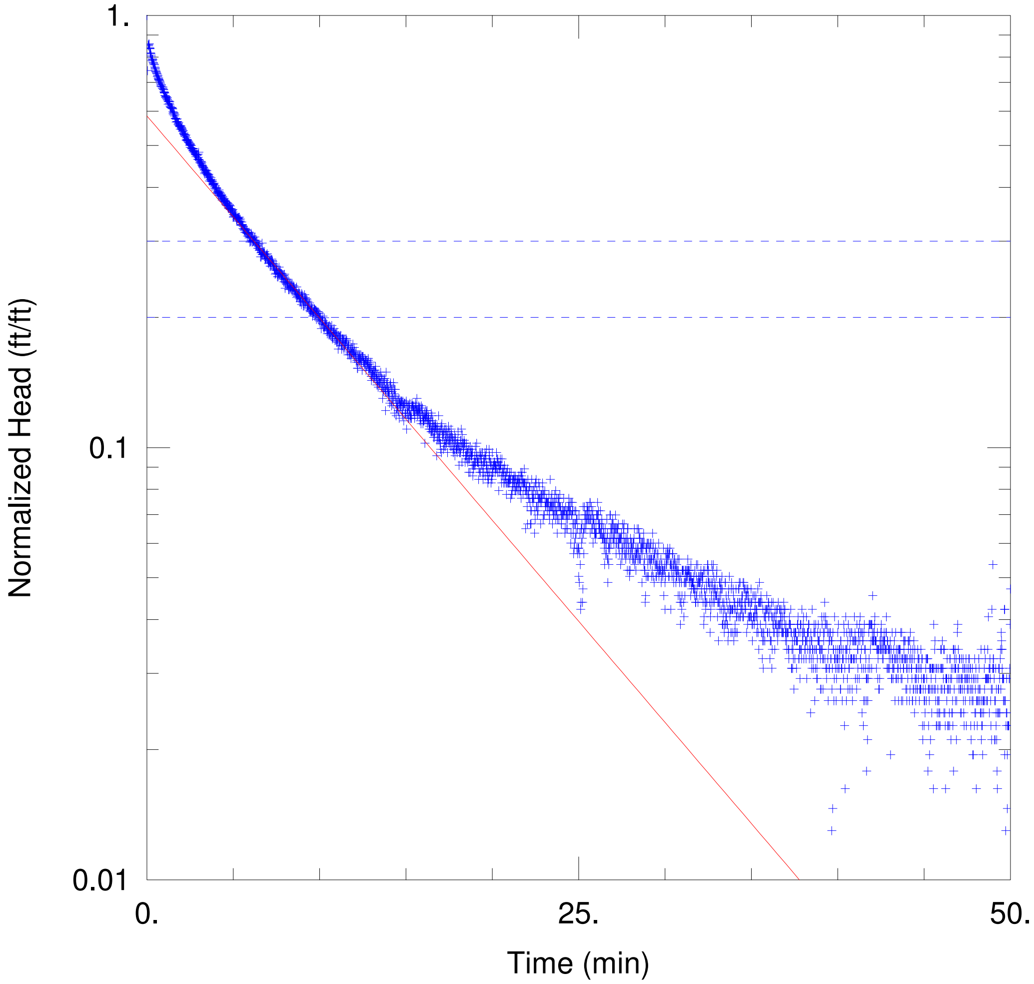
Saturated Thickness: 38.75 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-116)

Initial Displacement: 0.508 ft
Static Water Column Height: 38.75 ft
Total Well Penetration Depth: 38.75 ft
Screen Length: 20. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.4381 ft/day
y0 = 0.2653 ft



MW-116 SLUG G FALLING HEAD

Data Set: S:\...\MW-116_SlugGFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 11:12:37

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-116
Test Date: 3 Oct 2013

AQUIFER DATA

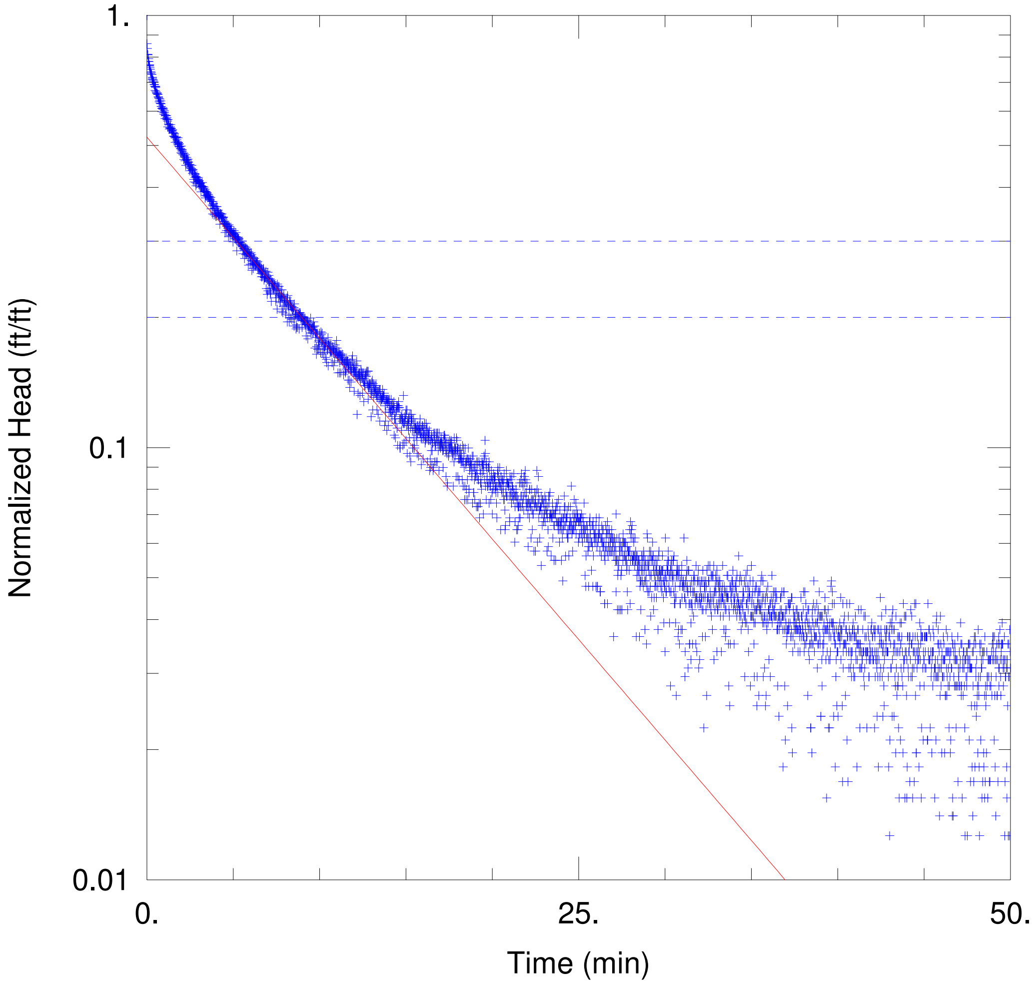
Saturated Thickness: 38.75 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-116)

Initial Displacement: 0.616 ft
Total Well Penetration Depth: 38.75 ft
Casing Radius: 0.167 ft
Static Water Column Height: 38.75 ft
Screen Length: 20. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.4884 ft/day
y0 = 0.3604 ft



MW-116 SLUG G RISING HEAD

Data Set: S:\...\MW-116_SlugGRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:13:57

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-116
Test Date: 3 Oct 2013

AQUIFER DATA

Saturated Thickness: 38.75 ft
Anisotropy Ratio (Kz/Kr): 0.1

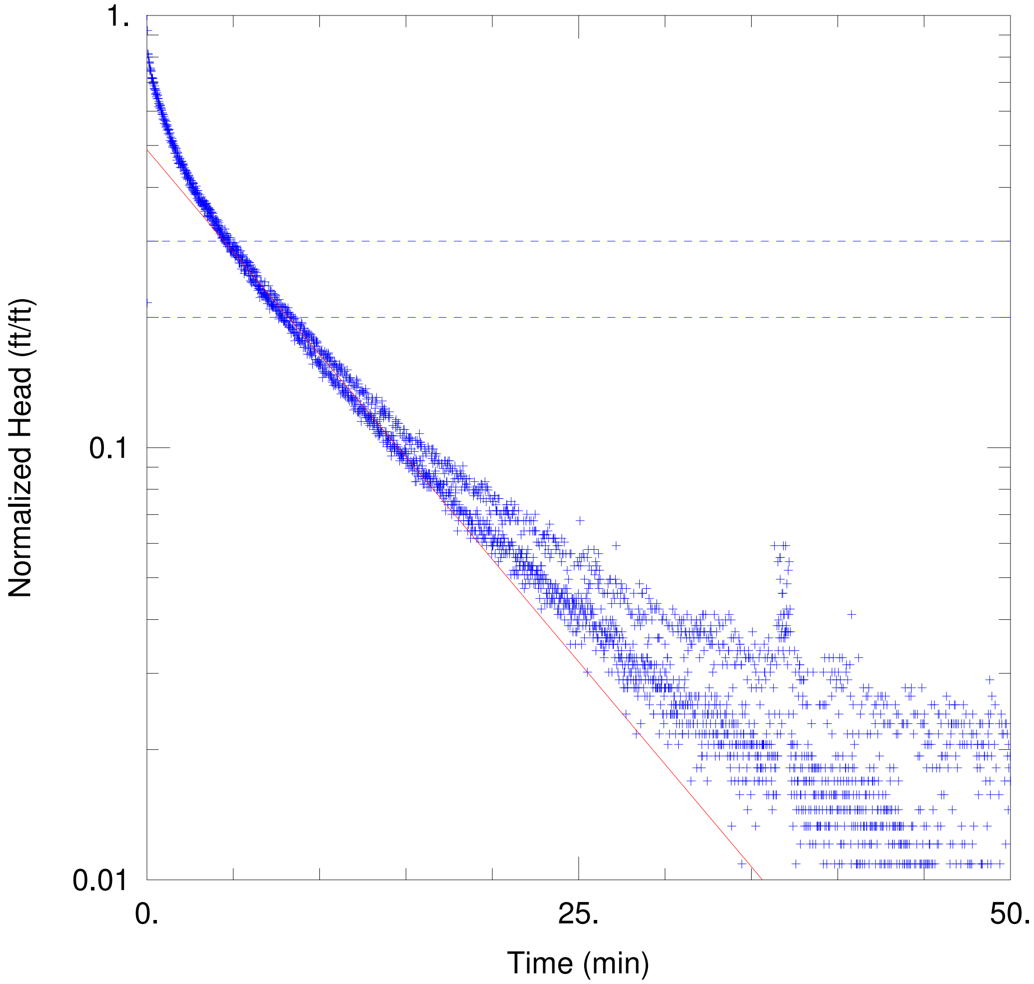
WELL DATA (MW-116)

Initial Displacement: 0.712 ft
Static Water Column Height: 38.75 ft
Total Well Penetration Depth: 38.75 ft
Screen Length: 20. ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.4854 ft/day
y0 = 0.372 ft



MW-116 SLUG I FALLING HEAD

Data Set: S:\...\MW-116_SlugIFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 11:16:13

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-116
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 38.75 ft
Anisotropy Ratio (Kz/Kr): 0.1

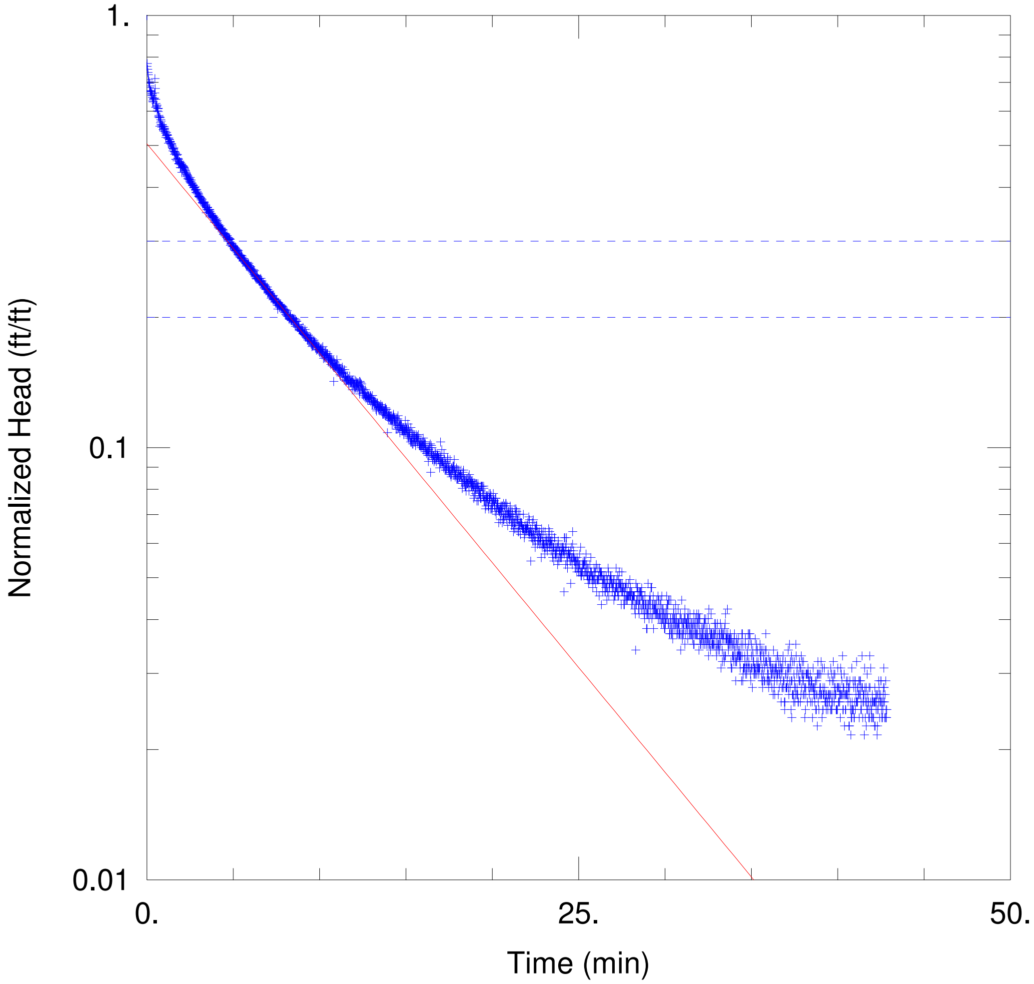
WELL DATA (MW-116)

Initial Displacement: 0.827 ft
Total Well Penetration Depth: 38.75 ft
Casing Radius: 0.167 ft
Static Water Column Height: 38.75 ft
Screen Length: 20. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.4951 ft/day
y0 = 0.4046 ft



MW-116 SLUG I RISING HEAD

Data Set: S:\...\MW-116_SlugIRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:18:05

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-116
Test Date: 2 Oct 2013

AQUIFER DATA

Saturated Thickness: 38.75 ft
Anisotropy Ratio (Kz/Kr): 0.1

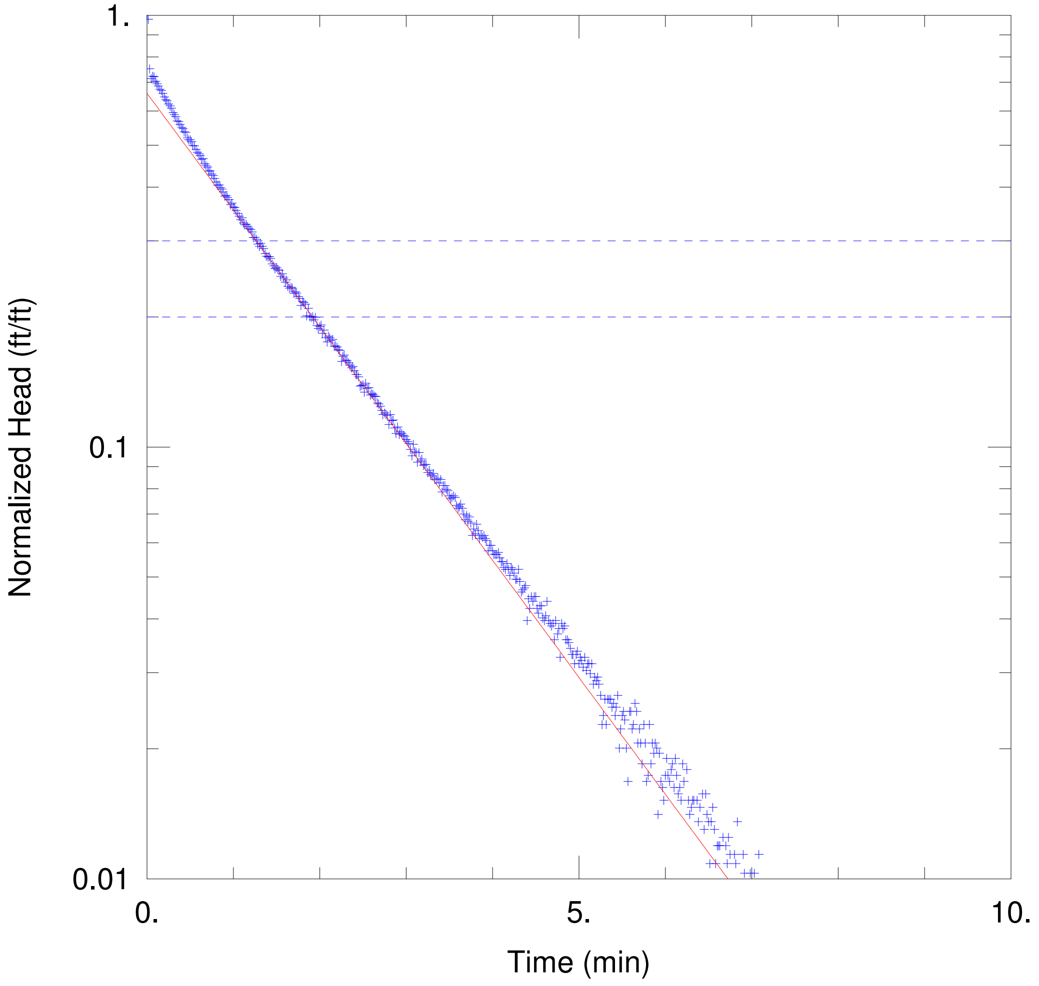
WELL DATA (MW-116)

Initial Displacement: 0.97 ft
Total Well Penetration Depth: 38.75 ft
Casing Radius: 0.167 ft
Static Water Column Height: 38.75 ft
Screen Length: 20. ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.5061 ft/day
y0 = 0.4893 ft



MW-117M SLUG D FALLING HEAD

Data Set: S:\...\MW-117M_SlugDFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:19:44

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117M
Test Date: 03 Oct 2013

AQUIFER DATA

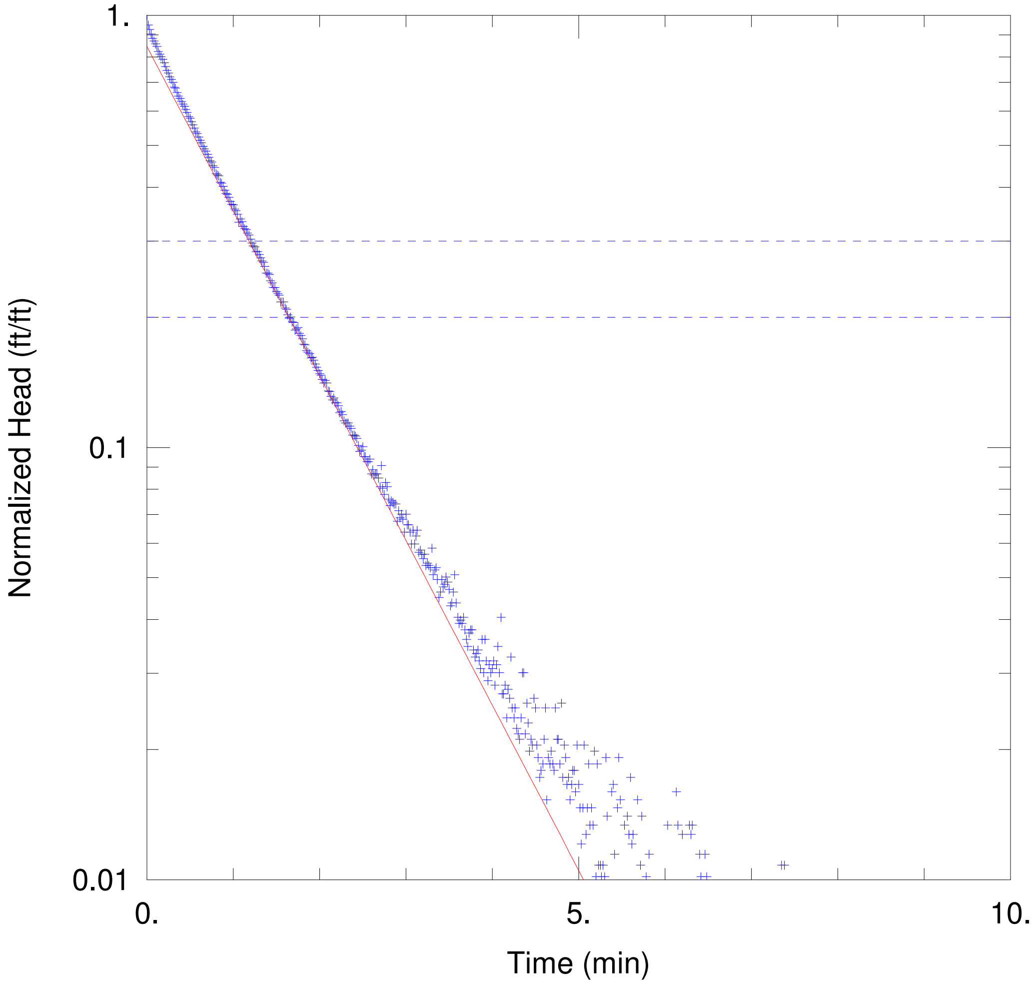
Saturated Thickness: 68.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-117M)

Initial Displacement: 1.843 ft
Total Well Penetration Depth: 68.1 ft
Casing Radius: 0.167 ft
Static Water Column Height: 68.1 ft
Screen Length: 25. ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.367 ft/day
y0 = 1.215 ft



MW-117M SLUG D RISING HEAD

Data Set: S:\...\MW-117M_SlugDRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:21:31

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117M
Test Date: 03 Oct 2013

AQUIFER DATA

Saturated Thickness: 68.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

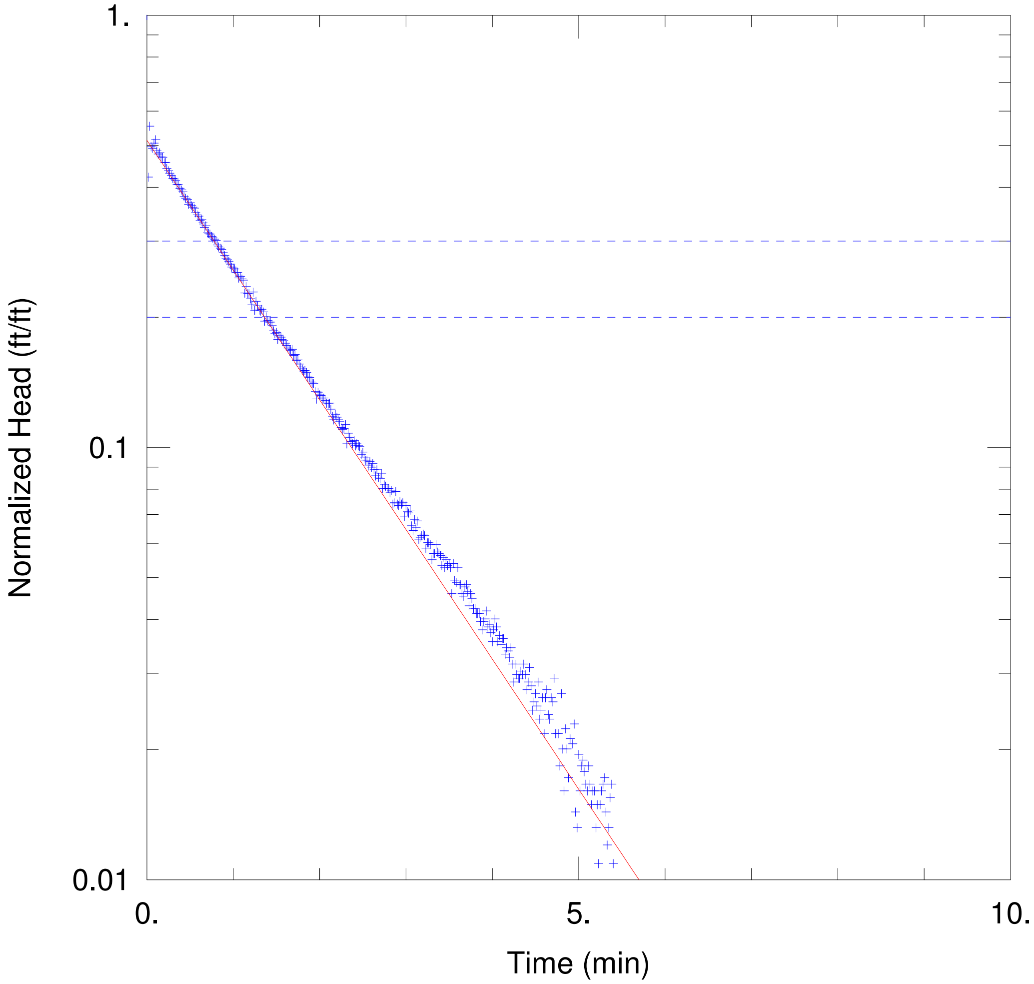
WELL DATA (MW-117M)

Initial Displacement: 1.551 ft
Static Water Column Height: 68.1 ft
Total Well Penetration Depth: 68.1 ft
Screen Length: 25. ft
Casing Radius: 0.167 ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.335 ft/day
y0 = 1.313 ft



MW-117M SLUG J FALLING HEAD

Data Set: S:\...\MW-117M_SlugJFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:23:01

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117M
Test Date: 03 Oct 2013

AQUIFER DATA

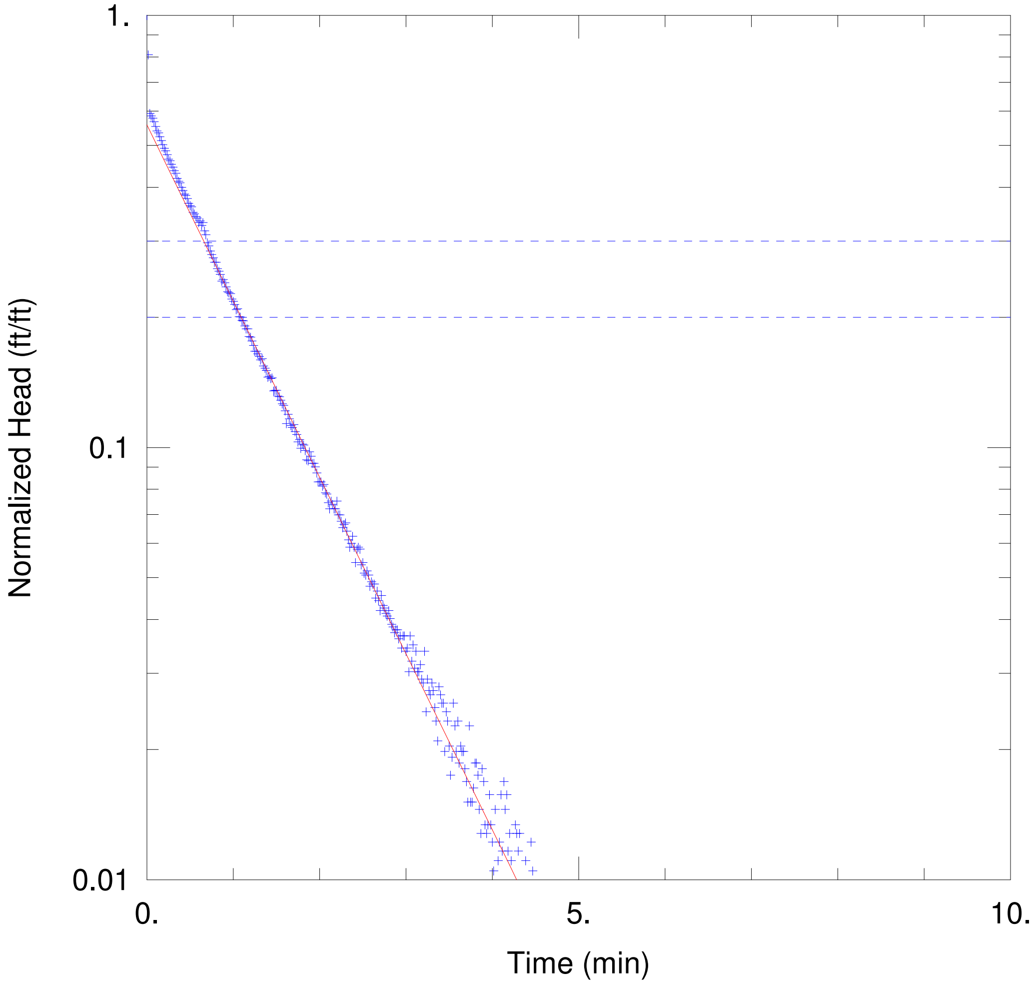
Saturated Thickness: 68.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-117M)

Initial Displacement: 1.744 ft
Total Well Penetration Depth: 68.1 ft
Casing Radius: 0.167 ft
Static Water Column Height: 68.1 ft
Screen Length: 25. ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.626 ft/day
y0 = 0.8953 ft



MW-117M SLUG J RISING HEAD

Data Set: S:\...\MW-117M_SlugJRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:24:25

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117M
Test Date: 03 Oct 2013

AQUIFER DATA

Saturated Thickness: 68.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

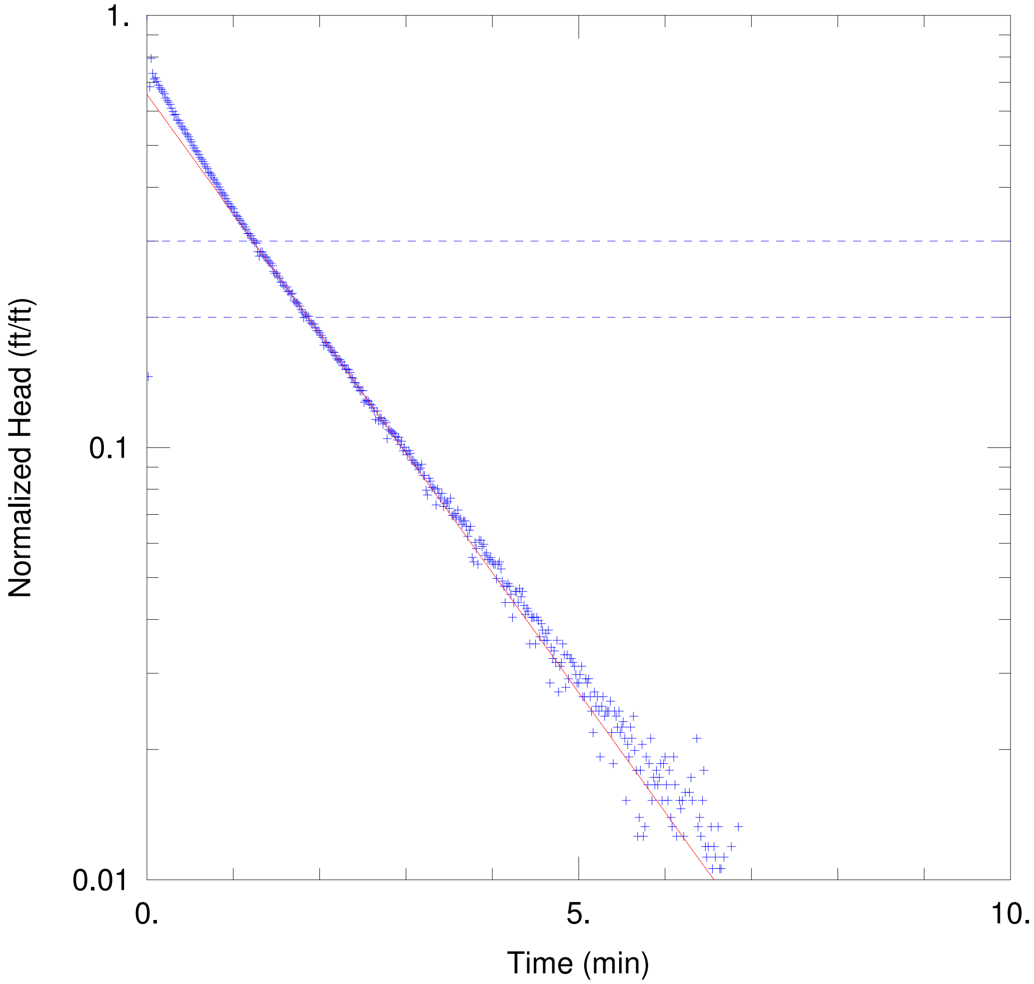
WELL DATA (MW-117M)

Initial Displacement: 1.718 ft
Total Well Penetration Depth: 68.1 ft
Casing Radius: 0.167 ft
Static Water Column Height: 68.1 ft
Screen Length: 25. ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.569 ft/day
y0 = 0.9572 ft



MW-117M SLUG K FALLING HEAD

Data Set: S:\...\MW-117M_SlugKFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:25:50

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117M
Test Date: 03 Oct 2013

AQUIFER DATA

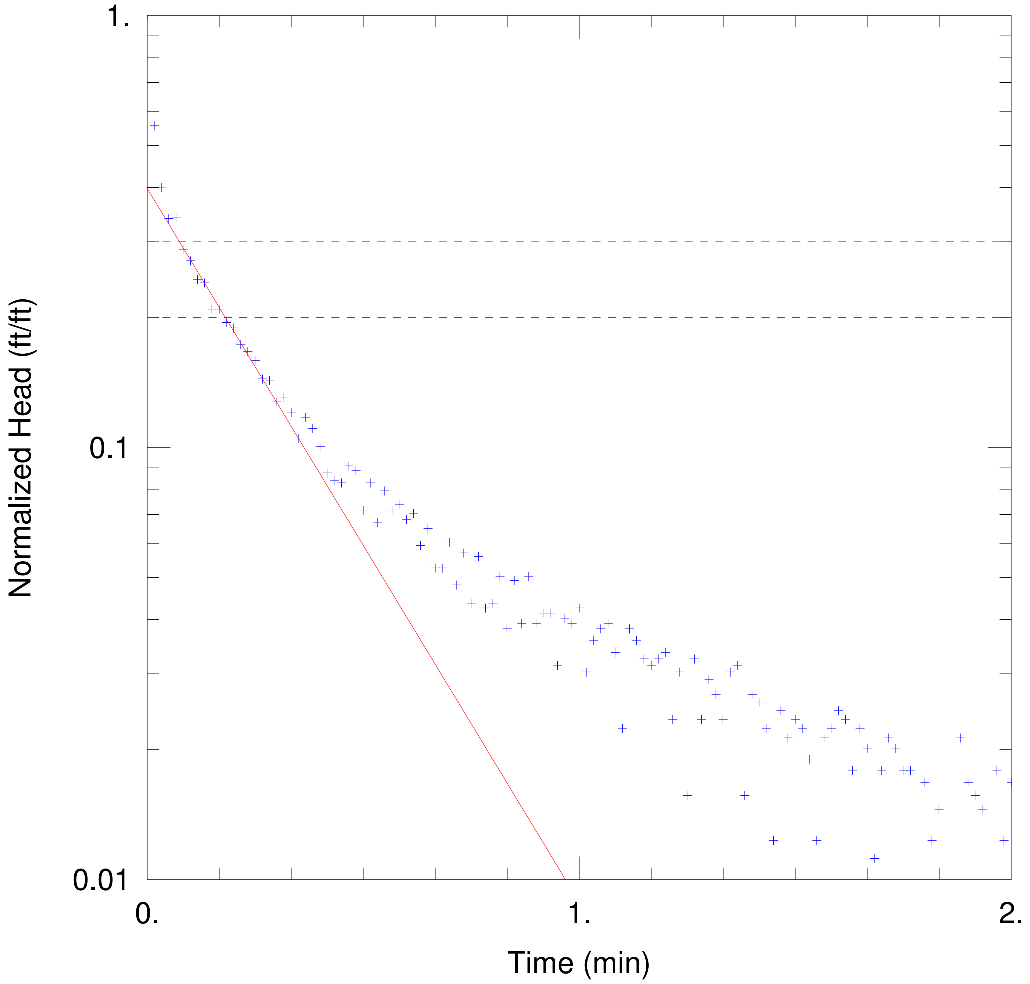
Saturated Thickness: 68.1 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-117M)

Initial Displacement: 1.508 ft
Static Water Column Height: 68.1 ft
Total Well Penetration Depth: 68.1 ft
Screen Length: 25. ft
Casing Radius: 0.167 ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.421 ft/day
y0 = 0.9893 ft



MW-117S SLUG D FALLING HEAD

Data Set: S:\...\MW-117S_SlugDFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:27:20

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117S
Test Date: 03 Oct 2013

AQUIFER DATA

Saturated Thickness: 44.04 ft
Anisotropy Ratio (Kz/Kr): 0.1

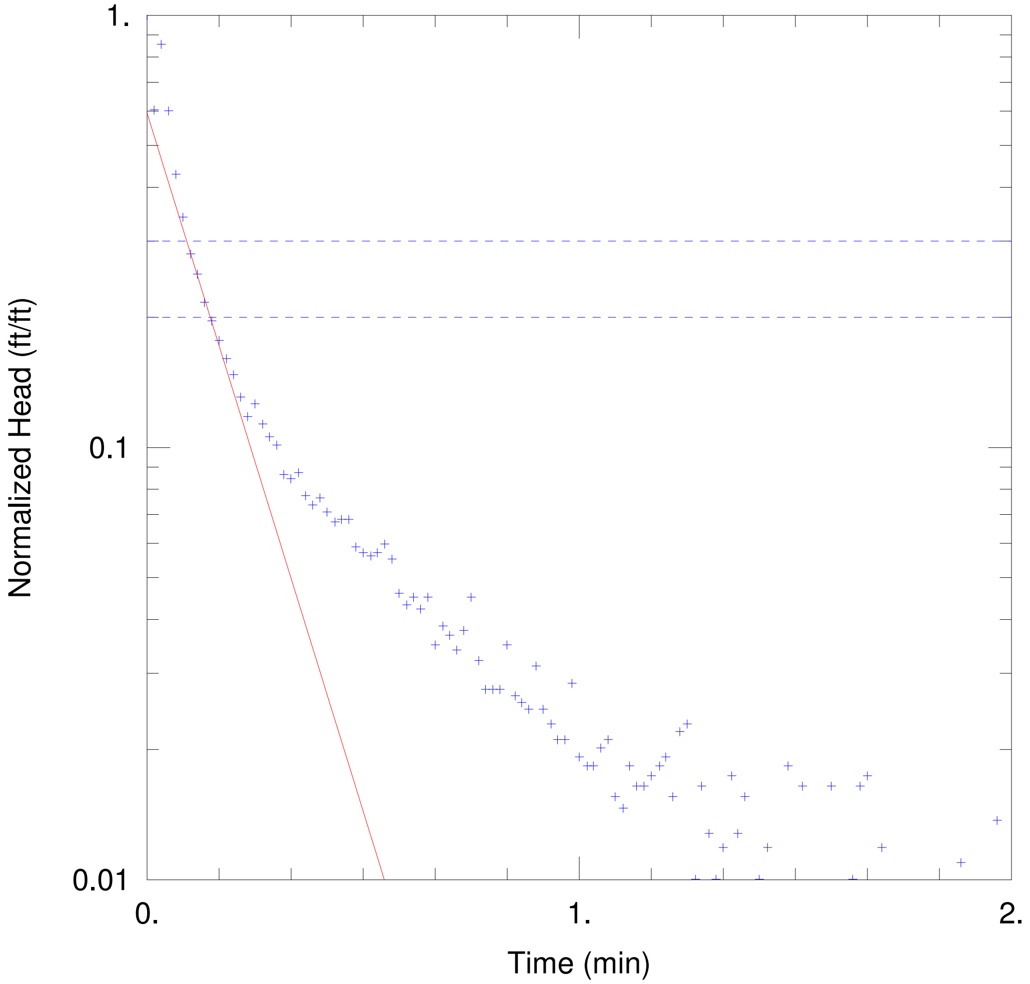
WELL DATA (MW-117S)

Initial Displacement: 0.894 ft
Total Well Penetration Depth: 44.04 ft
Casing Radius: 0.167 ft
Static Water Column Height: 44.04 ft
Screen Length: 44.04 ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 6.225 ft/day
y0 = 0.3555 ft



MW-117S SLUG D RISING HEAD

Data Set: S:\...\MW-117S_SlugDRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:29:28

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117S
Test Date: 03 Oct 2013

AQUIFER DATA

Saturated Thickness: 44.04 ft
Anisotropy Ratio (Kz/Kr): 0.1

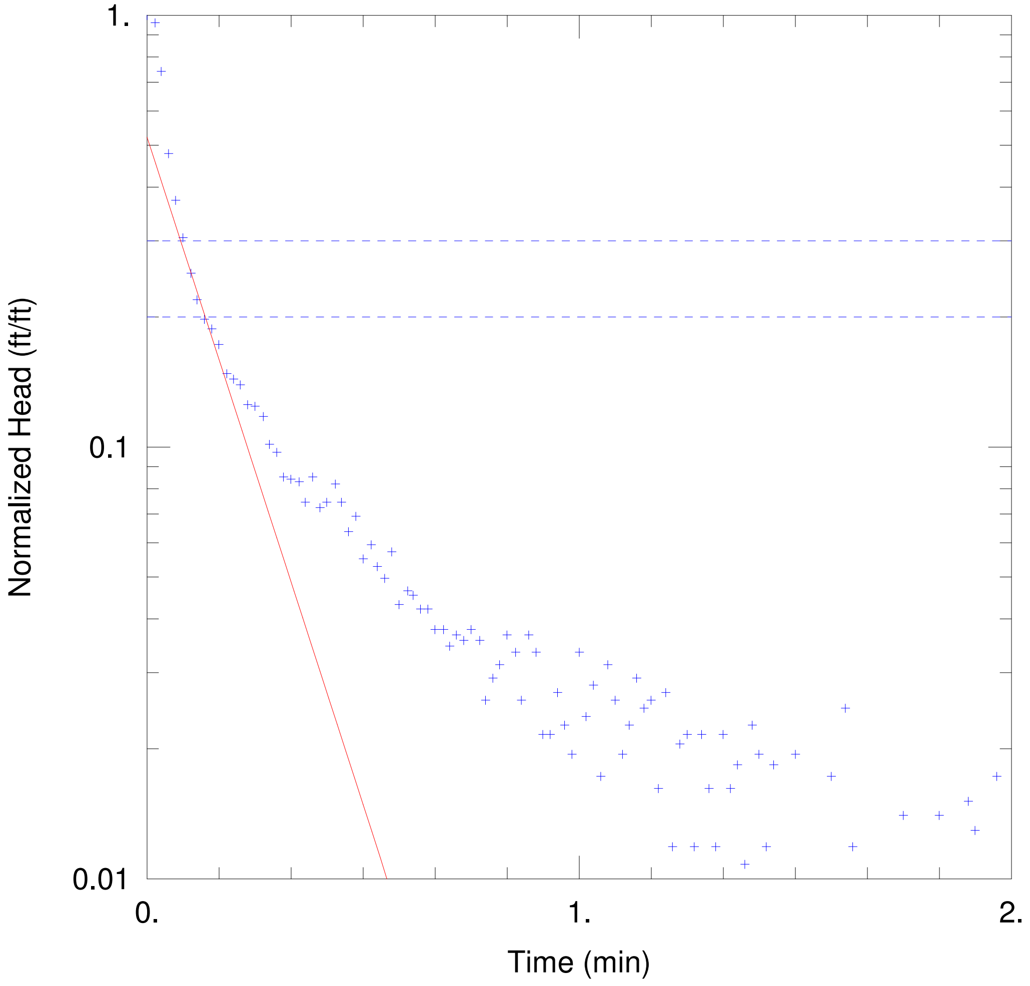
WELL DATA (MW-117S)

Initial Displacement: 1.084 ft
Total Well Penetration Depth: 44.04 ft
Casing Radius: 0.167 ft
Static Water Column Height: 44.04 ft
Screen Length: 44.04 ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 12.17 ft/day
y0 = 0.6436 ft



MW-117S SLUG K RISING HEAD

Data Set: S:\...\MW-117S_SlugKRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:31:39

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117S
Test Date: 03 Oct 2013

AQUIFER DATA

Saturated Thickness: 44.04 ft
Anisotropy Ratio (Kz/Kr): 0.1

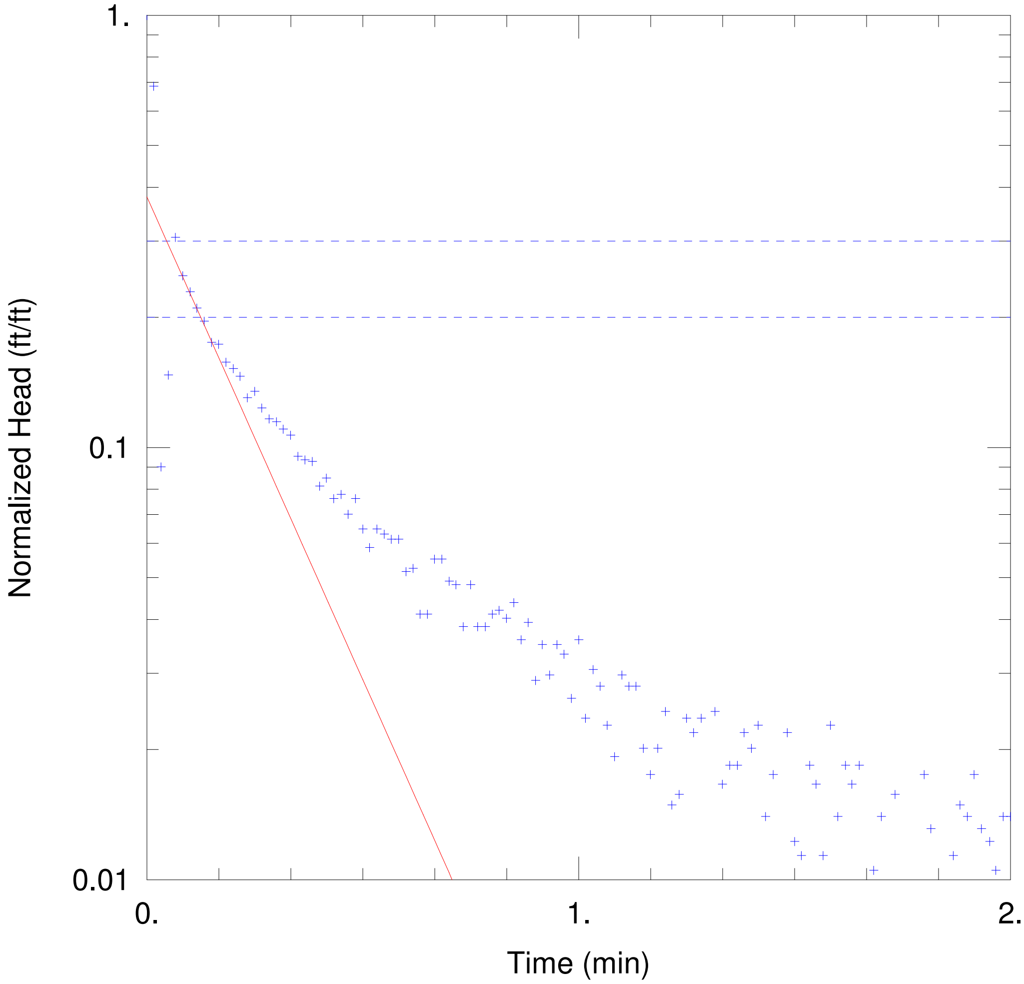
WELL DATA (MW-117S)

Initial Displacement: 0.926 ft
Total Well Penetration Depth: 44.04 ft
Casing Radius: 0.167 ft
Static Water Column Height: 44.04 ft
Screen Length: 44.04 ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 11.65 ft/day
y0 = 0.4831 ft



MW-117S SLUG L FALLING HEAD

Data Set: S:\...\MW-117S_SlugLFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:33:14

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117S
Test Date: 03 Oct 2013

AQUIFER DATA

Saturated Thickness: 44.04 ft
Anisotropy Ratio (Kz/Kr): 0.1

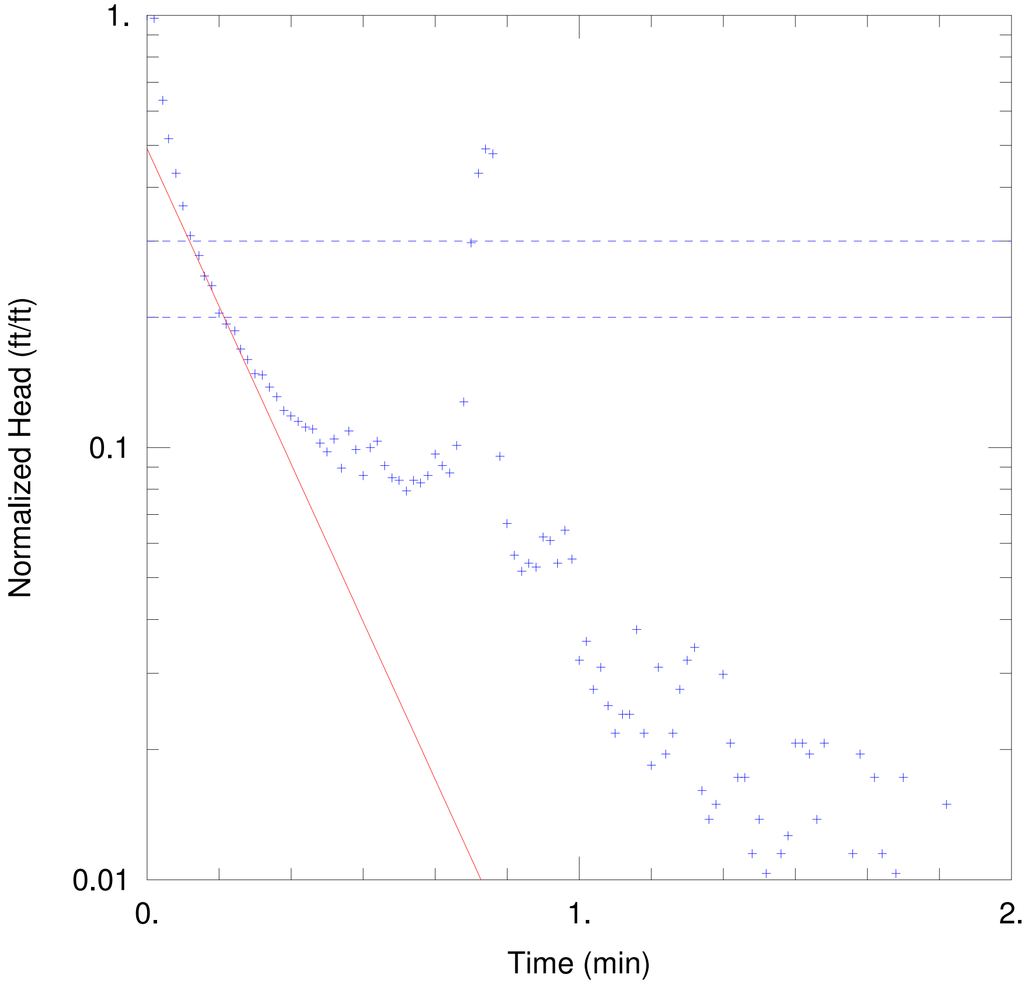
WELL DATA (MW-117S)

Initial Displacement: 1.142 ft
Total Well Penetration Depth: 44.04 ft
Casing Radius: 0.167 ft
Static Water Column Height: 44.04 ft
Screen Length: 44.04 ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 8.416 ft/day
y0 = 0.4338 ft



MW-117S SLUG L RISING HEAD

Data Set: S:\...\MW-117S_SlugLRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:34:30

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-117S
Test Date: 03 Oct 2013

AQUIFER DATA

Saturated Thickness: 44.04 ft
Anisotropy Ratio (Kz/Kr): 0.1

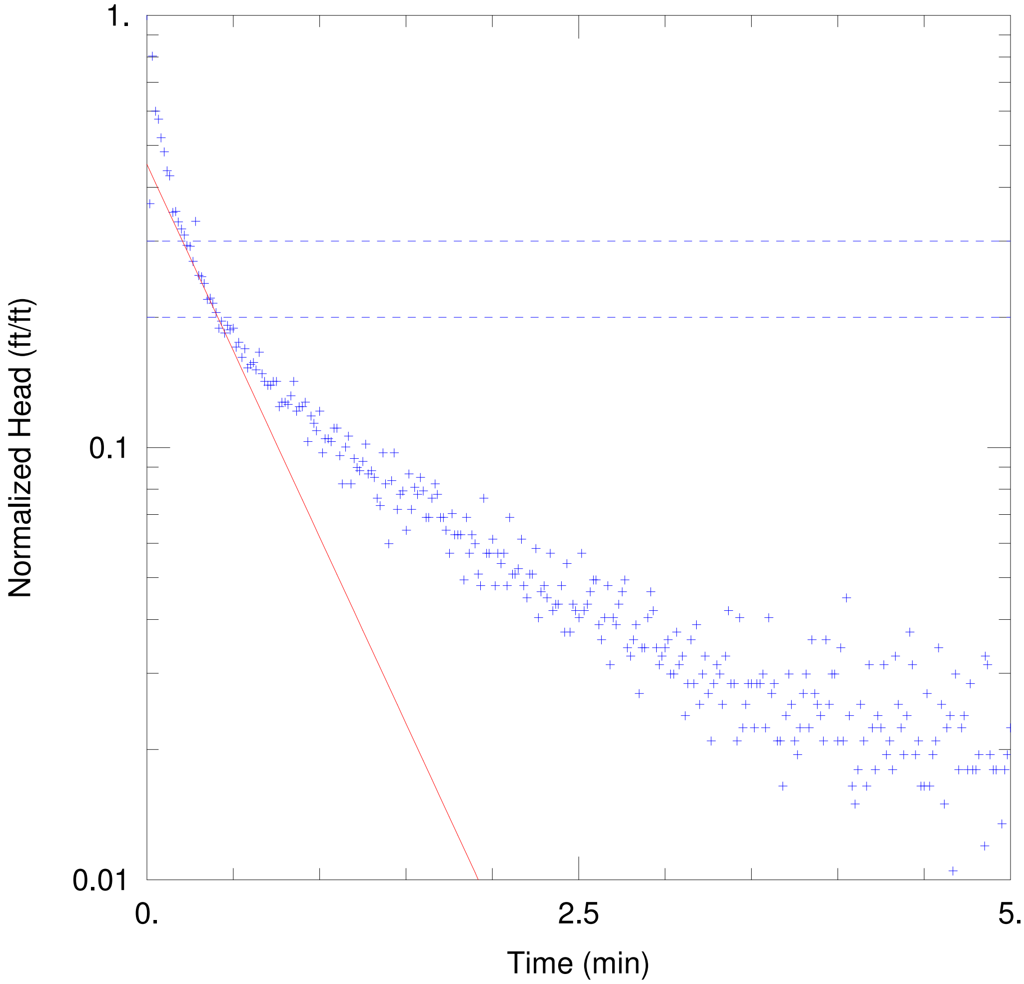
WELL DATA (MW-117S)

Initial Displacement: 0.87 ft
Total Well Penetration Depth: 44.04 ft
Casing Radius: 0.167 ft
Static Water Column Height: 44.04 ft
Screen Length: 44.04 ft
Well Radius: 0.4167 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 8.249 ft/day
y0 = 0.4279 ft



MW-118 SLUG C FALLING HEAD

Data Set: S:\...\MW-118_SlugCFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:35:46

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-118
Test Date: 01 Oct 2013

AQUIFER DATA

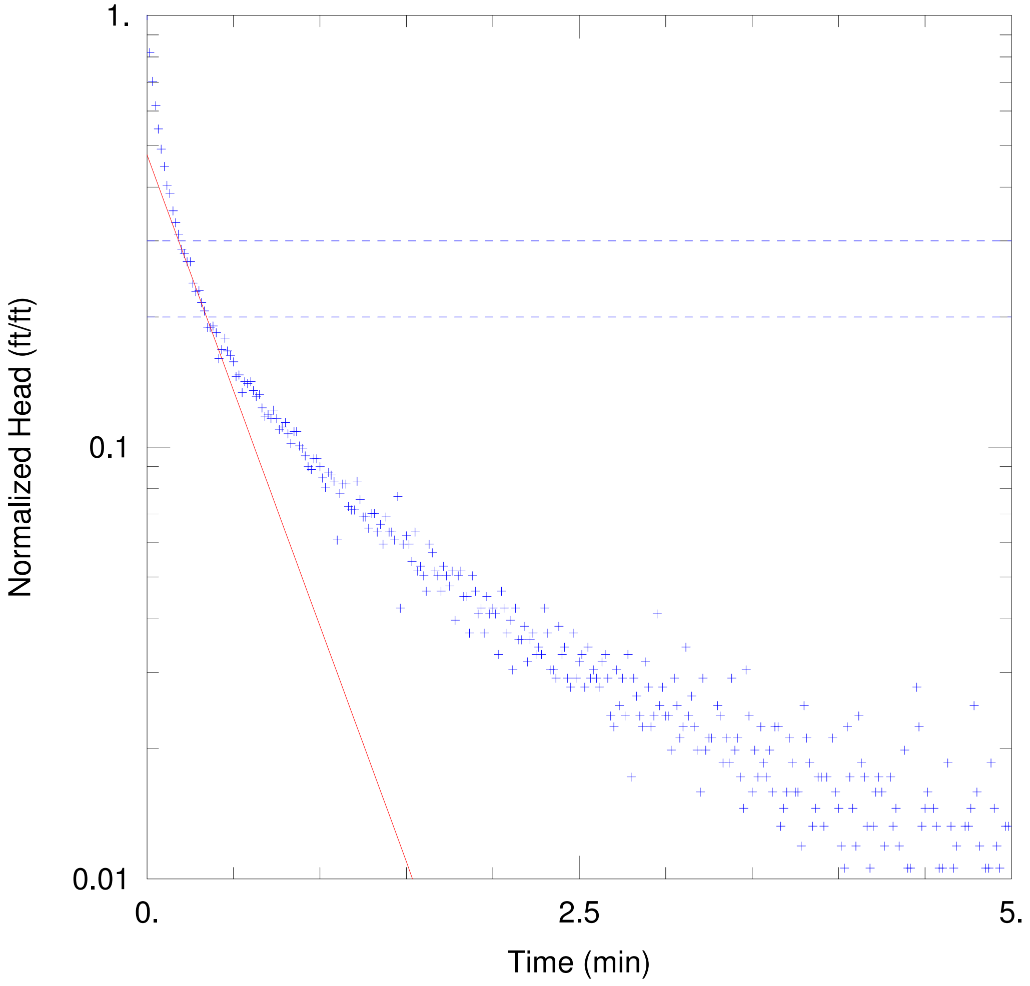
Saturated Thickness: 56.67 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-118)

Initial Displacement: 0.668 ft
Static Water Column Height: 50.67 ft
Total Well Penetration Depth: 56.67 ft
Screen Length: 56.67 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.805 ft/day
y0 = 0.3018 ft



MW-118 SLUG C RISING HEAD

Data Set: S:\...\MW-118_SlugCRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 15:57:42

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-118
Test Date: 01 Oct 2013

AQUIFER DATA

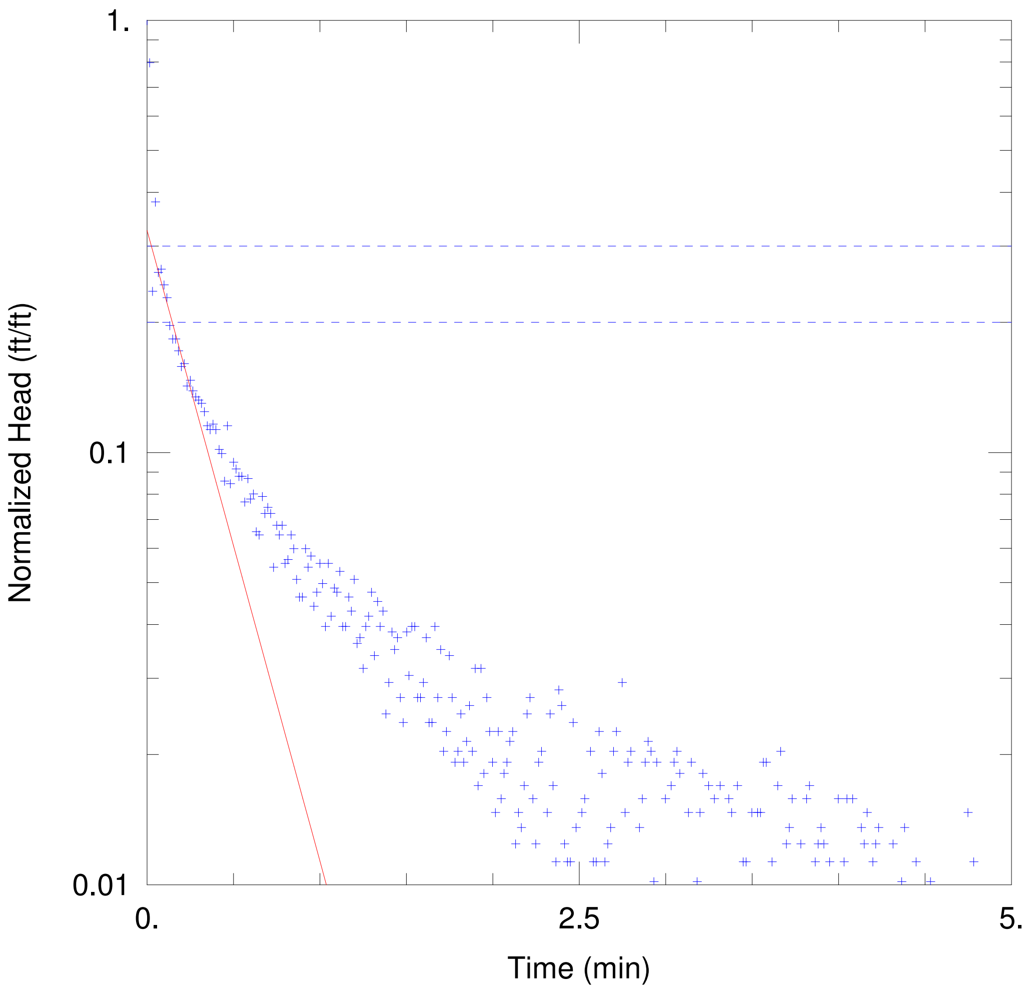
Saturated Thickness: 56.67 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-118)

Initial Displacement: 0.755 ft
Static Water Column Height: 50.67 ft
Total Well Penetration Depth: 56.67 ft
Screen Length: 56.67 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.549 ft/day
y0 = 0.3585 ft



MW-118 SLUG F FALLING HEAD

Data Set: S:\...\MW-118_SlugFFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 11:38:15

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-118
Test Date: 01 Oct 2013

AQUIFER DATA

Saturated Thickness: 56.67 ft
Anisotropy Ratio (Kz/Kr): 0.1

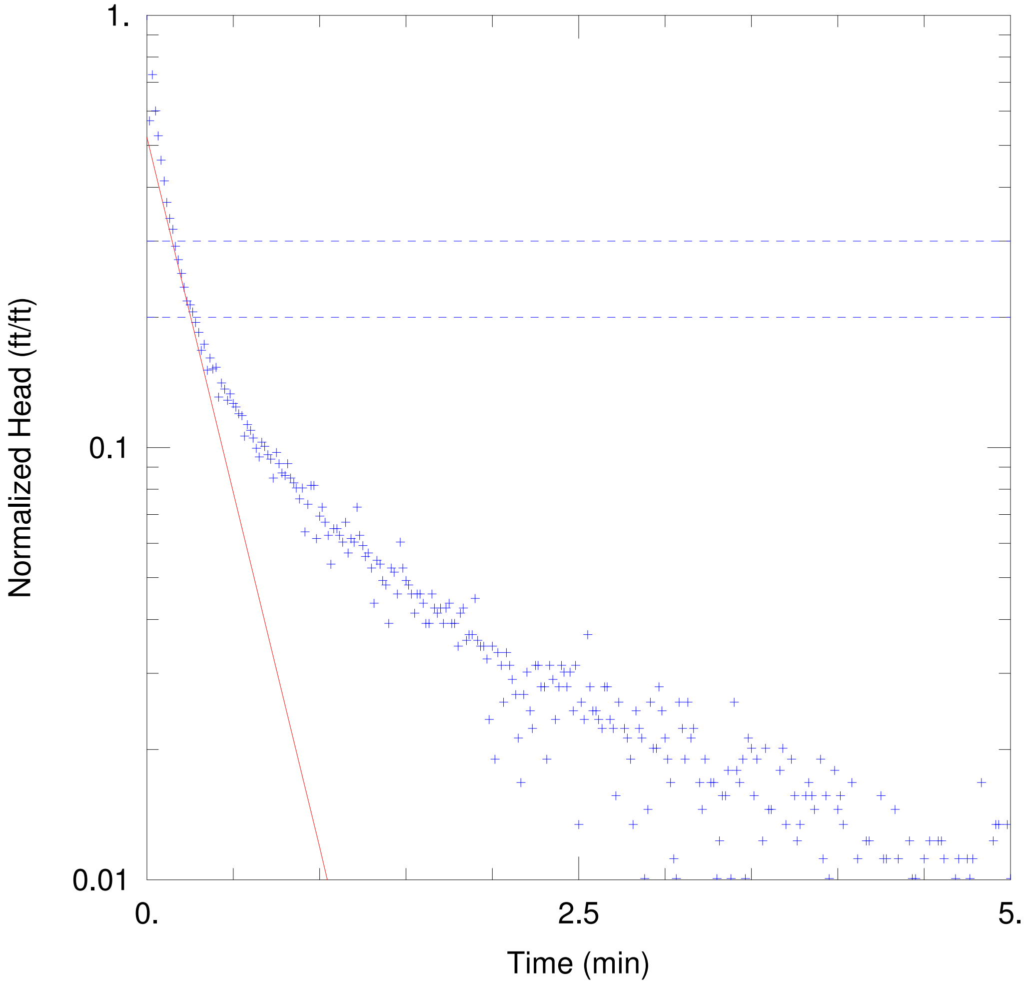
WELL DATA (MW-118)

Initial Displacement: 0.885 ft
Static Water Column Height: 50.67 ft
Total Well Penetration Depth: 56.67 ft
Screen Length: 56.67 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.746 ft/day
y0 = 0.2888 ft



MW-118 SLUG F RISING HEAD

Data Set: S:\...\MW-118_SlugFRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:39:36

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-118
Test Date: 01 Oct 2013

AQUIFER DATA

Saturated Thickness: 56.67 ft
Anisotropy Ratio (Kz/Kr): 0.1

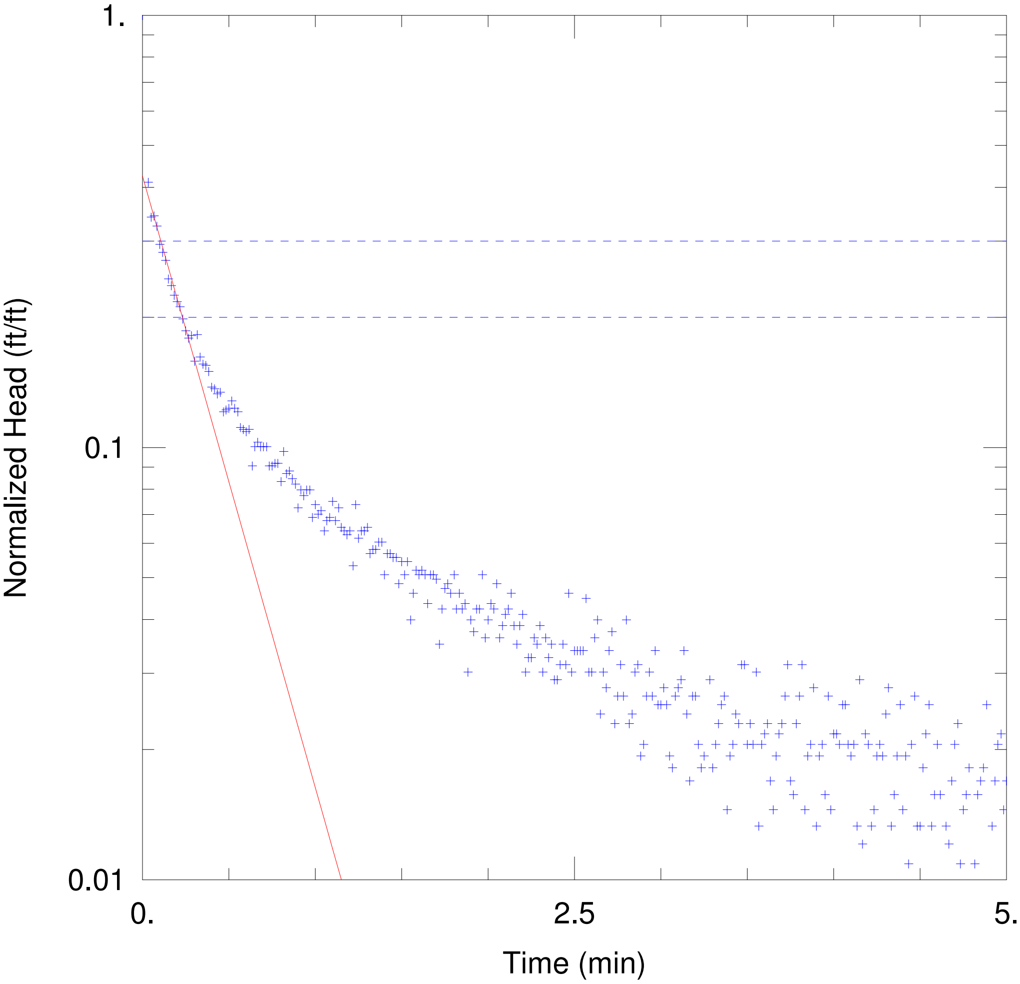
WELL DATA (MW-118)

Initial Displacement: 0.894 ft
Total Well Penetration Depth: 56.67 ft
Casing Radius: 0.167 ft
Static Water Column Height: 50.67 ft
Screen Length: 56.67 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.342 ft/day
y0 = 0.4663 ft



MW-118 SLUG I FALLING HEAD

Data Set: S:\...\MW-118_SlugIFallingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 11:41:18

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-118
Test Date: 01 Oct 2013

AQUIFER DATA

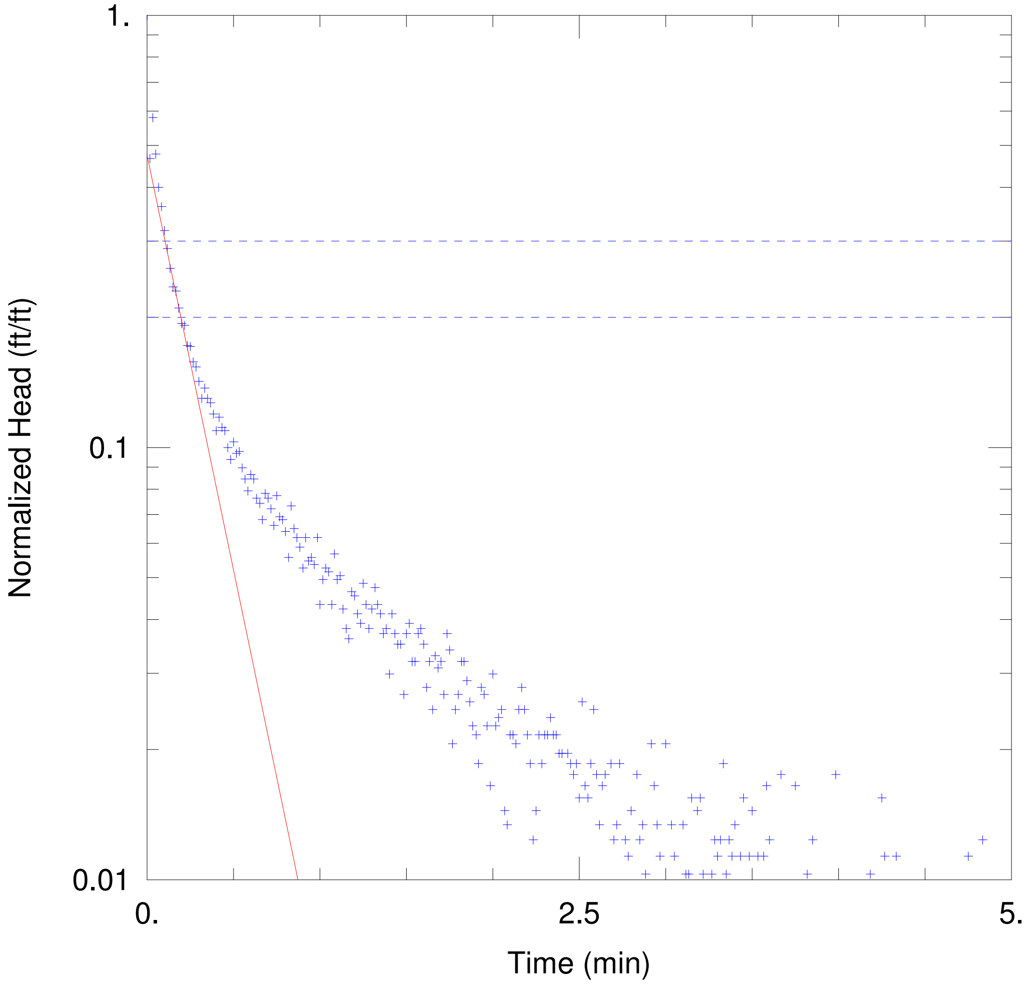
Saturated Thickness: 56.67 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-118)

Initial Displacement: 0.827 ft
Static Water Column Height: 50.67 ft
Total Well Penetration Depth: 56.67 ft
Screen Length: 56.67 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 4.601 ft/day
y0 = 0.351 ft



MW-118 SLUG I RISING HEAD

Data Set: S:\...\MW-118_SlugIRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:42:31

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-118
Test Date: 01 Oct 2013

AQUIFER DATA

Saturated Thickness: 56.67 ft
Anisotropy Ratio (Kz/Kr): 0.1

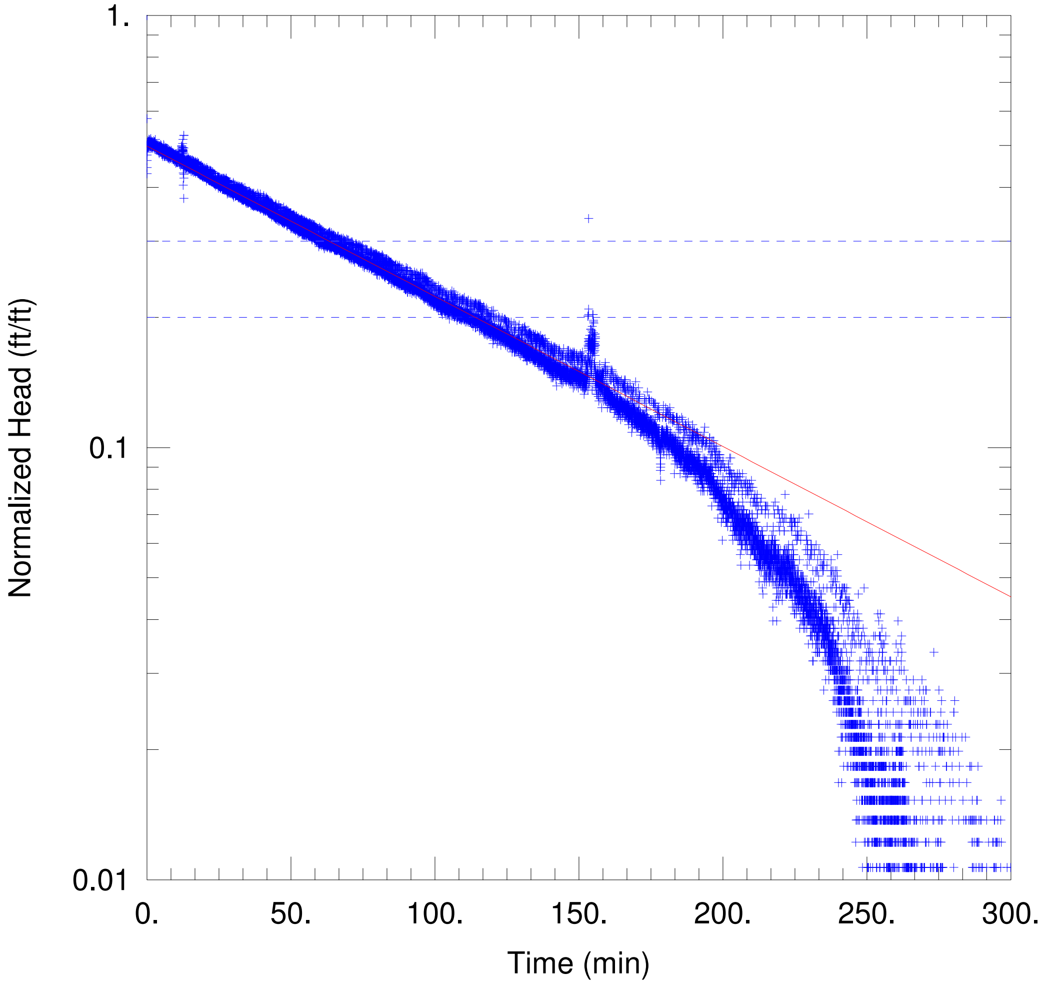
WELL DATA (MW-118)

Initial Displacement: 0.97 ft
Static Water Column Height: 50.67 ft
Total Well Penetration Depth: 56.67 ft
Screen Length: 56.67 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 6.246 ft/day
y0 = 0.4607 ft



MW-119 SLUG G FALLING HEAD

Data Set: S:\...\MW-119_SlugGFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:43:42

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.22
Location: Lisbon
Test Well: MW-109
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 4.19 ft Anisotropy Ratio (Kz/Kr): 0.1

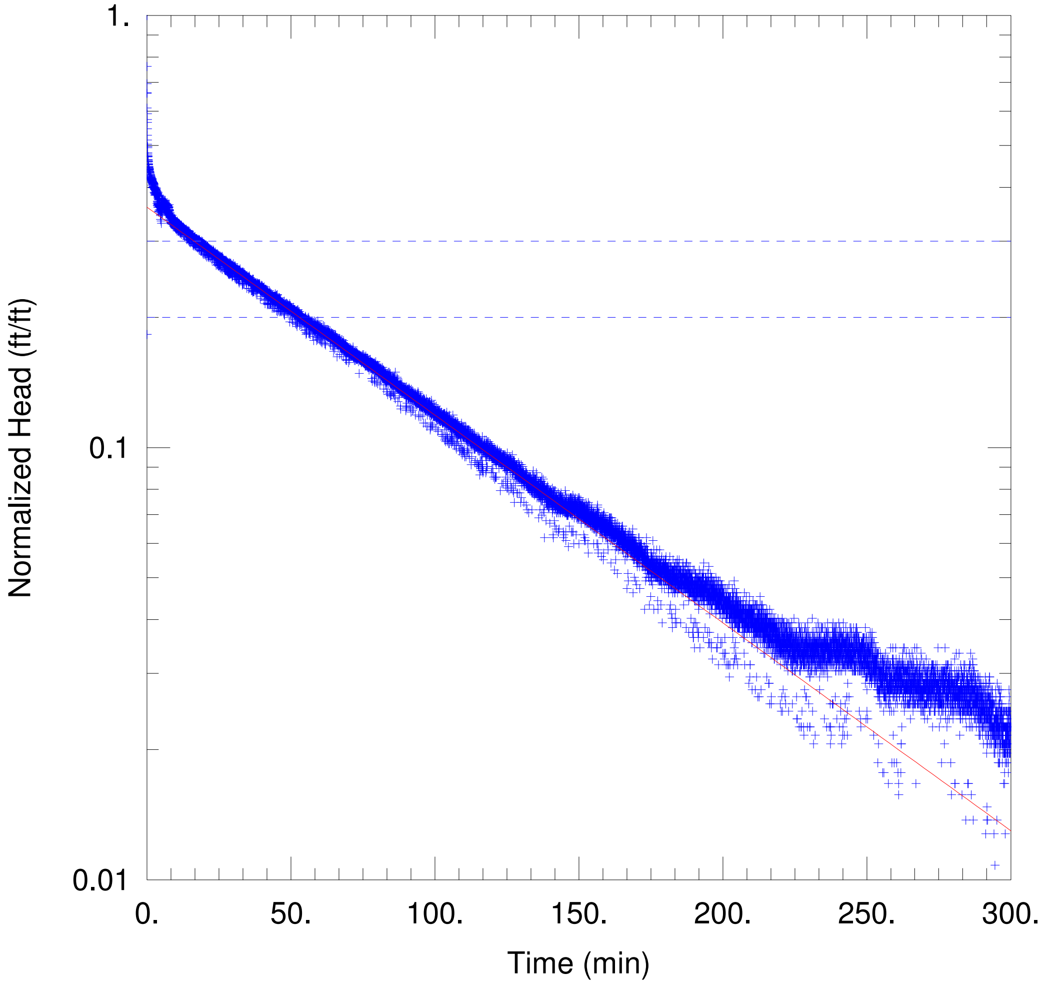
WELL DATA (MW-119)

Initial Displacement: 0.655 ft Static Water Column Height: 4.19 ft
Total Well Penetration Depth: 23.74 ft Screen Length: 19.55 ft
Casing Radius: 0.167 ft Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.1038 ft/day y0 = 0.3263 ft



MW-119 SLUG G RISING HEAD

Data Set: S:\...\MW-119_SlugGRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:45:15

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.22
Location: Lisbon
Test Well: MW-109
Test Date: 1 Oct 2013

AQUIFER DATA

Saturated Thickness: 4.19 ft Anisotropy Ratio (Kz/Kr): 0.1

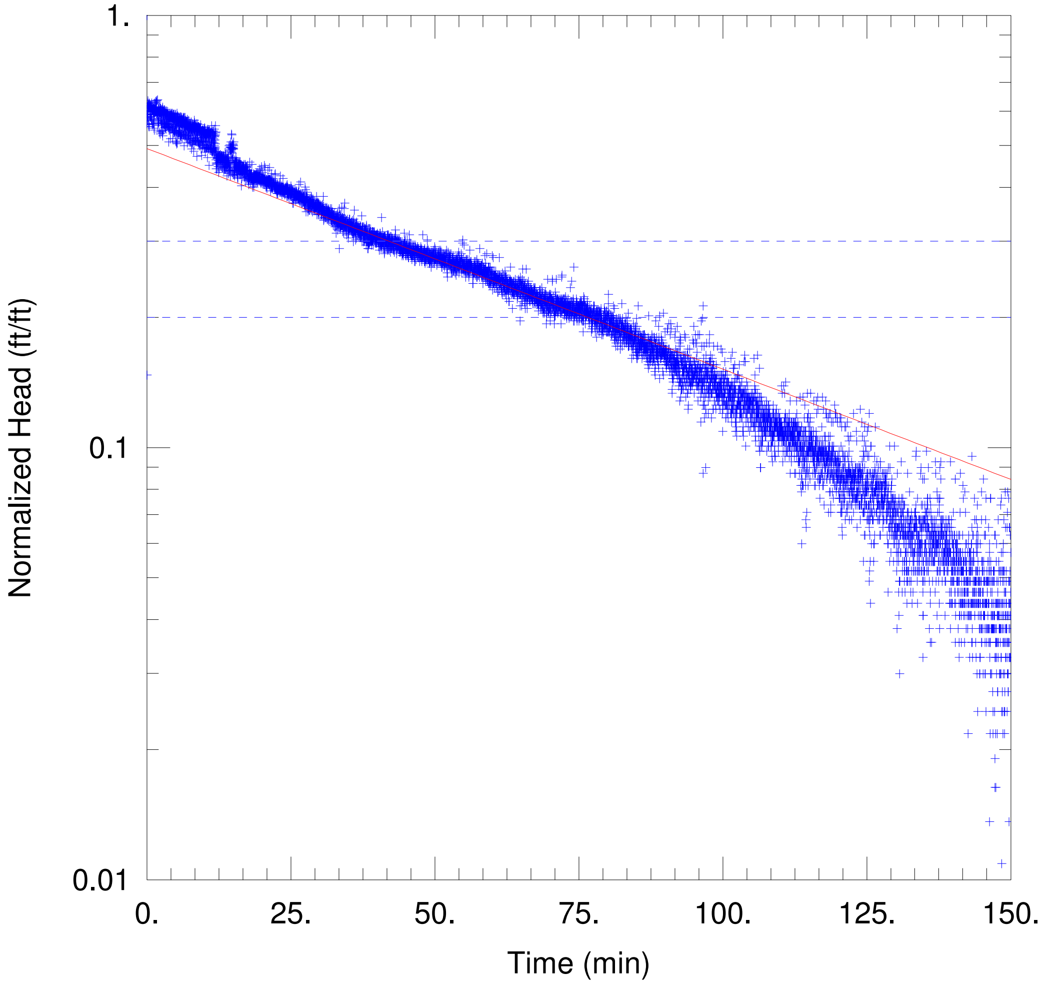
WELL DATA (MW-119)

Initial Displacement: 1.018 ft
Total Well Penetration Depth: 23.74 ft
Casing Radius: 0.167 ft
Static Water Column Height: 4.19 ft
Screen Length: 19.55 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.1436 ft/day y0 = 0.3662 ft



MW-119 SLUG H FALLING HEAD

Data Set: S:\...\MW-119_SlugHFallingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:46:27

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.22
Location: Lisbon
Test Well: MW-109
Test Date: 1 Oct 2013

AQUIFER DATA

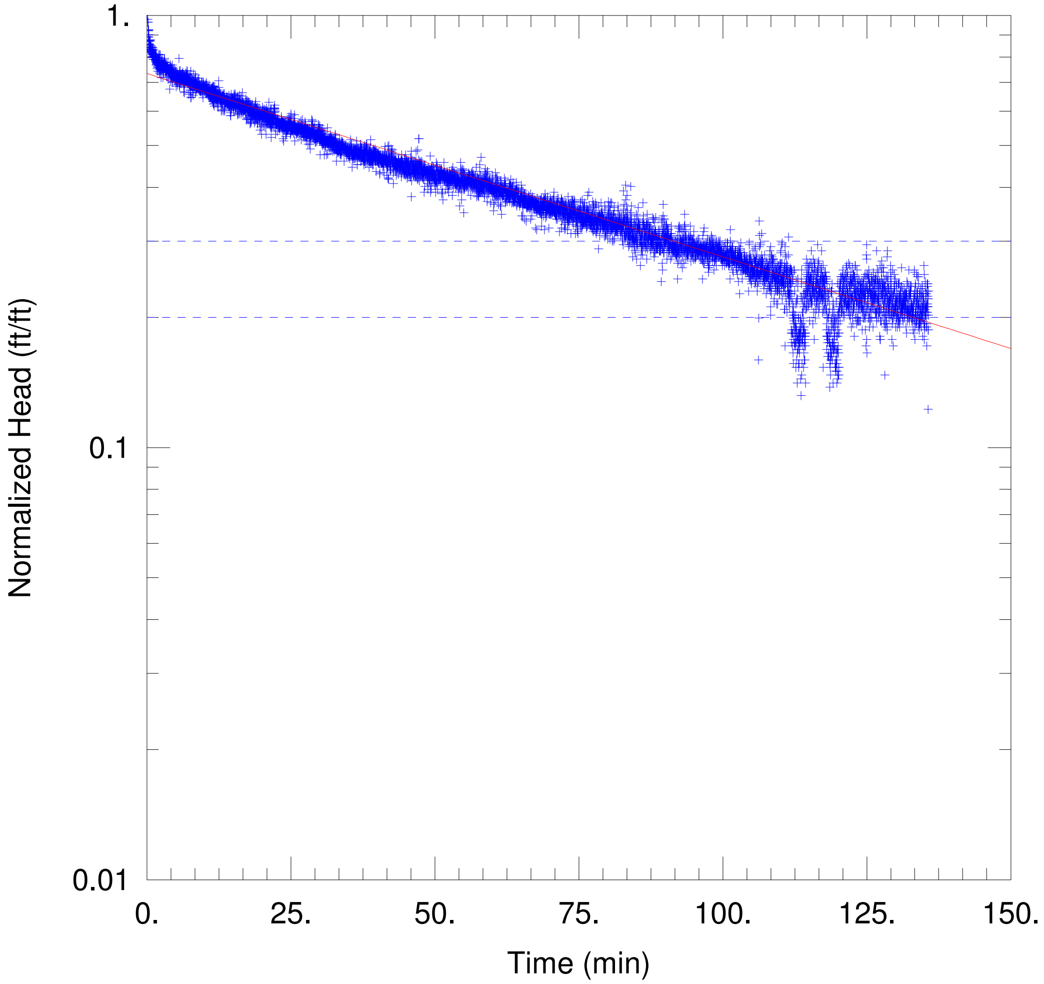
Saturated Thickness: 4.19 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-119)

Initial Displacement: 0.367 ft
Static Water Column Height: 4.19 ft
Total Well Penetration Depth: 23.74 ft
Screen Length: 19.55 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1524 ft/day
y0 = 0.1805 ft



MW-119 SLUG H RISING HEAD

Data Set: S:\...\MW-119_SlugHRisingHeadSlugHo_Kz.aqt
Date: 01/14/15 Time: 11:48:35

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.22
Location: Lisbon
Test Well: MW-109
Test Date: 1 Oct 2013

AQUIFER DATA

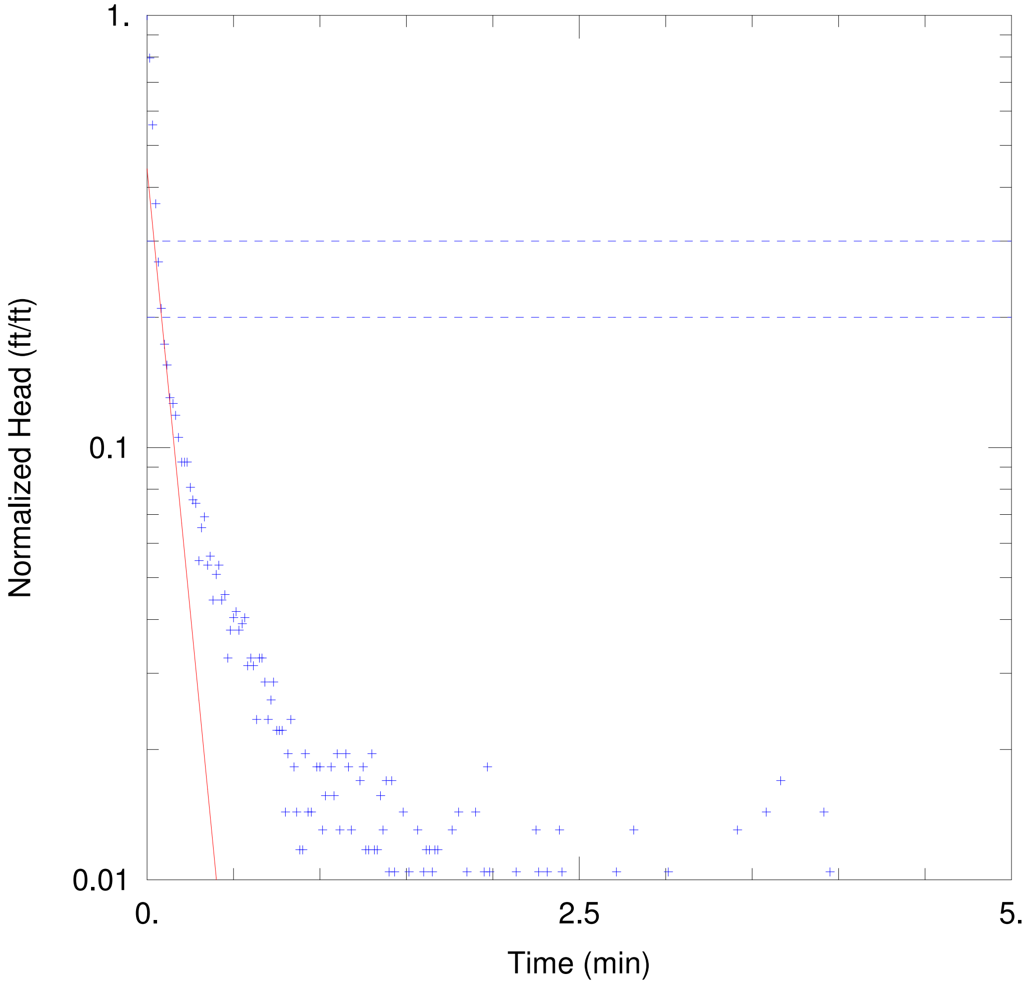
Saturated Thickness: 4.19 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-119)

Initial Displacement: 0.326 ft
Total Well Penetration Depth: 23.74 ft
Casing Radius: 0.167 ft
Static Water Column Height: 4.19 ft
Screen Length: 19.55 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1266 ft/day
y0 = 0.239 ft



MW-120 SLUG C RISING HEAD

Data Set: S:\...\MW-120_SlugCRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:50:29

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-120
Test Date: 03 Oct 2013

AQUIFER DATA

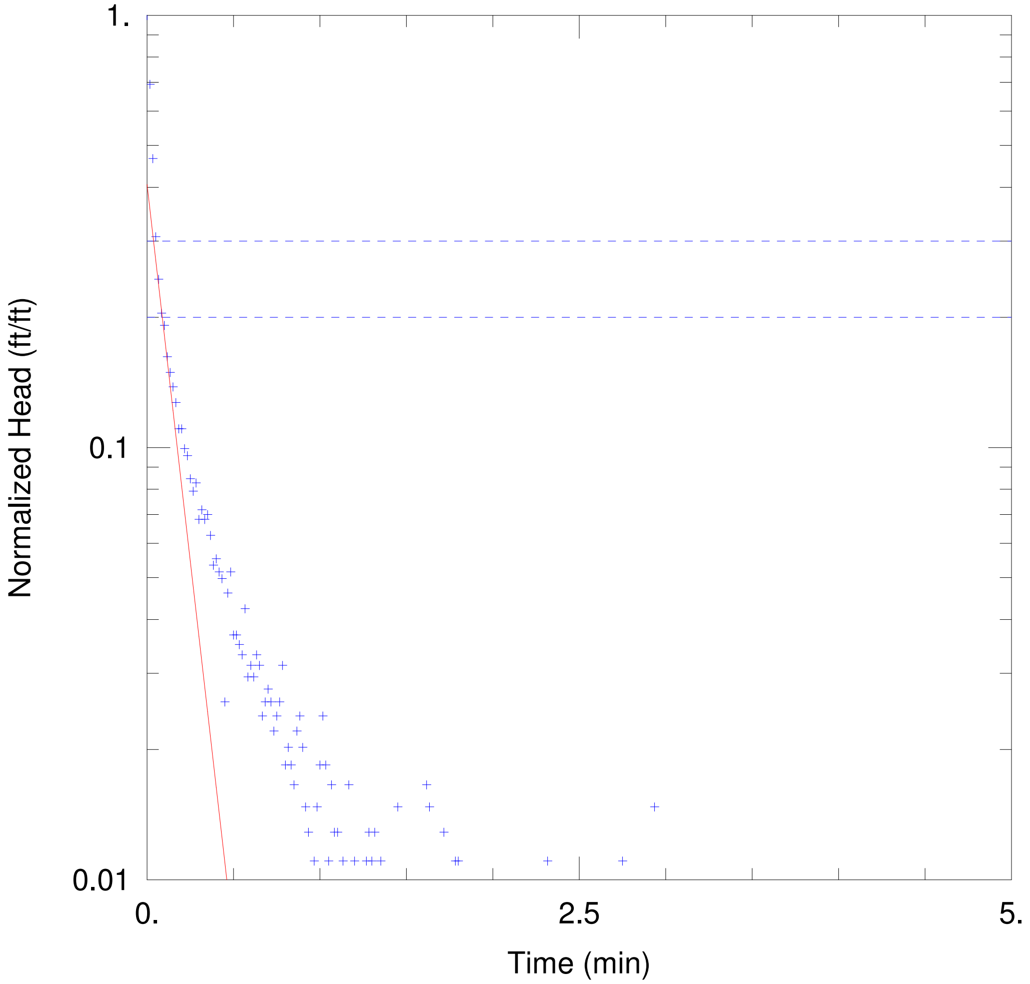
Saturated Thickness: 120.7 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-120)

Initial Displacement: 0.767 ft
Static Water Column Height: 120.7 ft
Total Well Penetration Depth: 120.7 ft
Screen Length: 120.7 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 7.39 ft/day
y0 = 0.3385 ft



MW-120 SLUG F RISING HEAD

Data Set: S:\...\MW-120_SlugFRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 11:52:01

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-120
Test Date: 03 Oct 2013

AQUIFER DATA

Saturated Thickness: 120.7 ft
Anisotropy Ratio (Kz/Kr): 0.1

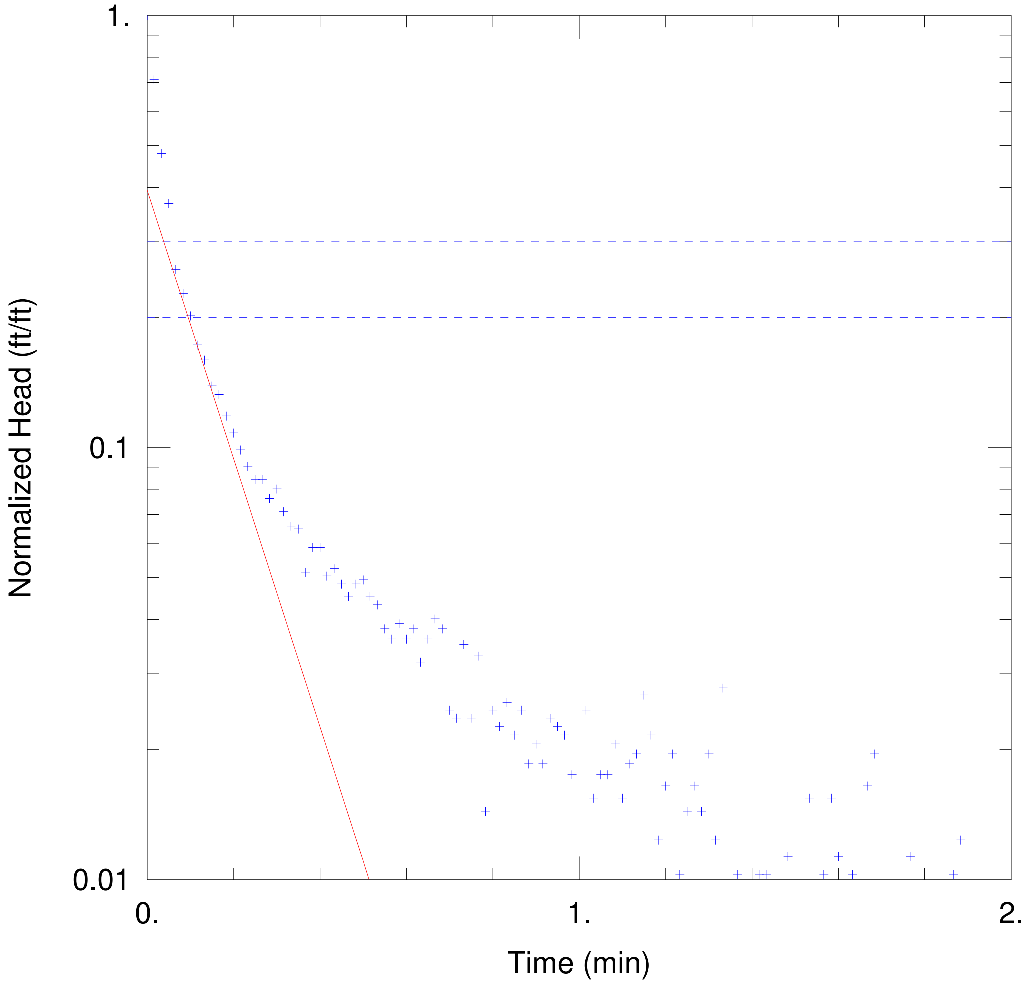
WELL DATA (MW-120)

Initial Displacement: 0.543 ft
Total Well Penetration Depth: 120.7 ft
Casing Radius: 0.167 ft
Static Water Column Height: 120.7 ft
Screen Length: 120.7 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 6.283 ft/day
y0 = 0.2204 ft



MW-120 SLUG L RISING HEAD

Data Set: S:\...\MW-120_SlugLRisingHeadGraphHo_Kz.aqt
Date: 01/14/15 Time: 15:52:09

PROJECT INFORMATION

Company: Rio Algom
Project: 1350.21
Location: Lisbon
Test Well: MW-120
Test Date: 03 Oct 2013

AQUIFER DATA

Saturated Thickness: 120.7 ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-120)

Initial Displacement: 0.972 ft
Static Water Column Height: 120.7 ft
Total Well Penetration Depth: 120.7 ft
Screen Length: 120.7 ft
Casing Radius: 0.167 ft
Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.597 ft/day
y0 = 0.3827 ft

APPENDIX B

DWMRC Follow-Up Comments on the DWMRC Response Document

State of Utah

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF WASTE MANAGEMENT
AND RADIATION CONTROL
Scott T. Anderson
Director

August 4, 2015

Anthony Baus
Rio Algom Mining LLC
P.O. Box 218
Grants, NM 87020

RE: Comments on the Rio Algom Mining LLC July 22, 2014 Supplemental Site Assessment
Out-of-Compliance Status at Trend Wells RL-1 and EF-8
Additional Request for Information
Radioactive Material License UT1900481, Amendment 5

Dear Mr. Baus:

The Division of Waste Management and Radiation Control has completed its review of Rio Algom Mining's (RAML) March 26, 2015 responses to the Division's October 17, 2014 interrogatory regarding the RAML July 22, 2014 Supplemental Site Assessment to address the out-of-compliance status at Trend Wells RL-1 and EF-8 (Site Assessment). Exceptions and explanations, as needed, are noted below.

The Division understands that RAML will follow through with its commitments for further work identified in the March 26, 2015 responses. Please note that the Site Assessment must meet the minimum requirements specified in the Stipulated Consent Agreements dated September 10, 2012 (Phase I Assessment) and July 23, 2013 (Phase II Assessment).

General Comment 2: RAML has generally acknowledged a need to provide site-specific data to support its claims. The intent is to avoid expression of speculation, hypothesis, or belief not accompanied by evidence. If RAML does present data or opinion on topics that are not currently conclusive, e.g., dealing with the origin of identified uranium or other contaminants found above state concentration limits in groundwater, RAML should apply the method of multiple working hypotheses and offer site-associated field data, laboratory data, literature references, or a combination thereof supporting and/or arguing against each hypothesis, providing a response as complete as possible. This approach will help reduce uncertainty and avoid dismissal of any potentially valid explanation of issues of importance.

General Comment 3: RAML has agreed to address comments on or changes to statements in the original SSA in writing as requested by Division staff, not only in statements in the main body of the revised SSA but also in all corresponding or relevant information in the appendices.

(Over)

DRC-2015-004262

Section 2.4.2 "Core Sampling": Division staff acknowledges and appreciate RMAL's commitment to conduct additional characterization of the Lisbon Fault (LF) including collection of core data from the LF below the water table as part of additional field investigations.

Section 3.1 "Hydrogeologic Conditions", Page 24, 4th Bullet Comment Regarding Section E-E' (and other, related interrogatories): Division staff acknowledge and appreciate RMAL's commitment to objectively examine different possible explanations for anomalous uranium concentrations in groundwater in locations west and southwest of the Lower Tailings Pond. It may be, as RAML has indicated, that these anomalous uranium concentrations are consistent with naturally occurring mineralized and geochemical conditions. However, it is also very plausible that these anomalous uranium concentrations are connected with a contaminant plume that has been observed moving toward the LF from the east. With groundwater concentrations of uranium in the well near the LF reaching 20 mg/L, compared with Utah State groundwater limits of 0.030 mg/L (i.e., 667x), the exploration of possible explanations and the justification for and/or critique of any particular possible interpretation of the anomalous concentrations should be as rigorous as possible. Division staff understand that RAML will provide additional (1) review of the literature, (2) analysis of core materials, (3) geochemical analysis, e.g., Piper diagrams and descriptions of conceptual models, (4) geostatistical analysis, and (5) geochemical modeling as described in March 26, 2015 RAML responses. A well should also be located and drilled to better identify plume continuity just east of Well MW-116.

Section 3.3.1 "Groundwater Elevations" Page 28 1st Paragraph: The Division understands that model flow and transport results will be submitted after the northern no-flow boundary condition has been re-evaluated and changed and after groundwater mass-balance issues near the northern area have been resolved. A well should be drilled to better delineate the westward extent of the edge of the plume.

Section 3.3.4 "Saturated Thickness of the BCA" Page 33: The Division also understands that model results will be submitted after RAML evaluates processes influencing groundwater flow north of the LSTM to better understand the potential for northerly flow and transport from the site.

Section 4.0 "Conceptual Site Model", South Plume: As agreed to by RAML, the concepts of downward drainage along the LF versus flow along the LF to the north-northwest need to be explored further and justified by site-specific data. The potential for flow across the LF, while not regarded as being likely, can also be explored, if that is desired by RAML.

If you have any questions or would like to schedule a meeting to discuss these comments, please call Phil Goble at (801) 536-4044.

Sincerely,

Scott T. Anderson, Director
Division of Waste Management and Radiation Control

STA/DAE/jr

c: Theresa Ballaine, Rio Algom Mining, LLC

APPENDIX C

Hydrogeological Monitoring

Drive Point Piezometers

The Drive-Point Piezometers (DPP) are constructed of stainless steel, 50 mesh cylindrical filter-screen, within a ¾" stainless steel drive-point body. Drive-points are installed using a hammer and extension pipes to reach the desired sampling/monitoring depth. The DPPs will be installed a few inches below grade in a small excavation covered by an irrigation box to prevent vandalism or disturbance by cows, etc. A stainless steel water level transducer will be placed within the screen of the Drive-Point Piezometer. The transducer contains an internal data logger which will record data at a specified interval. Data will be retrieved periodically by a field crew using a laptop or user-supplied download device. The procedure for installing drive point piezometers is as follows:

1. Locate area where the drive point will be placed.
2. Using a shovel, dig a hole large and depth enough for the irrigation box to sit flush with the ground.
3. Thread a length of extension pipe on the Drive-Point Piezometer Tip and tighten.
4. Place the Slide Hammer over the Drive Head and drive the device until 6" of the extension pipe remains above the ground.
5. Remove the hammer and Drive Head Assembly.
6. Attach a coupler to the previous extension pipe and tighten the next extension pipe to the coupler.
7. Repeat steps 4-6 until the desired sampling depth is reached.
8. Allow for water to stabilize in DPP, then take manual water level reading.
9. Install transducer in DPP opposite screen interval with the end of the cable at the surface. Note depth of logger and water above logger
    a. Loggers will be set to record at a frequency of 10 minutes to 1 hour depended on equipment. Final settings will be determined when equipment is ordered.
10. Install the irrigation box around the DPP. Keep all cables within the box.
11. Mark area with a pin flag and GPS and photograph the location for ease of finding it later.
12. Data will be downloaded every 4-6 months depending on capacity of data-logging equipment installed and frequency of measurement.

Temperature/Electrical Conductance Sensors

The temperature and EC sensor is built with a 9 cm x 3 cm epoxy body and 5.5 cm long stainless steel needles. The needles will be inserted horizontally into undisturbed soil. The sensor will record data at a specified interval and store it on an external data logger. Data will be retrieved periodically by a field crew using a laptop or user-supplied download device. The procedure for installing the temperature/EC sensors is as follows:

1. Locate area where the EC sensor will be placed.
2. Using a hand auger or post-hole digger, dig a hole to the desired depth where the sensor will be placed.

3. Orient the metal probes horizontally and push into the undisturbed soil making sure that the pins sit horizontally, if not, the plastic casing could block water from contacting the sensor pins and create a dry patch.
4. Pull the communication cable to the surface and backfill the hole with native soil.
5. Place the data logger nearby at the surface and attach it to a stake or other surface feature.
6. Connect the communication cable to the data logger.
    a. Loggers will be set to record at a frequency of 10 minutes to 1 hour depended on equipment.
7. Mark area with a pin flag and GPS and photograph the location for ease of finding it later.
8. Data will be downloaded every 4-6 months depending on capacity of data-logging equipment installed and frequency of measurement

APPENDIX D

Hydraulic Testing of Cores and Wells

1 Straddle-Packer Hydraulic Testing Procedure

1.1 Measurement and Test Equipment

Equipment needed for the straddle-packer hydraulic testing activities consists of equipment at the land surface and downhole equipment to be installed in the core holes. Equipment largely consists of "off-the-shelf" items ordered directly from qualified suppliers or standard equipment provided by qualified service companies. All equipment used will follow the supplier’s operation and calibration specifications and will be documented as part of the QA records.

The downhole equipment (collectively referred to as the test tool) consists of two inflatable Baski packers, a shut-in valve, a pulse generator, a slotted test zone section, feedthroughs (tubes passing through the packers) to connect the pressure transducers to the intervals monitored, and gauge carriers to house the transducers, as shown in Figure D-1 (not to scale).

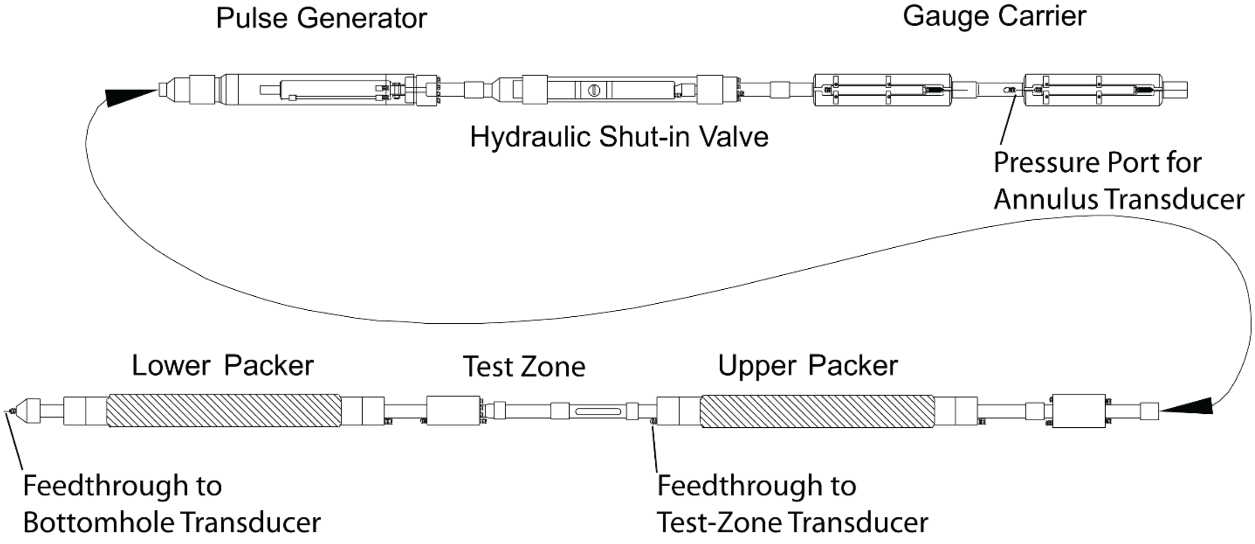


Figure D-1. Schematic of straddle-packer test tool.

The packers have sealing elements approximately 3 feet (ft) long to isolate the section of formation to be tested. The shut-in valve is a zero-displacement hydraulically actuated ball valve that separates the test interval from the tubing string that connects the test interval to ground surface. When the packers are fully inflated, closing the shut-in valve isolates the test interval. High-precision pressure transducers are mounted above the shut-in valve on gauge carriers and are connected to measurement points below the bottom packer and between the two packers by stainless steel lines and feedthroughs. Pressures are also monitored in the annulus between the borehole wall and pipe string above the top packer and in the pipe string.

The pulse tool is a hydraulic piston mounted in a sealed chamber connected to the test interval. In an isolated, or shut-in, test interval, extending or retracting the piston creates a near-instantaneous step change in pressure referred to as a “pulse” injection or withdrawal. Pistons with different displacements are available so that, depending on the length of the test interval, an appropriate piston can be selected to create pulses typically between 10 and 20 psi. Pulse withdrawals can be created by extending the piston prior to shut-in, and subsequently retracting the piston after the shut-in valve is closed. As the volumes of the piston and test zone are known, the magnitude of a pulse can be used to directly and precisely calculate test-zone compressibility (C_{tz}), which is a composite compressibility that includes contributions from the test equipment (“compliance”), the borehole fluid, and the geomechanical response of the borehole wall.

The downhole equipment is connected to the surface with hydraulic lines and an armored umbilical cable with transducer power and communication lines. The hydraulic lines and umbilical cable are secured to the outside of the galvanized pipe string that provides the overall mechanical connection between the service rig at surface and the downhole tool.

With the exception of reels for the stainless steel hydraulic lines and the umbilical cable, all surface equipment is contained within a customized trailer. The trailer contains the data-acquisition system (DAS) computer and equipment, intensifier pumps, and the hydraulic line control panel. The DAS acquires data from the downhole gauges, as well as additional transducers measuring barometric pressure and pressures on each hydraulic line. Data can be queried and viewed on-site, or can be accessed remotely over the internet using a secure web-based interface, allowing real-time interaction between personnel performing the tests and analysts at other locations to ensure that the proper tests are performed and the data are acceptable.

1.2 Straddle-Packer Hydraulic Testing Procedures

Straddle-packer hydraulic testing involves the following sequential activities:

- The test tool will be assembled, insofar as possible, on racks or on the ground in pieces as large as the pulling unit or workover rig can handle. The pieces so constructed will be connected in/over the hole, suspended from the rig. Pup joints will be used to provide the desired straddle length. All fittings will be carefully tightened. The packer-inflation line will be filled with water before connecting the line to the top packer. The lengths, diameters, and placement of all tool elements and gauges will be measured, and a sketch of the tool showing all of the measurements will be made in the Scientific Notebook (SN). Digital photographs of the tool, showing a scale, will also be taken and inserted in the SN.
- Once the tool is completely assembled, the straddle-packer portion will be put inside a length of 6-inch-diameter steel casing for leak testing. The packers will be inflated inside the casing to provide an isolated interval in the casing. Within the radially unsupported casing, packers should be inflated to a maximum of 500 psi to avoid overpressures leading to casing failure. A compressed nitrogen (or air) source will be connected to the tubing at the top of the tool and the isolated interval will be pressurized to at least 100 psi (maximum of 200 psi). All fittings and connections will then be sprayed with soapy water to check for leaks. Any fittings or connections found to be leaking will be tightened or replaced until no leaks remain. The packers shall then be deflated. The shut-in (SI) valve will then be closed, and the interior section of the upper tool (open to the inside of the tubing string) will be filled with fluid and

pressurized to at least 300 psi with the intensifier pump. The connections on the sediment trap and SI valve housing will be carefully examined for leaks.

- If any portion of the leak test fails, all exposed fittings and connections will again be checked for leaks and repaired as needed. After all leaks have been corrected, the tool will be reset in the casing and the entire leak-test process will be repeated until there is no further evidence of leaks. All gauges will be mounted in the gauge carriers and connected to the communication cable. Communication between the gauges and DAS will be verified.
- A pipe tally will be prepared by measuring and recording (to the nearest 0.01 ft) the lengths of enough joints of galvanized pipe to reach the desired test depth. The joints will be measured from the top of the coupling on one end to the point at which threads begin on the other end of the joint. The joints will be numbered sequentially, writing with chalk on the joint or coupling. All available pup joints will also be tallied.
- Based on the target depth and tool measurements, the number of full joints of pipe needed for the tool installation will be calculated. Pup joints will be added as needed to position the tool precisely. In selecting pup joints, allowance will be made for handling requirements at the surface. All pipe tallies and depth calculations will be checked by a second individual before testing of an interval begins.
- The test tool will be lowered into the core hole on galvanized pipe to its desired position with respect to the first interval to be tested.
- Once the tool is at the desired depth, all transducers will be connected to the DAS and data acquisition will be initiated. The shut-in valve will be maintained in an open position while the packers are inflated. The packers will be inflated to a pressure between 400 and 500 psi (measured at ground surface).
- The pulse piston will be set in its extended position (to enable a pulse-withdrawal test), after which the shut-in valve will be closed. The test-zone pressure should then begin to change relative to the annulus pressure (which might change slowly) and the pressure in the pipe (which should be constant) as the test-zone pressure equilibrates with the pressure of the interval to be tested. The bottom-hole pressure should show a pressure increase during packer inflation, and then may either increase or decrease depending on the natural formation pressure in the interval isolated.
- Enough water should be bailed or otherwise removed from the pipe to lower the pressure, which should be similar to the annulus pressure, by ~10 psi. This provides evidence that the shut-in valve is not leaking during a pulse test and prepares the tool for a slug-withdrawal test, if one is planned or necessary. The system will then be allowed to stabilize for up to 1 hr.
- The Test Leader will monitor the test-zone equilibration trend to determine when it is well-enough defined to allow testing to begin. Once the Test Leader determines that testing can begin, the pulse piston will be retracted to initiate a pulse-withdrawal test.
- The pulse test should continue until the pressure has recovered to within 0.5 psi of its pre-test value, or until on-going real-time analysis of the test data indicates that the hydraulic conductivity of the interval has been estimated to within less than an order of magnitude of uncertainty.

- If full pulse recovery occurs in less than 15 minutes, a test more appropriate to the apparently high hydraulic conductivity will be performed. The shut-in valve will be opened to initiate a slug-withdrawal (rising head) test. The Test Leader will evaluate the pressure data from the test zone in real time to determine if the test should be continued as a slug test or converted to a DST. Subject to the discretion of the Test Leader, the following guidelines will be used to determine if and when a slug-withdrawal test will be converted to a DST:
  - If 30% of the initial slug has dissipated after 1 hour (hr), the test will remain a slug test.
  - If 30% of the initial slug has not dissipated after 1 hr, the shut-in valve will be closed and the test will be converted to a DST. The time during which the shut-in valve was open will constitute the DST flow period and the time after shut-in will constitute the DST buildup period.
- Slug tests and DST buildup periods should ideally continue until at least 98% pressure recovery has occurred. They may be terminated sooner if the Test Leader determines that the data already collected are adequate for test analysis.
- After testing is terminated, the shut-in valve will be set to its normal open position, the packers will be deflated, and the test tool will be moved down to the next interval to be tested in the borehole. Careful records will be kept in the SN of the pipe joints added to or removed from the tool string and the pup joints used for the new installation. Packer inflation and testing will then proceed as described above.

After all testing is complete, the tool will be removed from the core hole and reinstalled in the 6-inch casing at the surface. The packers will be inflated with the shut-in valve open, after which the shut-in valve will be closed. After a few minutes of pressure stabilization, the pulse piston will be extended to create a pressure pulse in the test interval. The test interval pressure will then be monitored to verify that the tool was leak-free throughout the testing.

2 Pneumatic Hydraulic Testing Procedure

2.1 Measurement and Test Equipment

Equipment needed for the pneumatic hydraulic testing activities consists of equipment to be installed in the wells and equipment to control and monitor the tests. Equipment largely consists of "off-the-shelf" items ordered directly from qualified suppliers or standard equipment provided by qualified service companies. All equipment used will follow the supplier’s operation and calibration specifications and will be documented as part of the QA records.

The equipment installed in the wells includes a Kapsoid wellhead and two pressure transducers, one installed in the air-filled headspace between the water surface in the well and the Kapsoid wellhead and the other installed below the water surface in the screened interval of the well. The Kapsoid wellhead creates a pressure-tight seal at the top of the well casing, and has fittings to allow gas entry to and exit from the well as well as pressure measurements in the well. If any monitoring wells are nearby, pressure transducers are also installed in them below the water surface.

The pneumatic test control system comprises an air compressor, two flow control devices, the Kapsoid wellhead, connectors, hoses, and a data acquisition and control system (DACS), all housed within a customized trailer. The maximum pressure that may be applied to this system is 150 psi and is controlled by the output of the compressor system. Because all assembles have a safety pressure rating of at least 180 psi, a pressure relief control is not needed in the system. A sketch of the pneumatic test system is show in Figure D-2.

An air compressor generates the air pressure necessary to conduct the test. The compressor has a maximum pressure generation of 150 psi. The air compressor outputs pressurized air to a 3/8" I.D. braided hose (rated to 300 psi), which is connected to ½" Stainless Swagelok Tubing (rated to 3700 psi). The ½" Swagelok Tubing connects to Goodyear Horizon ½" I.D. braided hose (rated at 200 psi). The Goodyear Horizon hose attaches to one of the two Alicat Scientific Precision Gas Mass Flow Controllers (casing rated to 500 psi) which is immediately connected to a Swagelok "T" fitting (rated to a minimum of 4900 psi). The output of the Alicat Flow Controllers requires a ¾" OD down-step to ½" OD Swagelok fittings. It is important to note that the listed rating of 145 psi given on the spec sheets for the Alicat Flow Controllers is the working pressure for its internal valve, and the burst pressure is 180 psi. Exceeding the 145 working pressure will not create a hazard to personnel because the valve is contained within the stainless steel housing for the sensor (rated at 180 psi).The "T" fitting is connected to the second Alicat Scientific Flow Controller and a second section of Goodyear Horizon ½" I.D. braided hose (rated to 200 psi). The second Alicat Gas Flow Controller vents to the atmosphere. The output hose connects to the Kapsoid wellhead (rated to 384 psi) which is secured inside the top of the well casing. The configuration of the flow controllers is such that the first will regulate pressure increases into the well and the second will regulate pressure decreases out of the well. There is also a locked arm valve on the Kapsoid wellhead to allow for direct pressure release.

The Alicat Flow Controllers are controlled by the data acquisition and control system (DACS), utilizing a feedback loop that maintains the flow settings specified by the user. The DACS acquires data from the transducers and the flow controllers, as well as an additional transducer measuring barometric pressure. Data can be queried and viewed on-site, or can be accessed remotely over the internet using a secure web-based interface, allowing real-time interaction between personnel performing the tests and analysts at other locations to ensure that the proper tests are performed and the data are acceptable.

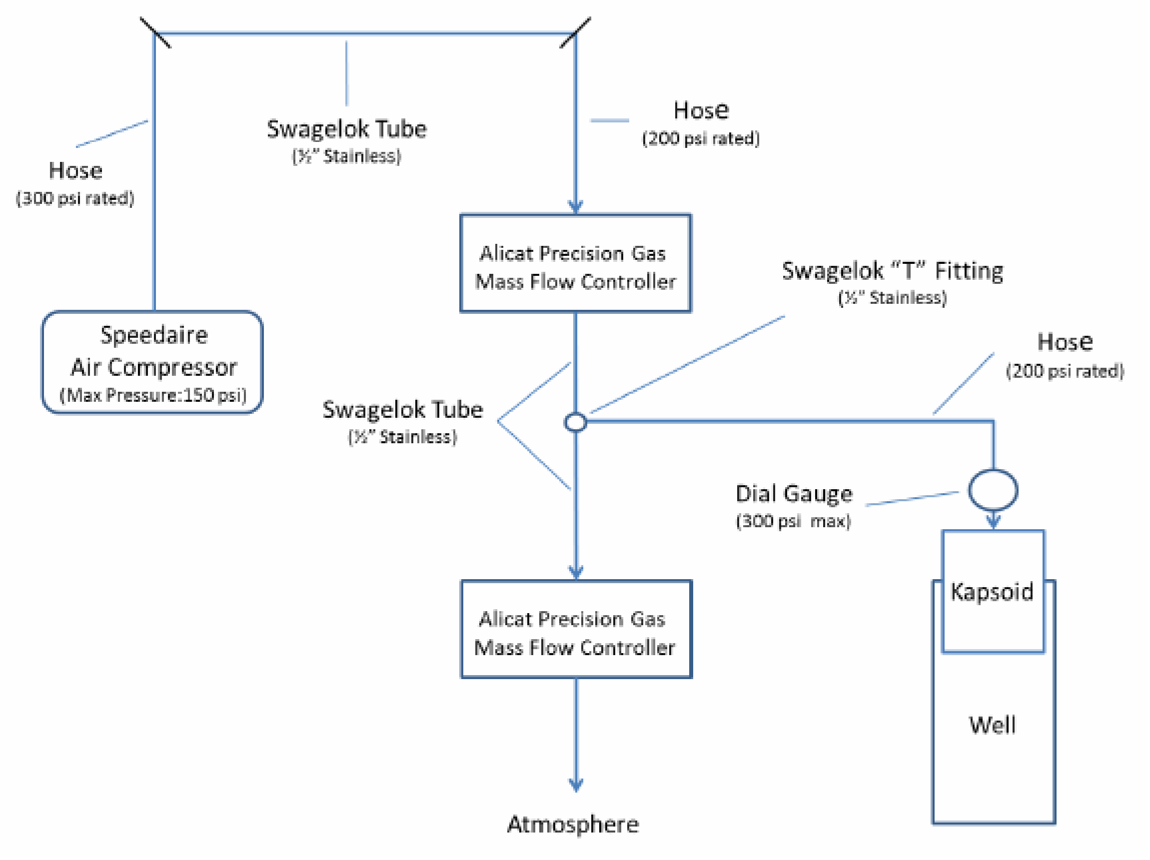


Figure D-2. Schematic of pneumatic testing system.

2.2 Pneumatic Hydraulic Testing Procedures

To conduct a pneumatic rising-head slug test, the air pressure in the headspace of the well is increased by the desired amount (e.g., 10 psi), which causes the water level in the well to go down. Once stable conditions are achieved, the air pressure is vented as rapidly as possible, and the water level begins to recover back to its original position. The recovery data can be analyzed as for any other slug test. Note that the water level should not be depressed below the top of the well screen.

A pneumatic sinusoidal test uses pneumatic pressure to create a sinusoidally varying pressure signal in a test well by manipulating the water level in the wellbore. By positioning pressure transducers both below the water level and in the head space above the water, both the total pressure (gas pressure + water pressure) acting on the formation and the changes in water level can be monitored. Changes in water level are used to calculate the flow rate into and out of the well.

Pre-test calculations/simulations are used to determine the optimal frequencies that will result in test objectives being met. Real-time analysis can then be used during actual test execution to determine if the estimated input frequencies need to be changed.

The procedures for conducting a pneumatic sinusoidal test are as follows:

- Increase the gas pressure in the test well, resulting in an increase in the total pressure. The system is then allowed to equilibrate for some period of time as the height of the water column decreases in response to the increased gas pressure, allowing the total pressure to return to static pressure (pre-test total pressure). During this equilibration period, a constant gas pressure above the water column is maintained.
- At the end of the equilibration period, the top of the water column is located at the desired position for the start of the sinusoidal test. From this position, gas pressure is used to control the rise/fall of the water column such that a sinusoidal pressure signal with a specified frequency is produced. The entire process is controlled by the DACS, utilizing a feedback loop that maintains the sinusoidal frequency specified by the user. The initial period of the sinusoidal cycle should be on the order of 1 minute.
- After two complete sine wave cycles, pause at the initial pressure to allow conditions to stabilize in the well.
- Initiate the next cycles with a period a factor of 2 to 3 greater than that of the previous cycles.
- After two complete sine wave cycles, pause at the initial pressure to allow conditions to stabilize in the well.

  Continue incrementing period by a factor of 2 to 3 until real-time analysis of the data from the test and observation wells shows test objectives have been achieved.

A pumping test is used to determine hydraulic properties of an aquifer by pumping one well for a specified length of time while collecting periodic water level measurements. Aquifer properties that can potentially be estimated using a pumping test include transmissivity (i.e., hydraulic conductivity multiplied by aquifer thickness), horizontal or vertical hydraulic conductivity, coefficient of storage, specific yield, and confining layer leakage. The two types of pumping tests most useful in determine aquifer hydraulic properties are the constant rate pumping test and the step-drawdown pumping test. The latter is best suited to determining the well’s reduction in specific capacity (i.e., specific yield per unit of drawdown) with increasing yields while the former is the most widely used pumping test in determining the transmissivity and storage values for an aquifer.

A pumping test can be performed using only the pumping well, however specific information such as aquifer storage will not be obtainable. The use of observation wells in obtaining additional drawdown and/or recovery data over time is recommended whenever possible, especially when information on aquifer storage, anisotropy, vertical leakage, or the distance to a recharge or no–flow (i.e., barrier) boundary is needed.

In comparison to a slug test, a pumping test is representative of a much larger area and is therefore a better estimation of the hydraulic parameters of an aquifer. Conversely, a pumping test requires a greater commitment of resources (time, money, and equipment) and produces large volumes of water that usually need to be containerized during the test.

Several analytical solution methods are available, two of the most widely used are the Theis (1935) equation and the Cooper and Jacob (1946) equation (often referred to as the Jacob straight–line method). A multitude of pumping test analysis software is available, though users are cautioned to make sure to understand all model or spreadsheet inputs as well as the assumptions of the governing equations. Far more extensive information on the design and analysis of pumping tests is covered in texts including, to name a few, Driscoll (1986), Kruseman and de Ridder (1991), Dawson and Istok (1991), Osborne (1993), and Fetter (1988).

Analyses of pumping tests require the following assumptions:

1. The water–bearing formation is homogeneous, isotropic, uniform in thickness, and infinite in areal extent.
2. The formation receives no recharge from any source.
3. The pumping well (i.e., the screened section) is fully penetrating the entire thickness of the water–bearing formation.
4. The water removed from storage is discharged instantaneously when the head is lowered.
5. The pumping well is 100% efficient.
6. All water removed from the well comes from aquifer storage.
7. Laminar flow exists throughout the well and aquifer.
8. The water table or potentiometric surface has no slope.

In reality, most pumping tests violate many of the above–mentioned assumptions to some degree or another. It is important to take all feasible measures to limit the extent of these violations whenever possible. Certainly, discussing these assumptions and any possible violations to them is important to any pumping test report.

3 Pumping Test Procedures

3.1 Design Considerations

Prior to performing an aquifer pumping test, all available site and regional hydrogeologic information should be assembled and evaluated. If retrievable, such data should include ground–water flow direction(s), hydraulic gradients, other geohydraulic properties, site stratigraphy, well construction details, regional water level trends, and the performance of other pumping wells in the vicinity of the test area. This information is used to select test duration, proposed pumping rates, and pumping well and equipment dimensions.

The precise location of an aquifer test is chosen to be representative of the area under study. In addition, the location is selected on the basis of numerous other criteria, including:

- Size of the investigation area;
- Uniformity and homogeneity of the aquifer;

- Distribution of contaminant sources and dissolved contaminant plumes;
- Location of known or suspected recharge or barrier boundary conditions;
- Availability of pumping and/or observation wells of appropriate dimension and screened at the desired depth; and
- Requirements for handling discharge.

The dimensions and screened interval of the pumping well must be appropriate for the tested aquifer. For example, the diameter of the well must be sufficient to accommodate pumping equipment capable of sustaining the desired flow rate at the given water depth. In addition, if testing a confined aquifer that is relatively thin, the pumping well should be screened for the entire thickness of the aquifer. For an unconfined aquifer, the wells should be screened at least in the bottom one– to two–thirds of the saturated zone and they may be screened throughout the entire thickness of the saturated zone.

Any number of observation wells may be used. The number chosen is contingent upon both cost and the need to obtain the maximum amount of accurate and reliable data. If at least three observation wells are to be installed and there is a known boundary condition, the wells should be configured such that water levels can be monitored both perpendicular and parallel to the boundary, with the pumping well at the intersection of the two well lines. If two observation wells are to be installed, they should be placed in a triangular pattern, non–equidistant from the pumping well. If observation wells are placed at 90–degree angles from the pumping well, radial anisotropy can be easily calculated. When observation wells are installed for aquifer testing purposes, they should be located at distances and depths appropriate for the planned method for analysis of the aquifer test data. Observation well spacing should be determined based upon expected drawdown conditions that are the result of the studies of geohydraulic properties, proposed pumping test duration, and proposed pumping rate.

3.2 Equipment

The equipment necessary to conduct a pumping test includes:

- a pump (suited for site conditions and requirements of the test)
- a water–level measuring devices (pressure transducers and/or electronic water–level indicators) accurate to at least 0.01 feet;
- a flow meter with totalizer (something as simple as a graduated bucket can also suffice, especially as backup);
- a digital watch with stopwatch function (used to keep time and to help determine discharge rate when using graduated containers);
- an electrical source (generator or electrical receptacle on site)
- an electronic data recorder programmed to suitable data collection intervals);
- barometer
- water quality meter(s) for noting changes as a function of capture zone

- hose or pipe to route pumped water away from test area
- gate valve
- adequately sized tank/container for storing water
- portable computer for preliminary analysis of data (optional)
- field forms and log book
- pen and paper
- backup equipment if feasible

Pumping equipment should conform to the size of the well and be capable of delivering the estimated range of pumping rates. The selection of flow meter, gate valve, and water transfer lines should be based on anticipated rates of water discharge. Both the discharge rate and test duration should be considered when selecting a tank for storing discharge water if the water cannot be released directly to the ground, sanitary sewer, storm sewer, or nearby water treatment facility.

3.3 Pumping-Test Preparations

If feasible for the site, slug tests or preliminary pumping tests (constant-rate or step drawdown) should be performed on the pumping well prior to the actual test. The preliminary pumping should determine the maximum drawdown in the well and the proper pumping rate should be determined by step drawdown testing. If the discharge rate varied by less than 5% (i.e., a constant–rate–pumping test), the time versus drawdown data from the pumping well can be used to estimate aquifer transmissivity. The preliminary pumping will also provide redevelopment of the pumping well by removing fines the adjacent formation and from the filter pack. Redevelopment of the pumping well will improve well efficiency during the pumping test and thus will allow for a better estimation of the aquifer's hydraulic properties. The aquifer should then be given time to recover before the actual pumping test begins (as a rule–of–thumb, one day). A record should be maintained in the field logbook of the times of pumping and discharge of other wells in the area, and if their radii of influence intersect the cone of depression of the test well.

Barometric changes may affect water levels in wells, particularly in semiconfined and confined aquifers. Therefore, it is advisable to monitor (perhaps hourly) the barometric pressure and water levels in key wells at least 24 hours (if possible) prior to performing a pumping test. If a ground–water fluctuation trend is apparent, the barometric pressure should be used to develop curves depicting the change in water level versus time. These curves should be used to correct the water levels observed during the pumping test. Ground–water levels and barometric pressures in the background should continue to be recorded throughout the duration of the test. If data loggers with transducers are used, backup field measurements should be collected in case of data logger malfunction. All measurements and observations should be recorded in a field notebook or on appropriate field forms.

All equipment should receive calibration, function checks, and fresh or charged batteries if needed.

3.4 Conducting the Pumping Test

Prior to the start of the pumping test, the following checks should be made:

- Ensure all piping, valves, and flow meters are properly installed.
- Ensure that all containers are in place to capture all pumped water.
- Ensure that the energy needs (batteries, electricity, or gas) for all equipment are provided, including backup energy sources for key equipment.
- Verify all equipment is present and place it at locations where it will be needed most.
- Verify the pump intake in located at the proper interval in the pumping well.
- Verify all transducers are placed at the proper depth and are properly secured so they will not move or be susceptible to contact form site personnel.
- Verify the data logger is properly programmed to record (typically logarithmically).
- Lower electronic water level tapes to just above the water levels inside each well.
- Warm up all equipment (such as a generator) that perform better after initial operations
- Ensure all personnel and field forms are in their start–of–test locations

Immediately prior to starting the pump, the water levels should be measured and recorded for all wells to determine the static–water levels upon which all drawdowns will be based. Data loggers should be reset for each well to a starting water level of 0.00 foot. At this time, a pumping test is initiated by starting the data logger and then starting the pump. The data logger needs to be started at least a split second before the pumping begins. Immediately afterwards, the time pumping started needs to be recorded along with water–level readings, especially at or near the pumping well. A suggested schedule for recording water–level measurements made by hand is as follows:

- 0 to 10 minutes – 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, and 10 minutes. It is important in the early part of the test to record with maximum accuracy the time at which readings are taken;
- 10 to 100 minutes – 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, and 100 minutes; and
- 120 minutes to end of test – every 1 hour (60 minutes).

At least 10 measurements of drawdown for each log cycle of time should be made both in the test well and the observation wells. Data loggers can be set to record in log time, which is very useful for data analysis. When logging data by hand, there should initially be sufficient field personnel to station one person at each well used in the pumping test. After the first two hours of pumping, two people are usually sufficient to complete most simplistic tests. It is advisable for at least one field member to have experience in the performance of pumping tests, and for all field personnel to have a basic familiarity with conducting the test and gathering data.

The discharge rate should be measured frequently throughout the test with a flow meter equipped with a totalizer and controlled to maintain a constant pump. This can be achieved, in part, by using a control valve. If used properly, the flow control valve can be pre-set for the test and will not have to be adjusted during pumping. When the pumping is complete, the total gallons pumped are divided by the time of pumping to obtain the average discharge rate for the test.

For a confined aquifer, the water level in the pumping well should not be allowed, if possible, to fall below the bottom of the upper confining stratum during a pumping test. The pitch or rhythm of the pump or generator provides a check on performance. If there is a sudden change in pitch, the discharge should be checked immediately and proper adjustments to the control valve or the generator engine speed should be made, if necessary. Do not allow the pump to break suction during the test. If the pump stops working during the test, make necessary adjustments and restart the test after the well has stabilized.

Water pumped from an aquifer during a pumping test should be disposed of in such a manner as to not allow the aquifer to recharge during the test. This means that the water must be piped away from the well and associated observation wells. Also, if contaminated water is pumped during the test, the water must be stored and treated or disposed of according to project specifications. The discharge water may be temporarily stored in drums, a lined, bermed area, or tanks. If necessary, it should be transported and staged in a designated secure area.

Field personnel should be aware that electronic equipment sometimes fails in the field. It is a good idea to record key data in the field logbook or on field forms as the data are produced. That way, the data are not lost should the equipment fail.

The total pumping time for a test depends on the type of aquifer and degree of accuracy desired. Economizing on the duration of pumping may yield less reliable results. It is always recommended to pump long enough to ensure the cone of depression achieves a stabilized condition. The cone of depression will continue to expand at an ever–decreasing rate until recharge of the aquifer equals the pumping rate, and a steady–state condition is established. The time required for steady–state flow to occur varies considerably from site to site. If steady–state conditions cannot be achieved in a reasonable time frame for the project, consider a test duration of at least 24 hours. A longer duration of pumping may reveal the presence of boundary conditions or delayed yield.

Use of portable computers allows time/drawdown plots to be made in the field. If data loggers are used to monitor water levels, the electronic data can be reviewed by scrolling with the data logger screen or via a portable computer. It is advisable to download the water level data before transporting the logger from the site.

3.5 References

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APPENDIX E

Site-Wide Groundwater Sampling and Analysis Plan

Site-Wide Groundwater Sampling and Analysis Plan

Rio Algom Mining LLC, Lisbon Facility

November 2015

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TABLES

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SITE-WIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN
RIO ALGOM MINING LLC, LISBON FACILITY

1.0 INTRODUCTION

Rio Algom Mining LLC (RAML) and its contractors have prepared this Site-Wide Groundwater Sampling and Analysis Plan (SAP), dated November 2015, for groundwater monitoring at the Lisbon Facility (Site) located near La Sal, Utah (**Figure 1**). This document is an extension of the Groundwater Monitoring Plan Version 2.0 (GMP) submitted to the Utah Division of Waste Management and Radiation Control (DWMRC) dated July 31, 2015. The difference between this document and the GMP is that this document includes guidance for sampling 28 “hydrogeology study” wells in addition to the 14 compliance wells addressed in the GMP that are listed in the Site’s Radioactive Materials License (License No. UT1900481 [License]). This SAP provides the procedures for sampling all existing wells at the Site. Any new wells (associated with the Phase 3 Supplemental Site Assessment or other future field work) will be sampled according to the same protocols described in this SAP.

1.1 BACKGROUND

Groundwater monitoring is currently conducted at the Site to meet the requirements of DWMRC Radioactive Materials License #UT1900481, Amendment 5, Condition 53G (License) (DRC, 2014). This SAP provides guidance for sampling an additional 28 wells located on and around the Site known as the “hydrogeology study” wells. These wells are monitored as part of an ongoing characterization of the lateral and vertical extent of groundwater contamination in the area. Wells installed in the future will also be monitored under this SAP.

Depth to water measurements and groundwater samples are obtained from 42 monitoring wells in accordance with the License requirements and Site characterization project. The primary constituent of concern (COC) identified at the Site is uranium. Other COCs include molybdenum, selenium, and arsenic. Total dissolved solids (TDS), chloride, sulfate, bicarbonate, and pH are also monitored at the Site. Additional analytes for the hydrogeology Site characterization include aluminum, copper, cadmium, and zinc.

In a letter dated February 7, 2011, DWMRC requested that RAML conduct a hydrogeologic assessment to investigate out-of-compliance (OOC) conditions at the Site (DRC, 2011). At compliance wells RL-1 and EF-8, uranium concentrations had exceeded established Alternate Concentration Limits (ACLs), resulting in the OOC conditions. The investigation was conducted in 2012 and 2013 and included the construction of 27 new monitoring wells, hydraulic testing and analysis, groundwater sampling, and an evaluation of various representative groundwater sampling methods.

This SAP has been prepared to provide details on the Site groundwater sampling program and quality assurance and quality control (QA/QC) procedures for all of the Lisbon Site wells.

2.0 GROUNDWATER MONITORING PROGRAM

The following sections describe the monitoring well network and summarize the analytical requirements for all of the wells.

2.1 MONITORING WELL NETWORK

There are 14 compliance monitoring wells and 28 hydrogeology study wells on and near the Site. **Figure 1** shows the locations of these monitoring wells. Construction details for the monitoring wells are summarized in **Table 1.**

2.2 LONG-TERM GROUNDWATER MONITORING PLAN COMPLIANCE MONITORING PROGRAM

Fourteen monitoring wells are currently sampled in accordance with the Long-Term Groundwater Monitoring Plan (LTGMP). These wells are designated as compliance monitoring wells, which are defined further below:

- Point of Compliance (POC) wells: EF-3A and OW-UT-9
- Point of Exposure (POE) wells: RL-4, RL-5, and RL-6
- Trend wells: EF-6, EF-8, ML-1, RL-1, RL-3, H-63, and LW-1
- Background wells: MW-5 and MW-13

The License stipulates ACLs as the enforceable groundwater protection standards (concentration limits) for these 14 compliance monitoring wells. The compliance designation for each well and respective ACLs are provided in **Table 2. Table 3** presents the analytical methods for the samples collected within the License compliance and hydrogeology study programs.

2.2.1 Monitoring Schedule

The combined compliance monitoring and hydrogeology study monitoring event will be conducted during the fourth calendar quarter of 2015 and 2016. The monitoring events are expected to take approximately two weeks to complete and will be conducted by a water sampling contractor under the technical direction of INTERA personnel.

2.2.2 Groundwater Monitoring Parameters

As specified in the LTGMP, compliance groundwater monitoring includes depth to water level measurement and groundwater sampling. Groundwater samples will be analyzed for the COCs uranium, molybdenum, selenium, and arsenic, and indicator parameters including TDS, chloride, sulfate, bicarbonate, and pH. In addition to these parameters, all samples will also be analyzed for aluminum, copper, cadmium, and zinc. **Table 3** lists the sampling analytes, methods, holding times, and sample container requirements. Groundwater quality indicator parameters monitored in the field include temperature, pH, electrical conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity. Indicator parameter stabilization criteria are provided in the groundwater sampling standard operating procedure provided in **Attachment 1.** Drawdown of the water column in the well will also be monitored during the pre-sampling purge, as described in **Attachment 1.**

2.2.3 Reporting

Reports summarizing the results of the compliance groundwater monitoring program are submitted to DWMRC on an annual basis. Annual compliance monitoring reports are submitted on or before March 1 of each year. Reports are required to include the following information:

- Groundwater sampling methodology
- Field parameter measurements and copies of field sampling data sheets
- Laboratory reports and chain-of-custody documentation
- Data evaluation
- Data tables summarizing recent and historical monitoring data
- Groundwater contour map(s)
- Isoconcentration maps for arsenic, molybdenum, selenium, and uranium
- Time series plots depicting constituents and parameters: arsenic, molybdenum, selenium, uranium, bicarbonate, chloride, sulfate, pH, TDS, and water level elevation

Analytical results for the 28 hydrogeology well samples will be prepared for delivery to RAML and provided to the DWMRC as needed under the requirements of the on-going Site characterization program.

3.0 GROUNDWATER MONITORING PROCEDURES

Groundwater monitoring will be performed by qualified and trained personnel. Procedures for data acquisition QA/QC, groundwater level measurement, groundwater sampling and analysis, and sample control are described in the following sections.

3.1 QUALITY ASSURANCE PLAN

Groundwater sampling and analysis will be conducted in accordance with the Quality Assurance Plan (QAP) prepared for this SAP (**Attachment 2**). The QAP describes the personnel responsible for data collection and establishes the sampling and analytical protocols and documentation requirements to ensure the groundwater monitoring data are collected, reviewed, and analyzed in a consistent manner. The QAP includes data quality objectives for data measurement, sampling procedures, sample and document custody procedures, laboratory analytical methods, internal quality control checks, data validation and reporting procedures, and corrective action procedures.

QA/QC procedures will be conducted in the field and laboratory. Field procedures will include field documentation, blind code labeling, and collection of quality control samples including sample duplicates, sampling equipment rinsate blanks, and transport blanks. Laboratory QA/QC procedures will include completion of laboratory performance criteria including sample holding times, matrix spike/matrix spike duplicate recoveries, and laboratory method blank results. Laboratory and field QA/QC procedures will be conducted in accordance with the QAP.

3.2 GROUNDWATER LEVEL MEASUREMENT

During each monitoring event, manual depth-to-water measurements will be obtained from wells designated in the program using a decontaminated electronic water level indicator. Water levels will be measured to the nearest 0.01-foot from the designated measuring point marked on the top of the well casing. Measurements will be recorded immediately on a water level field data sheet (**Attachment 3**). Water level measurements will be obtained in as short a period of time as practical. Standard operating procedures for water level measurement are provided in **Attachment 1.**

3.3 GROUNDWATER SAMPLE COLLECTION

The following sections provide the procedures to be utilized during the collection of groundwater samples from monitoring wells.

3.3.1 Field Instrument Calibration

At the beginning of each day of sampling, field instruments will be calibrated following manufacturer's recommended procedures using known, standard solutions. Calibration procedures, date, and time will be recorded on field instrument calibration data sheets (**Attachment 3**). Back-up instruments will be available in case of malfunction. Instrument maintenance will be performed as deemed appropriate by the manufacturer.

3.3.2 Groundwater Sampling Methods

The low-flow minimal purge method is the recommended method of sampling for License compliance monitoring wells and the Site characterization hydrogeology wells. The low-flow method has been approved by the DWMRC (DRC, 2015) as long as the appropriate pumping rates, drawdown stabilization, and field parameter stabilization criteria are followed

(ASTM, 2002). However, RAML will implement the standard purge method or the low-permeabilty well method if the low-flow sampling criteria cannot be met (**Attachment 1**). Sampling information will be recorded on field sampling data sheets (**Attachment 3**). General procedures for recommended sample methods are described in the following sections. Standard operating procedures for sampling methods are provided in **Attachment 1.**

Low-Flow (Minimal Purge), Standard Purge, and Low-Permeability Well Sampling Methods

When the low-flow method is used, groundwater samples will be collected in general accordance with the US EPA *Low-Flow (Minimal Drawdown) Ground-Water Monitoring Procedures* (Puls and Barcelona, 1996) and *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations, Designation D 6771-02* (ASTM, 2002). A submersible pump will be placed at the midpoint of the well screen interval. Wells will be purged through disposable tubing at rates less than 500 milliliters per minute to minimize water level drawdown. During purging, field parameters (pH, specific conductance, temperature, oxidation-reduction potential [ORP], dissolved oxygen [DO], and turbidity) will be monitored through a flow-through cell and recorded on field sampling data sheets at 3-minute intervals. With stable water levels in the well, groundwater samples will be collected after field parameters have stabilized within ±0.1 standard units for pH, ±3 percent for specific conductance and temperature, ±10 millivolts for ORP, and ±10 percent for turbidity and DO. These stabilization criteria are also presented in **Attachment 1.**

The standard-purge method may be employed if the low-flow criteria cannot be met. Likewise, some wells may contain such small amounts of water and low recharge rates that the low-permeability purging and sampling method may be used. Please see **Attachment 1** for a description of each of these methods.

3.3.3 Sample Filtration

Samples collected for dissolved parameters will be field-filtered using a disposable, in-line, 0.45-micron filter. Water samples will be pumped through the filter attached directly to the discharge tubing of the groundwater pumping system. A new filter and tubing will be used for each sample. A separate sample from MW-116 will also be filtered with a 0.10-micron filter for evaluation of geochemical parameters.

3.3.4 Quality Control Sampling

QA/QC sampling will be conducted in accordance with the QAP for the Site (**Attachment 2**). QA/QC samples will consist of duplicate samples, split samples, and equipment rinsate blanks. QA/QC samples will be clearly identified on the field sampling forms.

Duplicate Samples

Duplicate groundwater samples will be collected at a frequency of 10 percent of the total number of groundwater samples collected during quarterly or semiannual events. Specific locations will be designated for collection of duplicate samples prior to the beginning of sample collection. The duplicate samples will be collected at the same locations as the corresponding primary samples and will be collected simultaneously using identical sampling techniques. Duplicate samples will be treated in an identical manner as the primary samples during storage, transportation, and analysis. The duplicate sample containers will be assigned an identification number in the field so that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis.

Laboratory Split Samples

Laboratory split groundwater samples will be collected by the Utah DWMRC in conjunction with the regular sample at designated wells. Typically, split samples are collected at a frequency of 5 percent of the total number of primary groundwater samples collected during semiannual events. At each location, a second set of sample containers will be filled and submitted to a different laboratory. The split samples will be submitted for equivalent analysis as the primary sample.

Equipment Rinsate Blanks

To assess the effectiveness of equipment decontamination procedures, equipment rinsate blanks will be collected at a frequency of 5 percent of the total number of primary groundwater samples collected during semiannual events. Equipment blanks will be prepared by pouring or pumping reagent-grade de-ionized water over or through sampling devices after decontamination procedures have been conducted. The water will be collected and transported to the laboratory for the equivalent analysis as the primary samples.

3.3.5 Sample Designation and Labeling

All groundwater samples collected from monitoring wells, including duplicate samples, will be given a unique blind four-digit sample identifier. Sample identifiers will be recorded on field sampling data sheets. Sample containers will be labeled with the sample identifier, data and time of sampling, and sampler’s initials.

3.3.6 Equipment Decontamination Procedures

Before use at each location, the submersible pumps and depth-to-water sensors will be washed using a solution of water and Liqui-Nox™, rinsed with potable water, and rinsed a second time with distilled/deionized water. Disposable polyethylene tubing will be discarded after each well is sampled and replaced with new tubing. Samplers will use new, disposable gloves at each well location.

3.4 SAMPLE CONTROL

3.4.1 Sample Containers/Sample Handling

The sample containers will be prepared and provided by the analytical laboratory. Samples will be preserved consistent with conditions presented in **Table 3.** The type and size of container used for each parameter and the type of preservative added, if any, will be recorded on the field sampling data form. Sample containers will be placed in an ice-filled cooler immediately after sample collection. The sample containers will be kept closed, maintained under custody, and refrigerated until analysis. Maximum holding times from the time of sample collection until sample analysis are provided in **Table 3.**

3.4.2 Sample Custody

At the end of each sampling day and before samples are transferred offsite, sample information will be documented on the chain-of-custody/laboratory analysis request form. Once samples are collected, they will remain in the custody of the sampler or other authorized personnel until shipped to the laboratory. Upon transfer of sample possession to subsequent custodians, the persons transferring custody will sign the chain-of-custody form. During interstate transport, the chain-of-custody form will be placed in a resealable plastic bag and accompany each sample cooler to the laboratory. Signed and dated chain-of-custody seals will be placed on coolers prior to shipping. When the samples are received at the laboratory, the custody seal on the shipping container will be broken, and the condition of the samples will be recorded by the laboratory custodian. Chain-of-custody records will be included in the analytical report prepared by each laboratory.

The laboratory will also maintain a sample-tracking record that will follow each sample through the laboratory process. The sample-tracking record must show the dates of sample extraction or preparation and sample analysis.

3.4.3 Packaging and Shipping

Samples will be shipped to the analytical laboratory by overnight delivery. Samples will be packaged and shipped using the following procedures:

- Sample containers will be placed in resealable plastic bags in sealed, insulated coolers. A sufficient amount of ice will be placed around the samples.
- If used, glass bottles will be separated in the shipping container by shock-absorbent packaging material to prevent breakage.
- Sample shipments will be accompanied by chain-of-custody/laboratory analysis request forms, which will be sealed in plastic bags and placed inside each cooler.

3.5 LABORATORY ANALYSIS

Groundwater samples will be submitted for hydrochemical analysis to analytical laboratories certified by the State of Utah. Laboratory analyses will be performed using United States Environmental Protection Agency (US EPA)-approved methods. Samples will be analyzed for dissolved uranium, molybdenum, selenium, arsenic, aluminum, copper, cadmium, and zinc by US EPA Method 200.7_8 (US EPA, 1994); for TDS by Standard Method A2540 C (American Public Health Association [APHA], et al., 2012); for chloride and sulfate by US EPA Method 300.0 (US EPA, 1993); for bicarbonate as HCO_3 (alkalinity) by Standard Method A2320 B (APHA, et al., 2012); and for pH by Standard Method A4500-HB (APHA, et al., 2012). In addition to the required analyses, samples may also be analyzed for calcium, magnesium, potassium, and sodium by US EPA Method 200.7_8 (US EPA, 1994); carbonate as CO_3 by Standard Method A2320 B (APHA, et al., 2012); and specific conductance by Standard Method A2510 B (APHA, et al., 2012). Methods for required analyses are summarized in **Table 3.** Other analyses may be conducted for characterization purposes.

Laboratory QA/QC procedures will be conducted in accordance with the QAP (**Attachment 2**). Laboratory QA/QC procedures will include completion of laboratory performance criteria including sample holding times, matrix spike/matrix spike duplicate recoveries, and laboratory method blank analysis.

3.6 INVESTIGATION-DERIVED WASTE

Purge water and equipment decontamination water generated during groundwater sampling activities will be considered investigation-derived waste (IDW). Purge and decontamination water will be transported to a secured container on the RAML property and temporarily stored on-site. IDW will be transported and properly disposed at an appropriate facility following receipt of laboratory analytical results and disposal characterization. A RAML representative will sign and retain copies of all transport and disposal manifests.

4.0 REFERENCES CITED

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TABLES

TABLE 1. MONITORING WELL LIST, OCTOBER 2015
RIO ALGOM MINING LLC, LISBON FACILITY

No.	Well Status	Well I.D.	Ground Elevation (ft amsl)	Well Dia. (inches)	TD (ft btoc)	DTW (ft btoc)	Top Screen (ft btoc)	Base Screen (ft btoc)	Screen Length (ft)
1	License	EF-3A	6583.23	6	215	81.37	151	215	64
2	License	OW-UT-9	6705.6	6	142	122.89	120	140	20
3	License	RL-4	6682.94	5	178	156.48	138	178	40
4	License	RL-5	6687.96	5	188	151.91	151	188	37
5	License	RL-6	6463.3	5	20	16.02	9	19	10
6	License	EF-6	6569.12	4	137	70.71	107	137	30
7	License	EF-8	6574.42	4	244	73.73	213	243	30
8	License	ML-1	6531.81	4	157	41.95	137	156	19
9	License	RL-1	6654.18	5	125	116.28	105	125	20
10	License	RL-3	6705.91	5	185	170.13	165	185	20
11	License	H-63	6684.14	4	172	135.9	141	171	30
12	License	LW-1	6723.61	4	234	146.92	204	234	30
13	License	MW-13	6642.12	4	206	94.03	129	206	77
14	License	MW-5	6745.82	6	197	154.2	167	197	30
15	Hydrogeology	UW-1	6653.64	4	140	104.93	6553	6516	
	Hydrogeology	UW-1		4	140	104.93	100.64	137.64	37
16	Hydrogeology	MW-100	6724.19	4	204	146.92	6586	6521	
	Hydrogeology	MW-100		4	204	146.92	138.19	203.19	65
17	Hydrogeology	MW-101	6709.38	4	161	150.86	6570	6550	
	Hydrogeology	MW-101		4	161	150.86	139.38	159.38	20
18	Hydrogeology	MW-102	6701.46	4	137	125.04	6585	6565	
	Hydrogeology	MW-102		4	137	125.04	116.46	136.46	20
19	Hydrogeology	MW-102DB	6701.68	4	177	119.8	6556	6526	
	Hydrogeology	MW-102DB		4	177	119.8	145.68	175.68	30
20	Hydrogeology	MW-103	6662.56	4	113	82.51	6581	6551	
	Hydrogeology	MW-103		4	113	82.51	81.56	111.56	30
21	Hydrogeology	MW-104	6703.45	4	108	94.2	6635	6605	
	Hydrogeology	MW-104		4	108	94.2	68.45	98.45	30
22	Hydrogeology	MW-105	6622.46	4	136	73.04	6558	6488	
	Hydrogeology	MW-105		4	136	73.04	64.46	134.46	70
23	Hydrogeology	MW-106	6852.76	4	267	227.3	6616	6586	
	Hydrogeology	MW-106		4	267	227.3	236.76	266.76	30
24	Hydrogeology	MW-107S	6510.31	4	62	50.85	6480	6450	
	Hydrogeology	MW-107S		4	62	50.85	30.31	60.31	30
25	Hydrogeology	MW-107D	6510.59	4	82	50.94	6450	6430	
	Hydrogeology	MW-107D		4	82	50.94	60.59	80.59	20
26	Hydrogeology	MW-108	6513.14	4	170	24.78	6425	6345	
	Hydrogeology	MW-108		4	170	24.78	88.14	168.14	80
27	Hydrogeology	MW-109	6671.81	4	156	135.99	6548	6518	
	Hydrogeology	MW-109		4	156	135.99	123.81	153.81	30
28	Hydrogeology	MW-110	6622.05	4	142	133.99	6522	6482	
	Hydrogeology	MW-110		4	142	137.41	100.05	140.05	40
29	Hydrogeology	MW-111	6643.56	4	125.85	91.99	6569	6519	
	Hydrogeology	MW-111		4	125.85	91.99	74.56	124.56	50
30	Hydrogeology	MW-112	6534.56	4	141.8	44.79	6499	6394	
	Hydrogeology	MW-112		4	141.8	44.79	35.56	140.56	105
31	Hydrogeology	MW-113	6565.93	4	104.45	67.94	6508	6463	
	Hydrogeology	MW-113		4	104.45	67.94	57.93	102.93	45
32	Hydrogeology	MW-114	6553	4	199	57.49	6505	6355	
	Hydrogeology	MW-114		4	199	57.49	48	198	150
33	Hydrogeology	MW-115S	6576.36	4	126.9	75.31	6516	6451	
	Hydrogeology	MW-115S		4	126.9	75.31	60.36	125.36	65
34	Hydrogeology	MW-115M	6576.05	4	217	75.37	6451	6361	
	Hydrogeology	MW-115M		4	217	75.37	125.05	215.05	90
35	Hydrogeology	MW-116	6575.97	4	124	84.8	6474	6454	

TABLE 1. MONITORING WELL LIST, OCTOBER 2015
RIO ALGOM MINING LLC, LISBON FACILITY

No.	Well Status	Well I.D.	Ground Elevation (ft amsl)	Well Dia. (inches)	TD (ft btoc)	DTW (ft btoc)	Top Screen (ft btoc)	Base Screen (ft btoc)	Screen Length (ft)
	Hydrogeology	MW-116		4	124	84.8	101.97	121.97	20
36	Hydrogeology	MW-116	6575.97	4	124	84.8	6474	6454	
	Hydrogeology	MW-116		4	124	84.8	101.97	121.97	20
37	Hydrogeology	MW-117S	6584.63	4	126.7	82.25	6514	6459	
	Hydrogeology	MW-117S		4	126.7	82.25	70.63	125.63	55
38	Hydrogeology	MW-117M	6585.13	4	151.4	82.65	6461	6436	
	Hydrogeology	MW-117M		4	151.4	82.65	124.13	149.13	25
39	Hydrogeology	MW-118	6463.98	4	66.4	15.02	6454	6399	
	Hydrogeology	MW-118		4	66.4	15.02	9.98	64.98	55
40	Hydrogeology	MW-119	6588.13	4	90	70.19	6535	6515	
	Hydrogeology	MW-119		4	90	70.19	53.13	73.13	20
41	Hydrogeology	MW-120	6675.34	4	246.9	125.83	6560	6430	
	Hydrogeology	MW-120		4	246.9	125.83	115.34	245.34	130
42	Hydrogeology	MW-121	6593.27	4	201.85	198.49	6422	6392	
	Hydrogeology	MW-121		4	201.85	198.49	171.27	201.27	30
43	Hydrogeology	MW-122	6926.584	4	203	197.15	6770.584	6730.584	
	Hydrogeology	MW-122		4	203	197.15	156	196	40

TABLE 2. REGULATORY CONCENTRATION LIMITS FOR COMPLIANCE MONITORING WELLS
RIO ALGOM MINING LLC, LISBON FACILITY

WELL NAME	WELL DESIGNATION	ACTION LEVEL	REGULATORY CONCENTRATION LIMIT (mg/L)			
			Uranium	Arsenic	Selenium	Molybdenum
OW-UT-9	Point of Compliance	Alternate Concentration Limit	101.58	2.63	0.1	58.43
EF-3A	Point of Compliance	Alternate Concentration Limit	96.87	3.06	0.93	23.34
RL-4	Point of Exposure	Compliance	0.32	---	---	---
RL-5	Point of Exposure	Compliance	0.32	---	---	---
RL-6	Point of Exposure	Compliance	0.32	---	---	---
RL-1	Trend	Target Action Level	42.1	---	---	---
RL-3	Trend	Target Action Level	37.3	---	---	---
EF-6	Trend	Target Action Level	3.9	---	---	---
EF-8	Trend	Target Action Level	0.3	---	---	---
ML-1	Trend	Target Action Level	0.26	---	---	---
H-63	Trend	Target Action Level	0.06	---	---	---
LW-1	Trend	Target Action Level	0.028	---	---	---
MW-5	Background	Background	0.01	0.05	0.01	0.07
MW-13	Background	Background	0.02	0.066	0.01	0.05

Notes:
mg/L = milligrams per liter
--- = not applicable

TABLE 3. GROUNDWATER MONITORING ANALYTICAL METHODS
RIO ALGOM MINING LLC, LISBON FACILITY

PARAMETER	ANALYTICAL METHOD	LABORATORY REPORTING LIMIT (mg/L)	HOLDING TIME	CONTAINER AND SIZE	PRESERVATION METHOD
PRIMARY ANALYSES (REQUIRED)					
Uranium (dissolved)	EPA 200.7_8	0.0003	6 months	Plastic-250 mL	Field filter (0.45 micron) add nitric acid (HNO3) to pH<2, cool, <6oC
Arsenic (dissolved)	EPA 200.7_8	0.001	6 months		
Molybdenum (dissolved)	EPA 200.7_8	0.001	6 months		
Selenium (dissolved)	EPA 200.7_8	0.001	6 months		
Aluminum (dissolved)	EPA 200.7_8	0.100	6 months		
Copper (dissolved)	EPA 200.7_8	0.010	6 months		
Cadmium (dissolved)	EPA 200.7_8	0.010	6 months		
Zinc (dissolved)	EPA 200.7_8	0.010	6 months		
Chloride	EPA 300.0	1	28 days	Plastic-500 mL	Cool, <6^{o}C
Sulfate	EPA 300.0	1	28 days		
Bicarbonate, as $CaCO_3$	SM A2320 B	5	28 days		
Total Dissolved Solids	SM A2540 C	10	7 days		
Alkalinity	A2320B	5			
pH	SM A4500-H B	0.01	15 minutes[a]		
SUPPLEMENTAL ANALYSES (OPTIONAL)					
Calcium (dissolved)	EPA 200.7_8	1	6 months	Plastic-250 mL	Field filter (0.45 micron) add nitric acid (HNO_3) to pH<2, cool, <6^{o}C
Magnesium (dissolved)	EPA 200.7_8	1	6 months		
Potassium (dissolved)	EPA 200.7_8	1	6 months		
Sodium (dissolved)	EPA 200.7_8	1	6 months		
Iron (dissolved)	EPA 200.7_8	0.03	6 months		
Carbonate, as CO_3	SM A2320 B	5.00	28 days	Plastic-500 mL	Cool, <6^{o}C
Specific Conductance	SM A2510 B	5.00	28 days		

Notes:

[a] pH is measured in the field at the time of sample collection and checked in the laboratory.
mg/L = milligrams per liter
mL = milliliter
MW-116: filter with 0.45-micron and 0.1 micron filters (two samples)

ILLUSTRATION

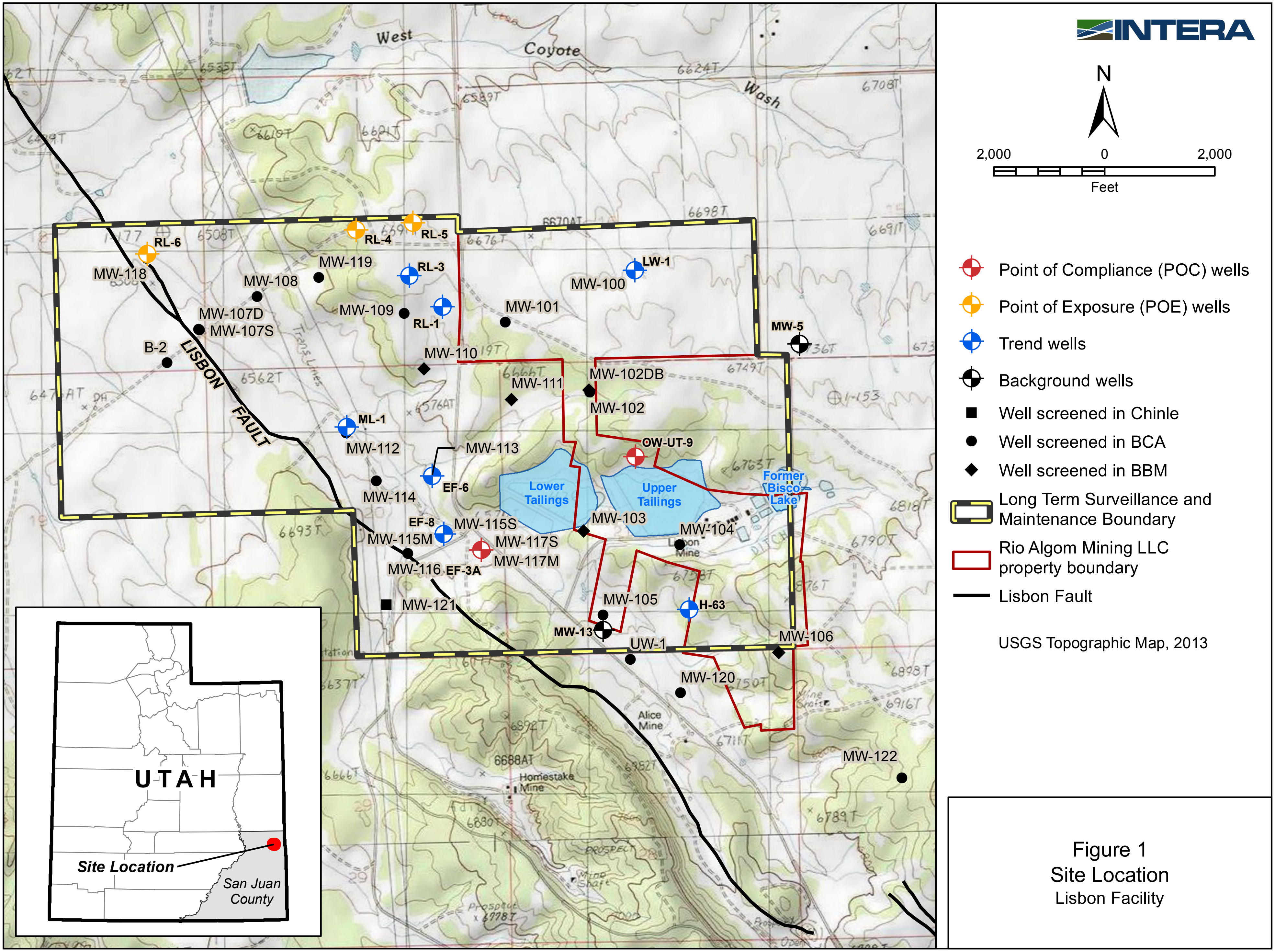

Figure 1
Site Location
Lisbon Facility

FILE: S:\Projects\Rio_Lisbon_SupplmentalSiteCharacterization\Graphics\GIS\MapDocs\Wells_INTERA_2015\Fig01_LocationMap.mxd 9/29/2015

ATTACHMENT 1

STANDARD OPERATING PROCEDURES
FOR GROUNDWATER MONITORING, ALL WELLS
LISBON, UTAH

TABLE OF CONTENTS

STANDARD OPERATING PROCEDURES FOR GROUNDWATER MONITORING, LICENSE COMPLIANCE AND HYDROGEOLOGY STUDY WELLS AT THE RIO ALGOM MINING LLC, LISBON FACILITY

1.0 SCOPE AND APPLICABILITY

The following sections describe standard operating procedures (SOPs) for measurement of water levels in wells and for collection of water quality samples from wells at the Rio Algom Mining, LLC Lisbon facility (RAML) in Lisbon, Utah.

The SOPs apply to groundwater sampling activities at the 14 wells designated as “license compliance wells” and the 28 “hydrogeology study wells.” Sampling methods for the 14 license wells have be documented in the Groundwater Monitoring Plan (GMP) prepared by RAML dated July 31, 2015 and approved by the Utah Division of Waste Management and Radiation Control (DWMRC) in a letter dated August 19, 2015. Sampling methods for the additional 28 hydrogeology study wells will be identical to those used for the license wells (low-flow sampling and potentially the volume-based standard purge method) with the addition of a method for sampling low-permeability formation wells, as described in U.S. Environmental Protection Agency (EPA) and United States Geological Survey (USGS) sampling literature (Yeskis and Zavala, 2002 and Wilde, 2006). SOPs for water level monitoring and low-flow sampling, volume-based purge and sampling, and low-permeability formation well sampling are described in the following sections.

2.0 GENERAL CONSIDERATIONS

Potential hazards associated with the planned tasks shall be thoroughly evaluated prior to conducting field activities. The site-specific Health and Safety Plan (HASP) for the RAML facility provides a description of potential hazards and associated safety and control measures.

Field personnel must wear powder-free nitrile gloves while performing the procedures described in this SOP. Specifically, powder-free nitrile gloves must be worn while measuring water levels, preparing sample bottles, preparing and decontaminating sampling equipment, collecting samples, and packing samples. At a minimum, nitrile gloves must be changed prior to the collection of each sample, or as necessary to prevent the possibility of cross-contamination with the sample, the sample bottles, or the sampling equipment.

Field sampling equipment shall be decontaminated prior to each use. Although water level measurement and sampling should typically be conducted from least to most impacted location, field logistics may necessitate other sample collection priorities. When sampling does not proceed from least to most impacted location, extra precautions must be taken to ensure that appropriate levels of decontamination are achieved.

3.0 WATER LEVEL MEASURMENT PROCEDURES

Water levels will be measured in wells prior to sampling. Construction details and any previous measurements for each well will be reviewed by the field staff before obtaining measurements.

3.1 Materials and Equipment

The following equipment is needed to measure water levels and well depth. All equipment which comes in contact with the well should be decontaminated prior to commencing field activities.

- Records of well construction details and previous measurements
- Electronic water level indicator with accuracy of 0.01 feet
- Field log or data sheet
- Weighted tape graduated to the nearest 0.01 feet

3.2 Measuring Point

Well depth and water level measurements will be referenced from a measuring point, established and marked at the top of the inner casing of each monitoring well. Generally, this point will be on the north side of the top of the casing. The measuring point is permanently marked using an indelible marker or a notch cut into the casing. A licensed surveyor has surveyed the measuring point elevation of each monitoring well and referenced measurements to the local datum for location and elevation.

3.3 Water Level Measurements

Manual water level measurements will be obtained from wells with an electronic water level indicator prior to sampling. The SOP for measuring water levels with an electronic water level indicator is as follows:

1. Open the protective outer cover of the monitoring well and remove any debris that has accumulated around the riser near the well plug. If water is present above the top of the riser and well plug, remove the water prior to opening the well plug. Do not open the well until the water above the well head has been removed.
2. Allow well to equilibrate for at least 5 minutes before measuring the water level.
3. Using an electronic water level indicator accurate to 0.01 feet, determine the distance between the established measuring point and the surface of the standing water present in the well. Repeat as necessary until two successive readings agree to within 0.01 feet. Record date and time of each water level measurement and the serial number of the water level indicator used.
4. Measure the well total depth and record.
5. Decontaminate the water level indicator in preparation for next use.

The accuracy of electronic water level indicators may be verified at least annually as part of routine maintenance. The entire length of the graduated tape/cable will be compared to a steel surveyor's tape of the same or greater length to determine accuracy at 100-foot increments. Water level indicators will be checked more frequently if there is reason to suspect the tape/cable was stretched during field operations.

4.0 GROUNDWATER SAMPLE COLLECTION PROCEDURES

SOPs for purge and sample methods are described below.

4.1 Materials and Equipment

The following equipment is needed to collect groundwater samples from wells. All equipment which comes in contact with the well should be decontaminated prior to commencing field activities.

General Materials and Equipment:

- Monitoring instruction sheet for each site
- Field logbook
- Field sampling data sheets (FSDS)
- Site maps
- Health & Safety Plan

- Indelible black-ink pens and markers
- Sample labels
- Chain-of-custody forms
- Custody seals
- Shipping labels
- Water level meter
- pH/conductivity/temperature/ORP meter, turbidity meter, and dissolved oxygen meter
- Field test kits for ferrous iron, ferric iron, dissolved oxygen, etc.
- Insulated cooler(s)
- Laboratory-supplied sample containers
- Sample preservative (i.e. acid, base, etc.)
- Ice
- Decontamination equipment: Liquinox or similar, and jugs for potable water

Equipment for Low-Flow and Standard Purge Sampling:

- Variable rate electric submersible pump and controller and/or air- or gas-driven bladder pump
- Portable generator
- Flow-through cell
- Disposable discharge tubing

4.2 Low Flow Sample Method

U.S. EPA (2007) recommends the use of adjustable-rate bladder and electric submersible pumps during low-flow purging and sampling activities. The following SOPs assume that a non-dedicated electric variable rate submersible pump will be used to purge and sample wells by the low flow method. The following procedures are used for low flow sampling and based on the ASTM Standard Practice (2002):

4.2.1 Purging

1. Prepare sampling equipment including calibration of field meters prior to use.

2. Measure and record the depth to water to the nearest 0.01 feet as described above. Using the specific details of well construction and current water-level measurement, determine the pump set depth, typically the mid-point of the saturated well screen or other target sample collection depth adjacent to specific high-yield zones. If disposable tubing is to be used, cut appropriate length of disposable tubing from roll and attach to pump.
3. Remove the decontaminated pump from the pump holder and rinse the pump off with water. Slowly lower the pump into the well to the target depth. Record the depth of the pump intake after lowering the pump into the location of highest permeable zone, or mid-point of screen if there are no distinct lithologic units within the screened interval based on the geologic log for the well.
4. Connect the cable for the control box to the pump reel. Start the generator. Make sure the generator is kept downwind from the sampling system.
5. Connect the discharge tubing from the pump to the base of the flow-through cell. Place the probes for the calibrated field meters into the flow-through box. Attach small section of discharge tubing to the top of the flow-through cell and place end of hose into bucket to catch purge water.
6. Place water level probe in well and record static water level on the FSDS.
7. If the well has been previously sampled using low-flow purging and sampling methods, begin purging at the rate known to induce minimal drawdown. Frequently check the drawdown rate to verify that minimum drawdown is being maintained. If sampling the well for the first time, begin purging the well at the minimum pumping rate of 100 milliliters per minute (mL/min) and slowly increase the pumping rate to no more than 500 mL/min. Monitor and record drawdown in well (if any). Record data on FSDS.
8. Adjust flow rate to minimize drawdown up to a maximum of 25% of the distance between the top of the screen and the pump intake (the 25% rule) (ASTM, 2002) (i.e., if the screen is 20 ft long and the pump intake is set in the middle of the screen, the distance from top of screen to pump intake is 10 ft, and 25% of 10 ft is 2.5 ft.) Note that the 25% rule in the ASTM guidance is conservative, and the ASTM guidance also states that the actual distance from top of screen to pump intake is an acceptable drawdown. (Note also that this criterion assumes that the starting water level is located above the top of the screen by a distance greater than the distance from top of screen to pump intake. If the water level is below the top of the screen, then all of the water is assumed to be representative of aquifer conditions.) In practice, water quality indicator parameter stabilization is the primary stabilization criteria. If drawdown occurs which

exceeds the recommended criteria, but parameters stabilize after the required number of measurements and time, then document the drawdown and proceed with sampling. Document the details of purging, including the purge start time, rate, and drawdown on the FSDS and in the field logbook.

9. Start recording field parameters on the FSDS sheet every three minutes. Purging should continue at a constant rate until the parameters stabilize. Stabilization is considered achieved when three sequential measurements are within the ranges listed below, based on ASTM (2002) and Utah Division of Waste Management and Radiation Control[1] (DRC, 2015) guidance:

• pH	± 0.1 standard units
• Specific Conductance	± 3%
• Temperature	± 3%
• ORP	± 10 millivolts
• Turbidity	± 10% (DRC, 2015)
• Dissolved Oxygen	± 10% (DRC, 2015)

4.2.2 Sampling

1. After specified parameters have stabilized, reduce flow rate on control box to approximately 100 mL/min.
2. Disconnect discharge tubing base of flow-through cell, being careful to contain water within the cell. Cut off approximately 0.5 feet from end of discharge tubing. Place a bucket beneath sampling tube to catch water.
3. Fill necessary sample bottles. Label sample bottles with a unique sample number, time and date of sampling, the initials of the sampler, and the requested analysis on the label. Additionally, provide information pertinent to the preservation materials or chemicals used in the sample. Record comments pertinent to the color and obvious odor. Record sampling information on FSDS sheet and in field logbook.
4. Fill all sample containers with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container. Immediately seal each sample and place the sample on ice in a cooler to maintain sample temperature preservation requirements. Fill bottles in the following order:
    - Metals, and Radionuclides
    - Filtered Metals and Radionuclides
    - Other water-quality parameters.

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[1] Formerly the Utah Division of Radiation Control (DRC).

5. Remove the pump from the well taking care that the tubing does not contact the ground while being retrieved. Decontaminate pump and tubing for next use.
6. Containerize and properly dispose of purge water and decontaminate water generated during sampling.

4.3 Volume Based (Standard Purge) Sample Method

If the low-flow purge criteria cannot be met, groundwater samples will be collected using the volume-based purge sampling method in accordance with procedures described in US EPA *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers* (Yeskis and Zavala, 2002) (DRC, 2015). The following SOPs assume that a non-dedicated electric variable rate submersible pump will be used to purge and sample wells by the volume-based method. The following procedures will be used for standard purge sampling:

4.3.1 Well Purging

1. Prepare sampling equipment including calibration of field meters prior to use.
2. Measure and record the depth to water to the nearest 0.01 feet as described above. Calculate a casing volume for the well based on the specific details of well construction, the current depth to water measurement, and casing diameter. For wells with multiple casing diameters, calculate the volume for each segment and use the sum of the values.
3. Remove the decontaminated pump from the pump holder and rinse the pump off with water. Slowly lower the pump into the well to the target depth. Set the pump immediately above the top of the well screen or 3 to 5 feet below the top of the water table. Lower the pump if the water level drops during purging. Record the depth of the pump intake after lowering the pump into location.
4. Connect the cable for the control box to the pump reel. Start the generator. Make sure the generator is kept downwind from the sampling system.
5. Purge the well until at least three casing volumes are removed. Maintain a purge rate so that recharge water is not entering the well in an agitated manner. Containerize all purge water.
6. Record field parameters periodically and after each casing volume is purged. Stabilization is considered achieved when three sequential measurements, collected three minutes apart, are within the ranges listed below:

pH	± 0.1 standard units
Specific Conductance	± 3%

• Temperature	± 3%
• ORP	± 10 millivolts
• Turbidity	± 10% (DRC, 2015)
• Dissolved Oxygen	± 10% (DRC, 2015)

If the indicator parameters have not stabilized after the removal of four casing volumes, field instruments will be recalibrated. If no problems are found, sampling can be conducted; however, the project manager will be notified and all information will be recorded in the field notebook and/or field purge record.

4.3.2 Sampling after Standard Purge

1. Collect samples within 2 hours of purging, if possible. It is acceptable to collect samples within 24 hours of purging.
2. Fill necessary sample bottles. Label sample bottles with a unique sample number, time and date of sampling, the initials of the sampler, and the requested analysis on the label. Additionally, provide information pertinent to the preservation materials or chemicals used in the sample. Record comments pertinent to the color and obvious odor. Record sampling information on FSDS sheet and in field logbook.
3. Fill all sample containers with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container. Immediately seal each sample and place the sample on ice in a cooler to maintain sample temperature preservation requirements.
4. Remove the pump from the well taking care that the tubing does not contact the ground while being retrieved. Decontaminate pump and tubing for next use.
5. Containerize and properly dispose of purge water and decon water generated during sampling.

4.4 Low Permeability Formation Sampling

The USGS recommends against sampling wells that pump dry or are slow to recover (Wilde, 2006). However, some wells on the Lisbon site and vicinity are known to be low-permeability formation wells, and sampling from these wells has been attempted in the past. The sampling method described in this SOP applies to wells completed in low-permeability formations that consequently do not readily recharge to the starting water level after purging. This SOP also applies to wells that contain so little water as to be difficult or impossible to purge and/or sample using standard pumping equipment, such as a bladder pump or an electric submersible pump (i.e., the wells contain only a few feet of water). EPA *Ground-Water Sampling*

Guidelines for Superfund and RCRA Project Managers (Yeskis and Zavala, 2002) provides guidance for sampling such wells:

> *. . . if a well has an open interval across the water table in a low permeability zone, there may be no way to avoid pumping and/or bailing a well dry (especially in those cases with four feet of water or less in a well and at a depth to water greater than 20 to 25 feet (which is the practical limit of a peristaltic pump)). In these cases, the well may be purged dry. The sample should be taken no sooner than two hours after purging and after a sufficient volume of water for a water-quality sample, or sufficient recovery (commonly 90%) is present (Herzog et al., 1988). (Yeskis and Zavala, 2002, p. 9)*

Purging such a well dry may be accomplished using any method available, including bailing, according to EPA. The maxim time allowable to achieve recovery to 90% of the starting water level is not provided in the EPA guidance, but is provided by the USGS, as follows:

> *After purging, the water level in the well should recover to approximately 90 percent of its starting water level before sampling should commence. In low-yield wells this can take several hours or longer, requiring potentially multi-day visits to complete a three-well-volume purge. The longer the recovery time, the lower the confidence that the samples to be collected can be considered representative of ambient aquifer water composition.*
>
> *RULE OF THUMB*
>
> *Do not sample wells at which recovery of water level after purging to 90 percent exceeds 24 hours. (Wilde, 2006, p. 94)*

Attempt the purge and sampling procedures as described in the following subsections.

4.4.1 Well Purging

1. Based on the above guidance, wells identified from past performance as low-permeability formation wells will be purged dry on a given sampling day.
2. The well will be checked 24 hours later to determine if the water level has recovered to at least 90% of its starting water level.
3. If the well has not recovered to 90% of its starting water level after a maximum of 24 hours, then the well will be identified as a well that should not be sampled under EPA and USGS guidance and that well will be recommended as a non-sampling well. The water level, if any, in the well, should still be gauged as part of the groundwater monitoring program.

4. If the water level has recovered to 90 percent or greater of the starting water level and sufficient water is available to fill the required sample containers, the well will be sampled using a bladder pump, electric submersible pump, or a bailer, with preference for the pumps as opposed to the bailer. (See below for sampling procedure).

5. If the well is sampled with a bailer, discharge the bailed sample into a separate container and collect one series of water quality indicator parameters. These parameters will be considered representative of aquifer conditions because all of the water present in the well has flowed into the well within the past 24 hours.

6. If the well is sampled with a pump, and sufficient water is available to use a flow-through cell, then record the water quality indicator parameters as shown below, to the extent that sufficient water is available to do so. If the quantity is limited, then record one measurement of each parameter and proceed to sample.

7. Stabilization is considered achieved when three sequential measurements are within the ranges listed below:

• pH	± 0.1 standard units
• Specific Conductance	± 3%
• Temperature	± 3%
• ORP	± 10 millivolts
• Turbidity	± 10% (DRC, 2015)
• Dissolved Oxygen	± 10% (DRC, 2015)

4.4.2 Sampling after Purge

1. Collect samples within 2 hours of purging, if possible. It is acceptable to collect samples within 24 hours of purging.

2. If not using a pump and flow-through cell, discharge the bailed sample directly into the sample container (if filtering is not required), or into a separate clean container such as a bucket or cubitainer, and transfer the water from that container to the sample bottles using a peristaltic pump (filtering, as needed).

3. Fill necessary sample bottles. Label sample bottles with a unique sample number, time and date of sampling, the initials of the sampler, and the requested analysis on the label. Additionally, provide information pertinent to the preservation materials or chemicals used in the sample. Record comments pertinent to the color and obvious odor. Record sampling information on the field sampling data sheet and in the field logbook.

4. Fill all sample containers with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container. Immediately seal each sample

and place the sample on ice in a cooler to maintain sample temperature preservation requirements.

5. Remove the pump from the well taking care that the tubing does not contact the ground while being retrieved. Decontaminate the pump and tubing for the next use.
6. Containerize and properly dispose of purge water and decontamination water generated during sampling.

4.4.3 Field Testing

Field test kits for specific constituent valence and concentration may be used. For example, ferrous and ferric iron, or dissolved oxygen, etc., may be requested.

Follow directions on the test kit package and record the results on the field form.

5.0 SELECT REFERENCES

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ATTACHMENT 2

QUALITY ASSURANCE PLAN

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ATTACHMENT 2

GROUNDWATER MONITORING QUALITY ASSURANCE PLAN
RIO ALGOM MINING LLC, LISBON FACILITY

1.0 INTRODUCTION

Rio Algom Mining LLC (RAML) and its contractors have prepared this data acquisition Quality Assurance Plan (QAP) for groundwater monitoring conducted at the Lisbon Facility (Site) located near La Sal, Utah. The QAP presents, in specific terms, the policies, organization, functions, and quality assurance/quality control (QA/QC) requirements designed to achieve the data quality goals described in the Groundwater Monitoring Plan, Version 2.0 (GMP) (RAML, 2015). The QAP was prepared in accordance with guidelines established in United States Environmental Protection Agency (U.S. EPA) publications, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document* (September 1986), and *RCRA Ground-Water Monitoring: Draft Technical Guidance* (November 1992).

1.1 BACKGROUND

Uranium mining and milling occurred at the Site from 1972 to 1989. Seepage from two tailings impoundments constructed during mining impacted groundwater at the Site. Interim and formal groundwater corrective action programs (CAPs) were implemented at the Site from the early 1980s through 2003 to minimize the impact of tailings water seepage on groundwater quality.

In 2003, an application for Alternate Concentration Limits (ACLs) was prepared by RAML and approved by the U.S. Nuclear Regulatory Commission (NRC). The approved ACL application established groundwater compliance concentrations and resulted in a long-term monitoring remedy for the Site. Groundwater compliance monitoring began at the Site in 2004 in accordance with the Long Term Groundwater Monitoring Plan (LTGMP) (KOMEX, 2004).

Currently, all Site activities are conducted in accordance with Utah Division of Waste Management and Radiation Control (DWMRC) [1] Radioactive Materials License No. UT1900481, Amendment No. 5 (License) (DRC, 2014). Among other specifications, the License specifies groundwater compliance concentrations, monitoring and reporting requirements, and identifies the following constituents of concern (COCs) for groundwater: uranium, molybdenum, selenium, and arsenic. The License also requires groundwater monitoring for pH, total dissolved solids (TDS), chloride, sulfate, bicarbonate, and groundwater elevation.

1.2 GROUNDWATER MONITORING PROGRAM

Groundwater monitoring is currently conducted at the Site to meet the requirements of the License or other objectives. Depth to water measurements and groundwater samples are obtained from monitor wells, in accordance with the License or other monitoring requirements. The monitoring program is described in detail in the GMP.

1.3 PURPOSE AND OBJECTIVE

The QAP establishes the sampling and analytical protocols and documentation requirements to ensure the groundwater monitoring data are collected, reviewed, and analyzed in a consistent manner. The QAP includes data quality objectives for data measurement, sampling procedures, sample and document custody procedures, laboratory analytical

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[1] Formerly the Utah Division of Radiation Control (DRC).

methods, internal quality control checks, data validation and reporting procedures, and corrective action procedures.

The QAP has been prepared for use by contractors who perform environmental services to ensure the data are scientifically valid and defensible. Compliance with this QAP is required for all staff participating in the monitoring program. The QAP shall be in the possession of the field team during all field activities. RAML and its subcontractors shall be required to comply with the procedures documented in this QAP in order to maintain comparability and representativeness of the data produced.

2.0 PROJECT ORGANIZATION

This QAP specifies roles for the Project Director, the QA Manager, and QC Monitors. The roles and responsibilities of these representatives and the project organization are described below.

2.1 PROJECT ROLES AND RESPONSIBILITY

2.1.1 Project Director

A representative of RAML will serve as project director. The project director oversees all Site activities and coordinates directly with regulatory authorities.

2.1.2 Quality Assurance Manager

The QA Manager is responsible for ensuring that the QA/QC protocols are properly employed. The QA Manager can be employed by RAML or its contractor. Typically, the QA Manager is not directly involved in the data generation (i.e., sampling or analysis) activities. The QA Manager is responsible for oversight of all aspects of QA/QC, including:

- Ensuring that the data generated during the monitoring program meet the specifications of the QAP;
- Auditing and reviewing QA/QC procedures; and
- Determining corrective measures when deviations from the QAP occur.

2.1.3 QC Monitors

The individuals who conduct field sampling activities and perform analyses in the laboratory are considered QC monitors. The responsibilities of field and laboratory personnel are described below.

Sampling QC Monitors

The Sampling QC Monitors are trained personnel qualified to perform all field sampling activities in accordance with this QAP. Sampling QC monitors also include support staff responsible for data processing and database management. The Sampling QC Monitors are responsible for the following:

- Ensuring that samples are collected, preserved, and transported as specified in the QAP;
- Checking that all sample documentation (labels, field data worksheets, chain-of-custody records,) is correct and transmitting that information, along with the samples, to the analytical laboratory in accordance with the QAP;
- Maintaining records of all samples, tracking those samples through subsequent processing and analysis, and, ultimately, where applicable, appropriately disposing of those samples at the conclusion of the program;
- Collecting quality control samples during the sampling event;
- Preparing QC and sample data for review by the QA Manager; and
- Preparing QC and sample data for reporting and entry into a computerized database, where appropriate.

Laboratory QC Monitors

Laboratory analysis QA/QC will be conducted by Laboratory QC Monitors employed by the contract analytical laboratory, in accordance with specific requirements of the laboratory's internal program. The Laboratory QC Monitors are responsible for the following:

- Training and qualifying personnel in specified QC and analytical procedures, prior to receiving samples;
- Receiving samples from the field and verifying that incoming samples correspond to the packing list or chain-of-custody sheet; and
- Verifying that QC and analytical procedures are being followed as specified in this QAP, by the internal QA/QC program, and in accordance with the requirements for maintaining National Environmental Laboratory Accreditation Program ("NELAP") certification.

2.2 PROJECT PERSONNEL

Project personnel who contribute to data acquisition and/or are responsible implementing QA/QC protocols are presented in **Table B-1**. If changes to project personnel are made, **Table B-1** will be updated and will be available to Utah DWMRC personnel upon request.

Table B-1. Project Personnel

COMPANY	PERSONNEL	PROJECT ROLE
Rio Algom Mining, LLC	Theresa Ballaine	Project Director
INTERA, Inc.	Cynthia Ardito Randy Arthur Robert Sengebush	Project Manager; Quality Assurance Manager Geochemist QC Monitor
Confluence Environmental	Josh Kerns	Senior Field Technician; Sampling QC Monitor
Energy Laboratories	Stephanie Waldrop	Analytical Project Manager; Analysis QC Monitor
MP Environmental	Jenny Orr	Waste Management Transportation Supervisor

3.0 QUALITY OBJECTIVES AND CRITERIA

The overall quality assurance objective for this monitoring program is to develop and implement sampling, sample handling, and analytical procedures that will provide data to fulfill the Site Data Quality Objectives (DQOs). DQOs for the groundwater monitoring program and the criteria for data quality measurement are described in the following sections.

3.1 DATA CATEGORIES

The groundwater monitoring program utilizes two general categories of data: (1) field screening data and (2) definitive data. Data categories are described as follows:

Field Screening Data

Field screening data are qualitative or semi-qualitative data obtained by use of approved field equipment. Data are generated by rapid methods of analysis with less rigorous sample preparation, calibration, and/or QC requirements than are necessary to produce definitive data. Physical test methods, including water level measurements and pH, specific conductance, temperature, turbidity, oxidation reduction potential (ORP), and dissolved oxygen measurements have been designated by definition as field screening methods.

Definitive Data

Definitive data are quantitative and are produced under controlled conditions using laboratory-grade instrumentation. Data are generated using rigorous analytical methods, such as approved US EPA reference methods. These methods have standardized QC and documentation requirements. Definitive data are not restricted in their use unless quality problems require data qualification.

3.2 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements that specify the field and laboratory data quality necessary to support specific decisions or regulatory actions. DQOs dictate the data type, quality, quantity, and uses needed to make decisions and are the basis for designing data collection activities. The DQOs for field screening data and definitive data obtained during the groundwater monitoring program are described below.

Field Screening Data

1) Measure water level and field parameters to determine formation aquifer stability prior groundwater sampling.
2) Obtain groundwater elevation measurements to assess groundwater flow paths and calculate hydraulic gradients for analytical purposes.

Definitive Data

1) Obtain groundwater quality data to monitor compliance with currently established ACLs.
2) Assess the geochemical conditions in the Burro Canyon Formation Aquifer.
3) Determine the concentration and extent of COCs in groundwater.
4) Obtain groundwater quality data to refine the conceptual Site model (CSM), support groundwater modeling, and develop new ACLs for the Site.

3.3 DATA QUALITY INDICATORS

The effectiveness of the QAP is measured by the quality of the data generated in the field and by the laboratory. Data quality will be assessed in terms of its precision, accuracy, representativeness, comparability, and completeness.

Precision

Precision measures the reproducibility of measurements. Precision is defined as the measure of variability that exists between individual sample measurements of the same property under identical conditions. Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate (two) or replicate (more than two) analyses and measures variability introduced by both the laboratory and field operations. Field duplicate samples will be analyzed to assess field and analytical precision. Precision is expressed as the relative percent difference (RPD) of a data pair and will be calculated by the following equation:

$$\text{RPD} = [(A-B)/((A+B)/2)] \text{ x } 100$$

In the above equation, A (original) and B (duplicate) are the reported concentrations for field duplicate samples analyses or the percent recoveries for analytical laboratory matrix spike and matrix spike duplicate samples.

Accuracy

Accuracy is defined as a measure of bias in a system or as the degree of agreement between a measured value and a known value. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS to a control limit. Accuracy will be evaluated by the following equation:

$$\% \text{ Recovery} = (\left| A-B \right| /C) \text{ x } 100$$

Where:

A = the concentration of the analyte in a sample
B = the concentration of the analyte in an unspiked sample
C = the concentration of spike introduced

Representativeness

Representativeness is defined as the degree to which a set of data accurately represents the characteristics of a population, parameter, conditions at a sampling point, or an environmental condition. Representativeness is determined by appropriate program design, and shall be achieved through use of the field, sampling, and analytical procedures outlined in this QAP.

Completeness

Completeness is defined as the percentage of valid data relative to the total number of measurements. Laboratory completeness is a measure of the number of samples submitted for analysis compared to the number of analyses found acceptable after review of the analytical data. Completeness for this project will be calculated using the following equation:

Completeness = (Number of valid data points/total number of measurements) x 100

Where the number of valid data points is the total number of valid analytical measurements based on the precision, accuracy, and holding time evaluation. Project completeness is determined at the conclusion of the data validation. The goal for data completeness is 100 percent for compliance-required analyses.

Comparability

Comparability is the confidence with which one data set can be compared to another data set. The objective for this QA/QC program is to produce data with the greatest possible degree of comparability. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions, and using standard and comprehensive reporting formats. Complete field documentation using standardized data collection forms shall support the assessment of comparability.

4.0 GROUNDWATER SAMPLING PROCEDURES

The procedures to be utilized during the collection of groundwater samples from existing monitoring wells are described in detail in Table 3 and Appendix D of the GMP. Table 3 shows the purge and sampling method designated as LF (low-flow). Appendix D provides Standard Operating Procedures (SOPs) for the low-flow sampling method. The following sections provide procedures specifically related to QA/AC protocols.

4.1 GROUNDWATER SAMPLING

4.1.1 Field Instrument Calibration

At the beginning of each day of sampling, the Sampling QC Monitor will inspect and calibrate field instruments following manufacturer's recommended procedures. Meters will be calibrated using known, standard solutions. Calibration procedures, date, and time will be recorded on field instrument calibration data sheets. Back-up instruments will be available in case of malfunction. Instrument maintenance will be performed as deemed appropriate by the manufacturer.

4.1.2 Sample Designation and Labeling

All groundwater samples collected from monitoring wells, including duplicate samples, will be given a unique blind 4-digit sample identifier. Sample identifiers will be recorded on field sampling data sheets. Sample containers will be labeled with the sample identifier, data and time of sampling, and sampler’s initials.

4.1.3 Sample Volumes, Containers, and Preservation

At a minimum, samples will be analyzed for dissolved uranium, molybdenum, selenium, and arsenic by US EPA Method 200.8, for TDS by standard method A2540 C, for chloride and sulfate by US EPA Method 300.0, for bicarbonate as HCO_3 by standard method A2320 B, and pH by standard method A4500-HB. In addition to the required analyses, samples may also be analyzed for calcium, magnesium, potassium, and sodium by US EPA Method 200.7, carbonate as CO_3 by standard method A2320 B, and specific conductance by standard method A2510 B. Standard methods for required analyses are summarized in **Table B-2**. Other analyses may be conducted for characterization purposes.

Sample volumes, container types, and preservation requirements for the analytical methods specified in the GMP are listed in **Table B-2**. The sample containers will be prepared and provided by the analytical laboratory. The type and size of container used for each parameter and the type of preservative added, if any, will be recorded on the field sampling data sheets (FSDSs). Sample containers will be placed in an iced cooler immediately after sample collection. The sample containers will be kept closed, maintained under custody, and refrigerated until analysis. Maximum holding times from the time of sample collection until sample analysis are provided in **Table B-2**.

Table B-2. Analytical Methods and Sampling Requirements

PARAMETER	ANALYTICAL METHOD	LABORATORY REPORTING LIMIT (mg/L)	HOLDING TIME	CONTAINER AND SIZE	PRESERVATION METHOD
PRIMARY ANALYSES (REQUIRED)					
Uranium (dissolved)	EPA 200.7_8	0.0003	6 months	Plastic-250 mL	Field filter (0.45 micron) add nitric acid (HNO3) to pH<2, cool, <6oC
Arsenic (dissolved)	EPA 200.7_8	0.001	6 months		
Molybdenum (dissolved)	EPA 200.7_8	0.001	6 months		
Selenium (dissolved)	EPA 200.7_8	0.001	6 months		
Aluminum (dissolved)	EPA 200.7_8	0.100	6 months		
Copper (dissolved)	EPA 200.7_8	0.010	6 months		
Cadmium (dissolved)	EPA 200.7_8	0.010	6 months		
Zinc (dissolved)	EPA 200.7_8	0.010	6 months		
Chloride	EPA 300.0	1	28 days	Plastic-500 mL	Cool, <6^{o}C
Sulfate	EPA 300.0	1	28 days		
Bicarbonate, as $CaCO_3$	SM A2320 B	5	28 days		
Total Dissolved Solids	SM A2540 C	10	7 days		
Alkalinity	A2320B	5			
pH	SM A4500-H B	0.01	15 minutes[a]		
SUPPLEMENTAL ANALYSES (OPTIONAL)					
Calcium (dissolved)	EPA 200.7_8	1	6 months	Plastic-250 mL	Field filter (0.45 micron) add nitric acid (HNO_3) to pH<2, cool, <6^{o}C
Magnesium (dissolved)	EPA 200.7_8	1	6 months		
Potassium (dissolved)	EPA 200.7_8	1	6 months		
Sodium (dissolved)	EPA 200.7_8	1	6 months		
Iron (dissolved)	EPA 200.7_8	0.03	6 months		
Carbonate, as CO_3	SM A2320 B	5.00	28 days	Plastic-500 mL	Cool, <6^{o}C
Specific Conductance	SM A2510 B	5.00	28 days		

Notes:

[a] pH is measured in the field at the time of sample collection and checked in the laboratory.

mg/L = milligrams per liter

mL = milliliter

MW-116: filter with 0.45-micron and 0.1 micron filters (two samples)

4.1.4 Sample Handling and Custody

At the end of each sampling day and before samples are transferred off site, sample information will be documented on the Chain-of-Custody/Laboratory Analysis Request form. Once samples are collected, they will remain in the custody of the sampler or other authorized personnel, until shipped to the laboratory. Upon transfer of sample possession to subsequent custodians, the persons transferring custody will sign the chain-of-custody form. During transport, the chain-of-custody form will be placed in a resealable plastic bag and accompany each sample cooler to the laboratory. Signed and dated chain-of-custody seals will be placed on coolers prior to shipping. When the samples are received at the laboratory, the custody seal on the shipping container will be broken and the condition of the samples recorded by the laboratory custodian. Chain-of-custody records will be included in the analytical report prepared by each laboratory.

Upon receipt of the samples, the laboratory will complete the chain-of-custody record. The condition of each sample container will be noted. The laboratory will also maintain a sample-tracking record that will follow each sample through the laboratory process. The sample-tracking record must show the dates of sample extraction or preparation, and sample

4.1.5 Packaging and Shipping

Samples will be shipped to the analytical laboratory by overnight delivery. Samples will be packaged and shipped using the following procedures:

- Sample containers will be placed in resealable plastic bags in a sealed, insulated cooler. A sufficient amount of ice will be placed around the samples.
- If used, glass bottles will be separated in the shipping container by shock-absorbent packaging material to prevent breakage.
- Sample shipments will be accompanied by a chain-of-custody/laboratory analysis request

form, which will be sealed in a plastic bag and placed inside each cooler.

4.2 QA/QC SAMPLES

Groundwater monitoring QA/QC samples will consist of duplicate samples, split samples, and equipment rinsate blanks. QA/QC samples will be clearly identified on the field sampling forms.

Duplicate Samples

A duplicate sample is a second sample collected at the same location as the original or primary sample. Duplicate sample results are used to assess precision of the sample collection process. Duplicate groundwater samples will be collected at a frequency of 10 percent of the total number of groundwater samples collected during an event. Specific locations will be designated for collection of duplicate samples prior to the beginning of sample collection. The duplicate samples will be collected at the same locations as the corresponding primary samples and will be collected simultaneously using identical sampling techniques. Duplicate samples will be treated in an identical manner as the primary samples during storage, transportation, and analysis. The duplicate sample containers will be assigned an identification number in the field so that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis.

Laboratory Split Samples

A split sample is a second sample collected at the same location as the original or primary sample, but submitted to a different laboratory. Laboratory split groundwater samples will be collected at a frequency of 5 percent of the total number of primary groundwater samples collected during an event. Specific locations will be designated for collection of split samples prior to the beginning of sample collection. Split samples will be collected at the same locations as the corresponding primary samples and will be collected simultaneously using identical sampling techniques. The split samples will be submitted for equivalent analysis as the primary sample.

Equipment Rinsate Blanks

An equipment rinsate blank is a sample of reagent-grade de-ionized water poured into or over or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis. Equipment blanks are used to assess the effectiveness of equipment decontamination procedures. Equipment rinsate blanks will be collected at a frequency of 5 percent of the total number of primary groundwater samples collected during an event. Equipment blanks shall be collected immediately after the equipment has been decontaminated. The blank shall be analyzed for the equivalent analysis as the primary samples. If an analyte is detected in the equipment blank, the appropriate validation flag shall be applied to all sample results from samples collected with the affected equipment.

4.3 FIELD DOCUMENTATION

All data generated as part of the groundwater monitoring program must be able to withstand challenges to their validity, accuracy, and legibility. To meet this objective, field data will be recorded in standardized formats and in accordance with prescribed procedures. Documentation of data collection activities must meet the following minimum requirements:

- Data must be entered directly, promptly, and legibly.
- Handwritten data must be recorded in ink. All original data records include, as appropriate, a description of the data collected, units of measurement, unique sample identification (ID) and station or location ID (if applicable), name (signature or initials) of the person collecting the data, and date of data collection.

- Any changes to the original data entry must not obscure the original entry. The reason for the change must be documented, and the change must be initialed and dated by the person making the change.

4.3.1 Field Sampling Data Sheets

Documentation of observations and data from sampling provide important information about the sampling process and provide a permanent record for sampling activities. All observations and field sampling data will be recorded on the FSDSs. FSDSs will include the following information:

- Name of the site/facility
- Description of sampling event
- Location of sample (well name)
- Sampler's name(s) and initials(s)
- Date(s) and time(s) of well purging and sample collection
- Type of well purging equipment used (pump or bailer)
- Depth to groundwater before sampling
- Field measurements (pH, specific conductance, water temperature, ORP, turbidity)
- Calculated well casing volume, if applicable
- Volume of water purged before sampling
- Volume of water purged when field parameters are measured
- Description of samples taken
- Sample handling, including filtration and preservation
- Types of sample containers and preservatives
- Weather conditions and external air temperature

The FSDSs will include notes describing any other significant factors observed during the sampling event, including, as applicable: condition of the well cap and lock; water appearance, color, odor, clarity; presence of debris or solids; any variances from this procedure; and any other relevant features or conditions.

4.3.2 Chain-of-Custody and Analytical Request Record

A Chain-of-Custody and Analytical Request Record form, provided by the analytical laboratory, will accompany the samples being shipped to the laboratory. A Chain-of-Custody shall be completed for each set of samples apportioned to a shipping container and shall include the following information:

- Sampler’s name
- Company name
- Date and time of collection
- Sample type (e.g., water)
- Sample location
- Number of sample containers in the shipping container
- Analyses requested
- Signatures of persons involved in the chain of possession
- Internal temperatures of the shipping container when opened at the laboratory
- Remarks section to identify potential hazards or to relay other information to the Analytical Laboratory.

5.0 LABORATORY ANALYTICAL PROCEDURES

All environmental analysis of groundwater samples will be performed by a contract analytical laboratory. The selected analytical laboratory is responsible for providing sample analyses for groundwater monitoring and for reviewing all analytical data to assure that data are valid and of sufficient quality.

5.1 ANALYTICAL LABORATORY REQUIREMENTS

The analytical laboratory will be chosen by RAML and must satisfy the following criteria: (1) certified by the State of Utah, (2) capable of performing the analytical methods set out in **Table B-2**, (3) experience in analyzing environmental samples with detail for precision and accuracy, and (4) operation of a stringent internal quality assurance and data validation program meeting NELAP certification requirements.

5.2 LABORATORY QUALITY CONTROL

All contract laboratories will conduct internal quality control for analytical services in accordance to NELAP standards. The purpose of the internal QA/QC program is to produce data of known quality that attain DQOs and that meet or exceed the requirements of the standard methods of analysis.

5.2.1 Method Detection Limits and Method Reporting Limits

Method Detection Limits

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The laboratory shall establish MDLs for each method and analyte for each instrument the laboratory plans to use for the project. The laboratory shall revalidate these MDLs at least once per 12-month period. The laboratory shall provide the MDL demonstrations upon request. Results less than or equal to the MDL shall be reported as the MDL value and flagged as not detected.

Method Reporting Limits

The analytical laboratory shall compare the results of the MDL demonstrations to the method reporting limits (MRLs) for each analytical method. The MDL may not be more than one-half the corresponding MRL. The laboratories shall also verify MRLs by including a standard at or below the MRL as the lowest point on the calibration curve.

5.2.2 Instrument Calibration

Analytical instruments shall be calibrated in accordance with the analytical methods. All analytes reported shall be present in the initial and continuing calibrations, and these calibrations shall meet the acceptance criteria. All results reported shall be within the calibration range. Records of standard preparation and instrument calibration shall be maintained and provided by the laboratory upon request. Records shall unambiguously trace the preparation of standards and their use in calibration and quantitation of sample results. Calibration standards shall be traceable to standard materials.

5.2.3 Quality Control Samples

Laboratory QC sample analysis shall be conducted to assess the accuracy, precision, and quality of the data. Laboratory QC samples shall be included in the preparation batch with the field samples. An analytical batch is a number of samples that are similar in composition and that are extracted or digested at the same time and with the same lot of reagents. The following procedures shall be performed at least once with each analytical batch of samples:

Matrix Spike/Matrix Spike Duplicate Samples

A matrix spike (MS) and matrix spike duplicate (MSD) is an aliquot of sample spiked with known concentrations for requested analytes. The spiking occurs prior to sample preparation and analysis. Each analyte in the MS and MSD shall be spiked at a level less than or equal to the midpoint of the calibration curve for each analyte. The matrix spike sample serves as a check evaluating the effect of the sample matrix on the accuracy of analysis. The matrix spike duplicate serves as check of the analytical precision. If either the MS or the MSD is outside the QC acceptance limits, the appropriate validation flag shall be applied to the analytes in all related samples.

Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank shall be carried through the complete sample preparation and analytical procedure and is used to document contamination resulting from the analytical process.

The presence of analytes in a method blank at concentrations equal to, or greater than, the MRL indicates a need for corrective action. Corrective action shall be performed to eliminate the source of contamination prior to proceeding with analysis. After the source of contamination has been eliminated, all samples in the analytical batch shall be reprepared and reanalyzed. No analytical data shall be corrected for the presence of analytes in blanks. When an analyte is detected in the method blank and in the associated samples and corrective actions are not performed or are ineffective, the appropriate validation flag shall be applied to the sample results.

Interference Check Sample

The interference check sample (ICS), used in inductively coupled plasma (ICP) analyses only, contains both interfering and analyte elements of known concentrations and is used to verify background and interelement correction factors.

When the ICS results are outside the acceptance limits stated in the method, corrective action shall be performed. After the system problems have been resolved and system control has been reestablished, reanalyze the ICS. If the ICS result is acceptable, reanalyze all affected samples. If corrective action is not performed or the corrective action was ineffective, the appropriate validation flag shall be applied to all affected results.

5.2.4 Quality Control Procedures

Holding Time Compliance

All sample preparation and analysis shall be completed within the method-required holding times. The holding time for a sample begins at the time of sample collection. The preparation holding time is calculated from the time of sample collection to the time of completion of the sample preparation process as described in the applicable method, prior to any necessary extract cleanup and/or volume reduction procedures. If no preparation (e.g., extraction) is required, the analysis holding time is calculated from the time of sample collection to the time of completion of all analytical runs, including dilutions, second column confirmations, and any required re-analyses. In methods requiring sample preparation prior to analysis, the analysis holding time is calculated from the time of preparation completion to the time of completion of all analytical runs, including dilutions, second column confirmations, and any required re-analyses. If holding times are exceeded and the analyses are performed, the results shall be flagged accordingly.

Standard Materials

Standard materials, including second source materials, used in calibration and to prepare samples shall be traceable to National Institute Standards and Technology (NIST), USEPA, American Association of Laboratory Accreditation (A2LA), or other equivalent approved source. Standard materials shall be current, and the following expiration policy shall be followed:

- The expiration dates for ampulated solutions shall not exceed the manufacturer's expiration date or one year from the date of receipt, whichever comes first.
- Expiration dates for laboratory-prepared stock and diluted standards shall be no later than the expiration date of the stock solution or material or the date calculated from the holding time allowed by the applicable analytical method, whichever comes first.
- Expiration dates for pure chemicals shall be established by the laboratory and be based on chemical stability, possibility of contamination, and environmental and storage conditions.
- Expired standard materials shall be either revalidated prior to use or discarded.
- The laboratory shall label standard and QC materials with expiration dates.

Supplies and Consumables

The laboratory shall inspect supplies and consumables prior to their use in analysis in accordance with NELAP standards and the laboratory's internal QA/QC program. The materials description in the methods of analysis shall be used as a guideline for establishing the acceptance criteria for these materials. An inventory and storage system for these materials shall assure use before manufacturers' expiration dates and storage under safe and chemically compatible conditions.

5.3 LABORATORY DOCUMENTATION

Documentation of all laboratory activities is critical for tracking data and evaluating data quality. The laboratory shall maintain written policies that define documentation requirements and procedures. Required documentation includes, but is not limited to, the following:

- Calibration and maintenance records for all instruments and equipment involved in the collection of environmental data;
- Preparation of calibration standards, spiking solutions, and dosing solutions such that each unique preparation can be tracked to the original material;
- Lot numbers for all standards, stock solutions, reagents, and solvents; and
- All sample processing or preparation for testing such that it is traceable to sample receipt records.

5.3.1 Laboratory Reports

A definitive data package shall be generated for each sampling event. The contracted laboratory's standard reporting format will be used and will include the following:

- All sample analyses and results of analyses. Any rejected data will be accompanied by explanations of the failure and the corrective action.
- The concentration, units, MDL, MRL, and any data qualifiers;
- The sample collection date, extraction date (if applicable), and analysis date;
- The field sample ID, laboratory sample ID, and the sample delivery group or analytical batch number; and
- All required QC data including detected concentrations, spike amounts (or concentrations), percent recoveries and the appropriate calculation of precision (relative percent difference [RPD], relative standard deviation [RSD]).

5.3.2 Electronic Data Deliverables

Analytical data will be submitted to the QC monitor and/or database manager in the form of an electronic data deliverable (EDD), in a uniform manner that meets the specified database requirements. Laboratory QC data shall be included in the data submission.

5.3.3 Record Keeping

The laboratory shall maintain electronic and hard copy records sufficient to recreate each analytical data package. The minimum records the laboratory shall keep contain the following:

- Chain-of-Custody forms;
- Initial and continuing calibration records including standards preparation traceable to the original material and lot number;
- Instrument tuning records (as applicable);
- Method blank results;
- Surrogate spiking records and results (as applicable);
- Spike and spike duplicate records and results;
- Laboratory records;
- Raw data including instrument printouts, bench work sheets, and/or chromatograms with compound identification and quantitation reports;
- Corrective action reports; and
- Laboratory-specific written SOPs for each analytical method and QA/QC function in place at the time of analysis of project samples.

5.4 DATA VERIFICATION, VALIDATION, AND REVIEW

The data verification, validation, and review procedures described in this section will ensure: (1) complete documentation is maintained, (2) transcription and data reduction errors are minimized, (3) the data are reviewed and documented, and (4) the reported results are qualified, if necessary. Laboratory data reduction and verification procedures are required to ensure the overall objectives of analysis and reporting meet method and project specifications.

5.4.1 Data Verification

The data verification process includes the initial review by the laboratory of the data packages to ensure that the analyses requested have been provided. Implementation of these procedures shall be defined in laboratory SOPs. The analyst performing the tests shall review 100 percent of the definitive data. After the analyst's review has been completed, 100 percent of the data shall be reviewed independently by a senior analyst (Laboratory QC Monitor) using the same criteria. Reviews must ensure the following:

- All data for project samples are reported accurately and completely;
- Sample analysis was conducted in accordance with required laboratory procedures and analytical methods; and
- Each data set is appropriately reviewed.

5.4.2 Data Validation

Data validation is the process of reviewing data and accepting, qualifying, or rejecting data on the basis of sound criteria using established U.S. EPA guidelines. Data are assessed for completeness and compliance with the requirements of the analytical methods. Validation by the laboratory will include a review of the following:

- Sample preparation information is correct and complete;

- Analysis information is correct and complete;
- Appropriate procedures were followed;
- Analytical results are correct and complete;
- QC samples are within established control limits;
- Blanks are within QC limits;
- Special sample preparation and analytical requirements have been met;
- Criteria for data quality have been met or deviations are documented in the package narrative and data flags have been appropriately applied; and
- Documentation is complete.

Each data package will include a comprehensive narrative detailing any QC exceedances and an explanation of qualifications of data results. Data qualification “flags” will be applied by the laboratory for data that do not meet quality criteria.

6.0 INTERNAL QUALITY CONTROL CHECKS AND PERFORMANCE AUDITS

The QA Manager will monitor the performance of the Sampling QC Monitors, and, to the extent practicable, the Laboratory QC Monitor to verify compliance with the QAP. In addition, the QA Manager and/or the Sampling QC Monitor will review and validate the analytical data generated by the laboratory to verify that it meets DQOs. Periodic system and performance audits may also be performed.

6.1 INTERNAL QC CHECK PROCEDURES

6.1.1 Duplicate, Split, and Blank Comparisons

Duplicate Samples

RPDs will be calculated to compare duplicate sample results to primary sample results. Non-conformance will occur if the RPD > 20%, unless the measured concentrations are less than five times the required detection limit. If non-conformance is observed, the QA Manager will determine if the deviation is indicative of a systematic issue which requires corrective action procedures described in **Section 7**. If the non-conformance appears to be an isolated incident, the QA Manager will:

- Notify the laboratory;
- Request the laboratory review all analytical results for transcription and calculation errors; and
- If the samples are within the holding time, the QA Manager may request the laboratory re-analyze the affected samples.

Equipment Rinsate Samples

The presence of analytes in an equipment rinsate blank will be considered a potential non-conformance condition. The QA Manager will determine if the non-conformance is indicative of a systematic issue which requires corrective action procedures described in Section 7. If the non-conformance appears to be an isolated incident, the QA Manager will:

- Notify the laboratory;
- Request the laboratory review all analytical results for transcription and calculation errors; and
- If the samples are within the holding time, the QA Manager may request the laboratory re-analyze the affected samples.

Split Samples

RPDs will be calculated to compare split sample results to primary sample results. Non-conformance will occur if the RPD > 20%, unless the measured concentrations are less than five times the required detection limits. If non-conformance is observed, the QA Manager will:

- Notify the laboratories;
- Request the laboratories review all analytical results for transcription and calculation errors; and
- If the samples are within the holding time, the QA Manager may request the laboratories re-analyze the affected samples.

6.1.2 Review of Laboratory Results and Procedures

Data review is conducted to assess the compliance of chemistry data with the DQOs defined in the QAP. Upon receipt of laboratory data packages, the QA Manager shall conduct a QA review including the following:

- Confirm that the analytical reports are complete, including all requested analyses, and results for each required constituent in each sample;
- Confirm that all reporting limits used by the laboratory are in conformance with the reporting limits presented in the GMP;
- Confirm that the analytical methods used by the laboratory are those specified in the GMP;
- Review the analytical reports to verify that the holding times for each method analysis were not exceeded; and
- Review the analytical reports to verify that the samples were received by the laboratory at a temperature no greater than the approved temperature specified in the GMP.

6.2 PERFORMANCE AUDITS

6.2.1 Field Program

The QA Manager, or a qualified person designated by the QA Manager or RAML, will conduct periodic internal audits of field activities. The audits will include inspection of field measurement records, field equipment calibration records, field sampling records, field instrument operation records, sample collection procedures, sample handling and shipping procedures, and chain-of-custody procedures. The audit will also include a check on the accuracy of data transfer from the laboratory records into the reporting spreadsheets.

Regulatory agencies may conduct external field audits. Field audits may be conducted at any time during the field operations and will be based upon the information presented in the QAP. The audits may or may not be announced at the discretion of the regulatory agencies.

6.2.2 Analytical Laboratory

All contract laboratories will conduct internal quality control for analytical services in accordance with NELAP standards. In-house and regulatory agency audits of laboratory systems and performance are a routine part of a laboratory QC program and shall be outlined in the laboratory's internal QA/QC plan. The audits consist of a review of the entire laboratory system and at a minimum, include examination of sample receiving; sample log-in; sample storage; sample chain-of-custody documentation procedures; sample preparation and analysis; and instrumentation procedures. The contract laboratory used for analysis of groundwater samples will be certified by the state of Utah for each parameter analyzed.

7.0 CORRECTIVE ACTIONS

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-quality-control performance that may affect the data quality. Corrective action should be taken for any procedural or systematic deficiencies or deviations noted in this QAP. All deviations from this QAP shall be documented in the applicable records and reported to the appropriate project management. Any corrective action that may have an impact on License conditions will be discussed with DWMRC prior to implementation. All proposed and implemented corrective action will be documented. If corrective actions are insufficient, the appropriate personnel may issue a stop work order until the problem can be resolved.

7.1 FIELD CORRECTIVE ACTION

During field activities, the field staff (Sampling QC Monitors) will be responsible for documenting and reporting all suspected technical and QA non-conformances and suspected deficiencies. The non-conformances and/or deficiencies will be documented and reported to the QA Manager. If the problem is associated with the field measurements or sampling equipment, the field staff will take the appropriate steps to correct the problem. Typical field procedures to correct problems include the following:

- Repeating the measurement to check for error.
- Making sure the meters or instruments are adjusted properly for the ambient conditions, such as temperature.
- Checking, recharging, or replacing batteries.
- Re-calibrating instruments.
- Replacing the meters or instruments used to measure field parameters.
- Stopping the work until the problem is corrected (if necessary).

If a non-conformance or problem requires a major adjustment to the field procedures as outlined in this QAP (e.g., changing sampling methodology), the RAML Project Director will notify DWMRC prior to initiating corrective actions. Modification to or replacement of the QAP to address major changes in field procedures will not occur without pre-approval by DWMRC.

7.2 LABORATORY CORRECTIVE ACTION

Corrective actions are required whenever unreliable analytical results prevent the quality control as specified by the method or the laboratory QAP from being met. The corrective action that is taken depends on the analysis and the non-conformance. NELAP provides an outline of the corrective actions that will be taken for problems associated with specific laboratory analyses. Corrective action will be taken if one of the following occurs:

- QC data are outside the acceptance criteria for precision and accuracy.
- Blanks contain contaminants above acceptance limits.
- Undesirable trends are detected in spike recoveries, or spike recoveries are outside the QC limits.
- There are unusual changes in detection limits.
- Inquiries concerning data quality are received from RAML.

Corrective actions are handled primarily at the bench level by the analyst who reviews the sample preparation or extraction procedures, performs the instrument calibration and analysis. If the problem persists or its cause cannot be identified, the matter will be referred to the department supervisor or QA department for further investigation. Once resolved, complete documentation of the corrective action procedure will be provided to the QA department. A summary of the corrective actions shall be included in the data package submitted to RAML. If further corrective actions are required to maintain compliance with

License requirements, DWMRC will be contacted for approval prior to implementation of the action.

7.3 DATA VALIDATION CORRECTIVE ACTION

Corrective actions may be initiated during data validation or data assessment. Potential corrective actions may include requesting re-sampling by the field team or reinjection/reanalysis of samples by the laboratory. These actions are dependent upon the ability to mobilize the field team, how critical the data are to the project data quality objectives, and if corrective action is required to maintain compliance with License conditions. When the QA Manager or QC Monitor identifies a corrective action situation, the RAML Project Director will be notified and has final responsibility for developing an implementation plan for the corrective action. The RAML Project Director will contact the DWMRC for approval of the corrective action implementation plan prior to its execution. Some examples of occurrences that would likely require corrective actions and pre-approval by the DWMRC are outlined below:

- Analytical detection limits or practical quantification limits are above the approved ACL as identified in the License.
- Analytical results are flagged due to a holding time violation.
- Analytical results are greater than an ACL and trigger accelerated monitoring as described in the License.

The first example would result in review of the laboratory contract and analytical procedure to confirm that the detection limit is below the License ACL. If this is not the case, then the laboratory would be contacted and requested to re-run the sample in compliance with the measurement protocol after approval by the DWMRC. Resampling might occur if re-analyzing was not possible within the required holding time.

In the second two examples, it may be appropriate to resample the well in question within a specified date, submit the sample for analysis within the correct holding time, and to evaluate the results with respect to ACLs. The specific corrective action would require pre-approval by the DWMRC and would be documented and submitted to the RAML Project Director and the DWMRC.

8.0 REFERENCES CITED

KOMEX, 2004, **Long Term Groundwater Monitoring Plan, Application for Alternative Concentration Limits, Source Materials License SUA-1119, RAMC Lisbon Facility, La Sal, Utah:** February 19, 2004.

Rio Algom Mining LLC (RAML), 2015, **Groundwater Monitoring Plan, Rio Algom Mining LLC, Lisbon Facility**: July 31, 2015.

Utah Division of Radiation Control (DRC), 2014, **Radioactive Materials License UT 1900481 – DRC Transmittal of License Amendment 5:** letter sent to Theresa Ballaine, Rio Algom Mining LLC, December 17, 2014.

United States Environmental Protection Agency (US EPA), 1986. **RCRA Ground-Water Monitoring Technical Enforcement Guidance Document**, September 1986.

_____, 1992, **RCRA Ground-Water Monitoring Draft Technical Guidance, Office of Solid Waste,** November 1992.

ATTACHMENT 3

GROUNDWATER SAMPLING FIELD FORMS

Water Level Measurements

Job Number: Date: Client:

Site:

Well I.D.	Time	Dia	Depth to NAPL	Thickness of NAPL	Depth to water (DTW)	Total Depth (measured)	Total Depth (historical)	Ref Point (TOC/ TOB)	Screen	Depth top of HS set

Meter Calibration Log

EQUIPMENT MAKE	EQUIPMENT MODEL	SERIAL NUMBER	DATE	TIME	TEMP OF CALIBRATION STANDARD (°C or °F)	pH STANDARD	pH STANDARD	pH STANDARD	SPECIFIC CONDUCTANCE	ORP	DISSOLVED OXYGEN
						4	7	10	__________ µS/cm	__________ mV	__________ mg/L or %

Confluence Environmental, Inc.

ORP Values (degrees in C then value): 5:257.0 10:250.5 15:244.0 20:237.5 25:231.0 30:224.5 35:218.0 40:211.5

Purging And Sampling Data Sheet

Job#:

Sampler:

Client:

Well ID:

Date (DDOct2012)**:**

Site:

Weather Conditions:

Sampler Signature:

Well diam: 1/4" 1" 2" 3" 4" 6" Other:

DTW:

Total Depth:

Purge equip: ES - diam: Bladder Peri Waterra Positive Air Displacement Ext. System

disp bailer teflon bailer other:

Tubing: OD: New Dedicated NA

Purge method: 3-5 Case Volume Micro/Low-Flow Extraction Other:

Pump depth/ intake: MS

Multipliers: 1"= 0.04 2"= 0.16 3"= 0.37 4"= 0.65 5"=1.02 6"= 1.47 Radius^2 X 0.163

(TD - DTW X Multiplier = 1 Volume

80% Recovery (TD - DTW X 0.20 + DTW)

1 Volume = _______ X _____ = _______ (Total Purge)

80%= N/A

Time	Temp (ºC / ºF)	pH	SP Cond (mS / µS)	Turbidity (NTU)	Purge Rate (gal or mL/ min)	Volume Removed (gal / L)	DO (mg/l)	ORP (mv)	DTW	Notes

Did well dewater? YES NO

Total volume removed: (gal / L)

Sample method: Disp Bailer Hydrasleeve New Tubing Ext. Port Other:

Sample date:

Sample time:

DTW at sample:

Sample ID:

Lab:

Number of bottles:

Analysis:

Equipment blank ID @

Field blank ID @

Duplicate ID:

Pre-purge DO:

Post purge DO:

Fe2$^+$:

Pre-purge ORP:

Post purge ORP:

NAPL depth:

Volume of NAPL:

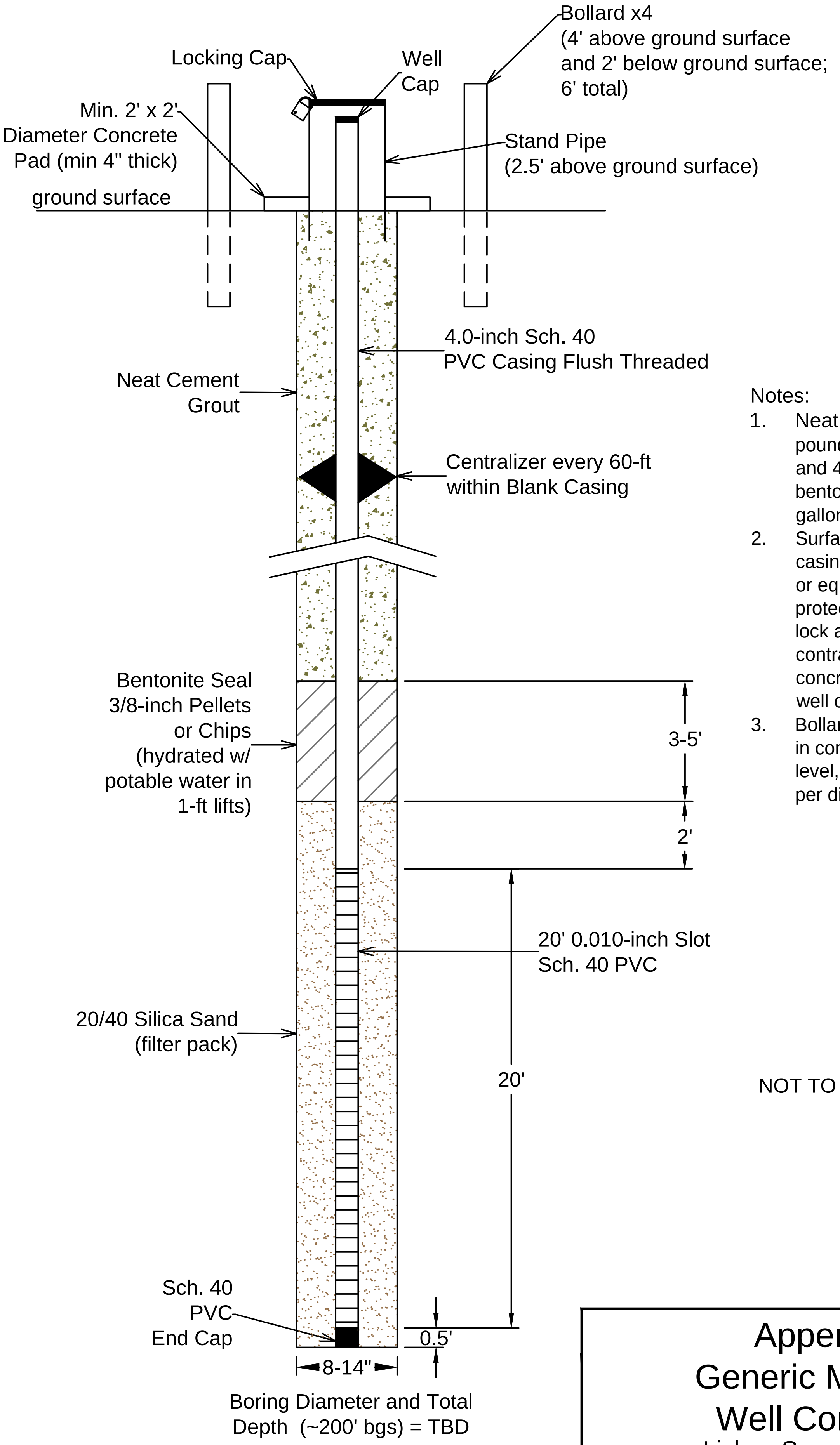
Volume removed: ml

Confluence Environmental, Inc.

3308 El Camino Ave., Suite 300 #148, Sacramento, CA 95821

APPENDIX F

Well Construction Diagram



Notes:

1. Neat cement grout: 1 x 94 pound sack of Portland cement and 4.7 pounds of powdered bentonite with no more than 6 gallons of clean water.
2. Surface completion: 2.5-ft PVC casing stick up with PVC well cap or equivalent; standard steel protective casing with locking lid, lock and key to be provided by contractor, casing painted yellow; concrete pad sloping away from well casing.
3. Bollards: 4 metal traffic posts set in concrete, 4-ft above ground level, painted yellow, positioned per direction of field supervisor.

NOT TO SCALE

Appendix F
Generic Monitoring Well Completion

Lisbon Supplemental Site
Assessment Phase 3 Work Plan

APPENDIX G

Coring and Core Logging

Coring and Core Logging

This section describes the methods that will be used to drill, describe, label, and handle core collected at the Lisbon Facility (Site).

The purpose of drilling rock core on the Lisbon site is to document the geologic, structural, and geochemical characteristics of the geologic units near and within the Lisbon Valley Fault (LF) zone. The LF is a regional normal fault located on the western margin of the project Site. Coring the rock above, within, and below the fault will provide a visual record of the nature of the fault which will aid in the interpretation of how the fault may influence groundwater flow and geochemistry. Core samples from selected intervals near and in the fault zone will be analyzed for whole rock chemistry which will be used to identify potential chemical impacts to groundwater from minerals within the fault zone.

The methods for collection, description, and handling of rock core described here are based on the geologic literature, including U.S. Department of the Interior, Bureau of Reclamation (1998), Engineering Geology Field Manual, Second Edition, Volume 1 (1998), and ASTM (1999, 2008).

Coring Method

Rock core will be obtained using a Speedstar 50K or 110K air rotary drilling rig (or equivalent) equipped with 94 mm wireline rock core drilling capability (94 mm core is approximately 3.7 inches in diameter), or HQ core (2.5-inch diameter) (ASTM, 1999). The boring diameter will be 156 mm or 6.14 inches. Core will be collected below the alluvial/bedrock contact from the entire bedrock interval. A temporary conductor casing may be installed within the alluvial interval and landed up to 5 feet into bedrock. Total depth (TD) of the borings is expected to be up to approximately 200 feet below ground surface (bgs). Actual TD will be determined in the field based on depth of key intervals such as the LF and geologic formation contacts.

Lithologic Core Description

The rock units are expected to consist of sedimentary units such as sandstone, mudstone, shale, etc., but may also include material such as fault gouge and fault breccia. The lithologic descriptions will be based on visual inspection with a 10-power hand lens and will be recorded on a field form. Core features will be measured using a tape measure and recorded with dimensions of feet, tenths and hundredths of a foot, and inches for boring or well diameter, such as 6-inch diameter boring, 4-inch diameter well, etc. The rock core will be described by the field geologist under the supervision of a Utah Professional Geologist.

The core descriptions will include the following information:
Lithology with lithologic descriptors

  General Rock Name (i.e. sandstone, mudstone, shale, etc., based on AGI standard rock classification)

  Composition (mineralogy, i.e. quartz 75%, feldspar 20%, lithic fragments 5%, etc., using hand lens and percentage chart)

Grain/particle size (i.e. fine-grained, medium-grained, coarse-grained, pebble, cobble, etc., using grain-size chart)
Sorting (well sorted, poorly sorted, etc. using sorting chart)
Rounding (well rounded, angular, etc., using rounding chart)
Color (Munsell color chart or equivalent)
Cementation, silicification, and mineralization, including reaction to hydrochloric acid

Bedding/lamination/foliation/flow texture
Contacts (bedding or geologic unit contacts)
Rock unit (member or formation) name (if known)
Other (i.e. fossils, carbonized wood, petrified wood, etc.)

Structural Discontinuity Description

Structural discontinuities consist of all structural breaks in the rock core, such as joints, shears/faults, and fault zones. Observing and documenting these features is a major objective of the core drilling and sampling program.

The following features will be identified and documented:
Joints: a type of natural fracture, relatively planar, with no obvious displacement; document joint characteristic such as open, healed, filled). Joints occur in sets and typically have uniform orientation.
Shear: a structural break where differential movement has occurred, characterized by polished surfaces, striations, slickensides, gouge, breccia, mylonite, or any combination of these).
Fault: a shear with significant continuity which can be correlated between observation locations.
Shear/fault zone: a band of parallel or subparallel fault or shear planes.
Shear/fault gouge: pulversized material derived from crushing or grinding of rock by shearing.
Shear/fault breccia: cemented or uncemented, predominantly angular and commonly slickensided rock fragments resulting from crushing or shattering of rock.

Rock Quality Designation

Rock quality Designation (RQD) is a fracture index which consists of the total length of solid core that is greater than or equal to 4 inches long, divided by the length of the core interval (core run) in inches (Bureau of Reclamation, 1998, p. 96).

Documentation

Lithologic and discontinuity observations will be recorded on a standard boring log form which includes the following data:

Site name
Boring identification
Date
Drilling equipment and contractor
Geologist name

Boring cuttings and/or core description
Boring total depth
Depth to first groundwater
Depth to groundwater after time
Cutings or rock core lithology
Rock discontinuities
RQD
Other observations

Core Handling and Storage

The rock core will be placed in core boxes using the industry standard method of placing the core in the box so that the top of the core is to the upper left and the bottom of the core is to the lower right, when viewing the box from the side (ASTM, 2008). The boring identification number and core interval will be clearly labeled inside the box and on the outside of the box. Wood blocks may be placed in the box to identify core depth intervals or identify the interval of unrecovered core. The core boxes and wood blocks will be provided by the drilling contractor.

Core in boxes will be stored in a location which protects the boxes from the elements.

Photographs of Core

Core will be documented with color photographs within the core box, together with a tape measure or scale, graduated in feet and tenths of feet. The boring identification and depth interval will be visible in each photograph.

References

American Society for Testing and Materials, 1999, Designation: D 2113-99, Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation.

American Society for Testing and Materials, 2008, Designation: D5079-08, Standard Practices for Preserving and Transporting Rock Core Samples.

U.S. Department of the Interior, Bureau of Reclamation, 1998, Engineering Geology Field Manual, Second Edition, Volume 1.

APPENDIX H

Lisbon Work Plan Schedule

Rio Algom
Lisbon Work Plan

ID	ℹ	Task Name	Duration	Start	Finish
1		**1.0 Hydrogeological Evaluation**	**305 days**	**Mon 10/19/15**	**Fri 12/16/16**
2		**1.1 Site Water Balance**	**305 days**	**Mon 10/19/15**	**Fri 12/16/16**
3		**1.2 Geologic Model**	**305 days**	**Mon 10/19/15**	**Fri 12/16/16**
4		Preliminary Geologic Model	95 days	Mon 10/19/15	Fri 2/26/16
5		Final Geologic Model	77 days	Thu 9/1/16	Fri 12/16/16
6		**1.3 Hydraulic Testing**	**305 days**	**Mon 10/19/15**	**Fri 12/16/16**
7		Evaluate Confined Aquifer Conditions	45 days	Mon 10/19/15	Fri 12/18/15
8		Hydraulic Testing for New Wells and Core Holes	100 days	Mon 8/1/16	Fri 12/16/16
9		**2.0 Geochemical Evaluation**	**358 days**	**Mon 10/19/15**	**Wed 3/1/17**
10		**2.1 Geochemical Characterization**	**337 days**	**Mon 10/19/15**	**Tue 1/31/17**
11		**2.2 Site-Wide Hydrochemical Monitoring, Database Management, Annual Sampling, and Analysis Report**	**358 days**	**Mon 10/19/15**	**Wed 3/1/17**
12		**2.3 Geochemistry of the LF Zone**	**337 days**	**Mon 10/19/15**	**Tue 1/31/17**
13		**2.4 Attenuation of COC Transport in the North and South Plumes of the BCA**	**302 days**	**Mon 12/7/15**	**Tue 1/31/17**
14		**3.0 Coring and Well Installation**	**236 days**	**Mon 12/7/15**	**Mon 10/31/16**
15		Permitting	170 days	Mon 12/7/15	Fri 7/29/16
16		Site Preparation and Drilling Activities	66 days	Mon 8/1/16	Mon 10/31/16
17		**4.0 Flow and Transport Model**	**325 days**	**Mon 12/7/15**	**Fri 3/3/17**
18		Preliminary Model Development	60 days	Mon 12/7/15	Fri 2/26/16
19		Final Model Development	110 days	Mon 10/3/16	Fri 3/3/17
20		**5.0 New ACLs and TALs**	**20 days**	**Mon 3/6/17**	**Fri 3/31/17**
21		**6.0 Reporting**	**85 days**	**Mon 3/6/17**	**Fri 6/30/17**
22					
23		**Note: Schedule is subject to change due to modifications in field-related activities or project scope.**			
24					
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