2013 Field Hydrogeology Report
Pogo Mine
Delta Junction, Alaska

Report Prepared for

Sumitomo Metal Mining Pogo LLC

SUMITOMO METAL MINING CO., LTD.

Report Prepared by

srk consulting

SRK Consulting (U.S.), Inc.

SRK Project Number 147900.020
April 1, 2014

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1 Introduction

Field investigations were conducted to characterize the hydrogeologic system at the Pogo site and to provide the data needed to construct, advance and improve the groundwater flow model in support of permitting the East Deep Expansion of the mine. The investigations were carried out during the field seasons of 2012 and 2013.

The 2012 field program provided water level data and values for hydraulic conductivity within Liese Ridge, the diorite dike and the immediate area of the East Deep expansion. In addition, the 2012 program included installation and testing of two wells to quantify the direction of flow between the bedrock and Goodpaster Alluvium, testing of the existing exploration water supply wells, and attempts to collect hydraulic data from exploration coreholes being drilled underground by Pogo. The data collected in 2012 formed the basis for developing a preliminary groundwater flow model. That preliminary model, described in detail in the model report (SRK, 2013), required additional data to simulate mine inflows and potential future impacts to surface and groundwater resources to an acceptable level of confidence. The purpose of the flow model is to predict groundwater inflow, estimate potential dewatering requirements, and support the permitting of the East Deep Expansion.

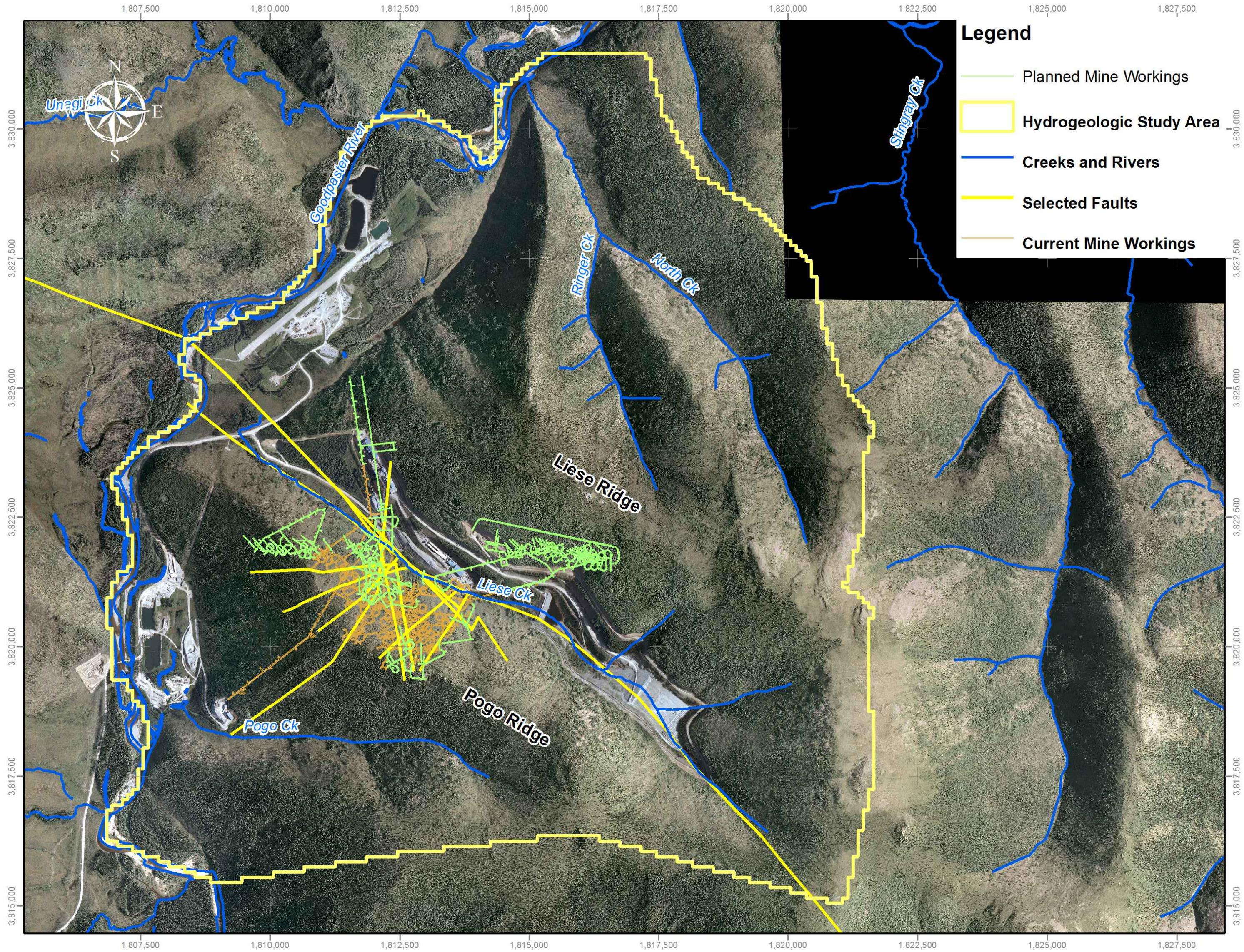
To extend the results of the previous year's field program, the field program for 2013 collected hydrogeologic information specifically needed to fill gaps in information critical to conduct a transient calibration and refine the predictive simulations of the model.

The field program began early June 2013 and continued until late September when the onset of freezing weather terminated the field season. It involved the following activities:

- Seven coreholes were drilled underground specifically to target structures of hydrogeologic interest. The holes were each fitted with a mechanical packer (Margo Plugs) and a valved shut-in assembly to accommodate a data logging pressure transducer (hereafter called PT). Each of the underground coreholes was hydraulically tested, sampled; and
- Six surface exploration coreholes were tested and temporary or permanent wells were installed; each was subsequently tested.

This report documents the field work conducted during the 2013 field season.

The Hydrologeological Study Area for Pogo, defined by the boundaries of the groundwater numerical flow model, is shown on **Figure 1**. The approach taken by SRK relative to both the surface and underground drillholes was to integrate hydrogeological data collection with surface and underground exploratory drilling being conducted by Pogo as part of their exploration of the East Deep deposit. A groundwater flow model requires data that characterize the flow of groundwater through the geologic materials associated with the deposit and surrounding country rock. Given the relatively low and uniform hydraulic conductivity of the bulk country rock, discontinuities in the rock capable of conveying larger volumes of water were the focus of the testing work. Specifically, the margins of the diorite intrusive, the veins of the East Deep deposit, and a number of faults suspected of producing large discrete inflows were tested where exploration drillholes provided the opportunity for interception.



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HYDROGEOLOGICAL STUDY

HYDROGEOLOGICAL STUDY AREA DEFINED BY THE NUMERICAL MODEL BOUNDARY

SRK JOB NO.: 147900.020

FILE NAME: 147900.020.Rev.A.Figure.1.Base.Map.Of.Hydrogeological.Study.Area.Defined.By.Numerical.Boundary.2014-03-28.dwg

POGO UNDERGROUND MINE IN ALASKA

DATE:	APPROVED:	FIGURE:	REVISION NO.
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2 Field Program

2.1 Surface Exploration Drillholes

SRK planned and directed the installation of piezometers in six surface drillholes. Five of the six were in holes drilled as part of the Pogo geology exploration program. One hole was drilled explicitly as a hydrogeology characterization hole. The holes for hydrogeological study were selected to provide the additional data needed to strengthen the understanding of the groundwater flow system and fill the gaps in that understanding that were identified during development of the preliminary groundwater flow model. Piezometers were installed in six surface drillholes (13-H3, ED_K 13-562, ED_K 13-597, EDW_C 13-695, SP_C 13-651, SP_G 13-758). The locations of the piezometers are presented on **Figure 2**. Specific objectives to the 2013 field program were to:

- Characterize the behavior of groundwater near the margin of the diorite dike in the North Zone on the flank of Liese Ridge (holes 13-562, 13-597, and 13-695);
- Establish groundwater monitoring points along Pogo Ridge above the existing Liese workings, and generating water levels for 1) comparison to pre-mining water levels and 2) future monitoring of trends over time (holes 13-H3, 13-651, and 13-758); and
- Provide additional water level data and hydraulic conductivity values in support of the groundwater flow model (all holes).

2.1.1 Installation of Piezometers

All surface holes were drilled as HQ-size (2.98-inch diameter hole) coreholes with HW size (3.93-inch inside diameter) surface casing. The holes telescoped to an NQ size with depth, although the piezometers were installed into the upper portions of the exploration holes, within the HQ diameter. The piezometers in the deep angled holes have no bottom plugs. The bottoms of the installations were left open to allow monitoring of water levels should levels drop significantly in the future. As shown in the schematic diagram on **Figure 3**, the piezometers were constructed of flush-threaded two-inch, Schedule 80 PVC. The piezometer strings were inserted by the drill crew immediately after a hole was terminated at Total Depth. The string consisted of approximately 100 feet of blank casing and 7 feet of an annular seal assembly. The assembly consisted of a cement basket with two Benseal sleeves immediately above the basket. Photos of the seal assembly are presented in **Appendix A**. Screened intervals were limited to 30 feet in the angled holes. Piezometers in the two shorter vertical holes (13-H3 and 13-758) were constructed with longer screened sections. The screens were alternated with blank casing to increase the strength of the piezometer string while maintaining a long open interval. Details of piezometer construction are presented in **Table 1**.

2.1.2 Hydraulic Testing of Piezometers

Falling head slug tests were conducted in four of the piezometers (13-H3, 13-562, 13-695, and 13-651). The tests were performed with a pressure transducer installed into the piezometer. A pre-test water level was recorded, and then 5 gallons of water were poured into the piezometer. The water was poured as quickly as possible to induce an essentially instantaneous rise in water level. Water level recovery was recorded by the transducer at a one-minute frequency. The pressure transducers were downloaded and the interval for readings lengthened for long-term monitoring.

The slug tests were analyzed using the Hvorlsev method. Test data and analytical plots for the surface core holes are presented in **Appendix B**. Values for hydraulic conductivity calculated from the test data are provided in **Table 2**. The analyses yielded values for hydraulic conductivity with a geometric mean of $1.4x10^{-3}$ ft/day, a maximum value of 4.910^{-2} ft/day, and minimum of $1.4x10^{-4}$ ft/day. These results are similar to the mean and range in values obtained during the 2012 field program, and within the range of all bedrock tests conducted at the Pogo site.

Table1: Summary of Surface Drillholes and Piezometer Installations

Drillhole Name	Drill Pad	Purpose	Easting	Northing	Collar Elevation (ft. amsl)	Azimuth	Dip	Total Hole Depth (ft.)	Installed Piezo Depth (ft.)	Depth of Cement Basket (ft.)	Screen Interval (ft.)	Bottom Cap?
13-H3	2013_H3	Water level above Liese workings	1812235	3820041	2,520	--	-90	718	718	151	multiple (1)	Y
13-562	ED_K	Diorite Contact	1813342	3822625	2,166	277	-82	2800	350	109	320-350	N
13-597	ED_K	Diorite Contact	1813342	3822625	2,166	29	-85	3300	350	109	320-350	N
13-695	EDW_C	North Zone Area	1812922	3823509	2,192	192	-81	2758	359	109	329-359	N
13-651	SP_C	Current Water Level	1813573	3818867	2,578	80	-71	2006	309	109	None	N
13-758	SP_G	Water level near Liese workings	1813951	3819365	2,685	--	-90	959	681	111	multiple(2)	Y

Notes:
(1) Screen alternates with blank casing from 151 ft to 718 ft at a ratio of 30 ft of screen to 20 ft of blank. Total of 320 feet of screen.
(2) Screen alternates with blank casing from 111 ft to 681 ft at a ratio of 10 ft of screen to 10 ft of blank. Total of 280 feet of screen.

Table 2: Summary of Surface Drillholes and Results of Hydraulic Tests

Drill Pad	Hole ID	Coordinates		Start of Long-Term Monitoring	Date of Hydraulic Test	Collar Elevation	Total Length	Total Depth	Azimuth	Inclin-ation	Measured Static WL	Static WL Elevation	Hydraulic Conductivity
		Easting	Northing			(ft. amsl)	(ft.)	(ft.)	(deg.)	(deg.)	(ft. depth)	(ft. amsl)	(ft/day)
2013_H3	13-H3	1812235	3820041	7/27/2013	7/30/2013	2,520	718	718	0	-90	141	2,379	4.90E-02
ED_K	13-562	1813342	3822625	8/6/2013	8/6/2013	2,166	2,800	2,773	277	-82	240	1,928	7.10E-04
EDW_C	13-695	1812922	3823509	8/6/2013	8/6/2013	2,192	3,000	2,963	192	-81	232	1,963	1.40E-04
SP_C	13-651	1813573	3818867	7/27/2013	7/19/2013	2,578	1,880	1,778	80	-71	117	2,467	7.50E-04

Geometric Mean	1.4E-03
Minimum	1.4E-04
Maximum	4.9E-02

Note:
All tests were conducted as falling head slug tests

2.1.3 Potentiometric Data from Piezometers

Dedicated pressure transducers were installed in five of the piezometers for the purpose of long-term monitoring of groundwater levels. One of the six piezometers (13-597 at drill pad ED_K) was plugged at 114 feet in depth and was not fitted with a pressure transducer. From the presence of bentonite on the water level probe, it appears that the bentonite seal is plugging the piezometer casing. Piezometer 13-597 is located on the same drill pad as but with a different azimuth than 13-562. Because of the plug, no potentiometric elevation data can be collected from 13-597.

Long-term monitoring of the 2013 piezometers began in late July and early August, 2013 (**Table 2**). Data collection has continued to date, and will continue in the piezometers installed in 2012 and 2013. A time-plot of the groundwater elevation data from both sets of piezometers is presented on **Figure 4**. The short traces for the water elevations in the 2013 piezometers are a result of trimming the data to show only the static levels and do not include the variations in level at the time of the installation of the pressure transducers and subsequent hydraulic testing.

The water levels in the piezometers generally show a seasonal increase during the summer, thought to be a result of increased infiltration to groundwater after the spring melt.

2.2 Underground Coreholes

The underground core holes were drilled to intersect and hydraulically test specific features of hydrogeologic interest. The targets were identified as a result of the uncertainties borne out by the initial numerical modeling effort. One key uncertainty in the preliminary model is described here: larger inflows to the workings occurred at faults or at the contact with the diorite intrusive, yet testing from the previous 2012 field program showed only slightly higher values for hydraulic conductivity than the surrounding country rock. Based on previous results, it was not clear if the faults and diorite contacts acted as consistent and pervasive conduits for groundwater flow, or if the larger inflows were confined to isolated areas in within those features. To resolve this issue, SRK and the Pogo Geology department identified locations where those features could be intersected with relatively short, near horizontal, core holes. The features that are known or suspected to be in places that produce the larger inflows to the workings are:

- The margin of the diorite intrusive (contact with country rock);
- N1, and N2 faults;
- The D3_3 fault package that includes the Liese and Graphite faults; and
- Intersections of the diorite contact with the various faults.

Existing cutouts or muckbays in the areas of interest were identified. Using the Vulcan model (which SRK uploaded to Leap Frog), the collar locations, azimuth, and inclinations were selected that provided relatively short drill lengths to intersect the target features. Holes ranged between 202 and 600 feet in length. All holes were drilled into ribs within the cutouts or bays and are secluded from day to day underground traffic and mining activities. **Table 3** summarizes the corehole locations and alignments while **Figure 5** shows the locations of the holes.

Table 3: Summary of Underground Drillholes

Drillhole Name	Target	Easting	Northing	Collar Elevation (ft. amsl)	Azimuth (deg.)	Inclination (deg.)	Static Pressure (psi)	Total Length (ft)
13Hydro-01	Diorite Contact, N2 Fault	1815297	3821248	1,215	76.4	21	80	464
13Hydro-02	N1 Fault	1812596	3821217	1,090	33	23	100	500
13Hydro-03	Diorite Contact	1814608	3821731	887	260	30	65	218
13Hydro-04	N2 Fault	1815296	3821254	1,217	48.4	15	265	425
13Hydro-05	Diorite Contact/Faults	1815302	3821243	1,218	129	31	230	600
13Hydro-06A	D3_3/Diorite Contact	1812199	3822644	1,067	225	27	95	202
13Hydro-06B	D3_3 Fault	1812207	3822663	1,062	86.4	18.4	120	453

Once the holes were completed Margot Plugs were installed. The plugs were equipped with a ball valve and a pressure transducer reading port. The ball valve maintained the static hydraulic pressure, keeping the hole sealed and allowing the pressure transducer to collect data at a rate of one reading per minute. The Margot plug was left in place, and the pressure transducer recorded pressures, allowing the drill rig to pivot and continue drilling desired targets. The hydrostatic pressure data that were collected are presented on **Figure 6**.

Flow and shut-in testing was conducted on the finished holes. A test consisted of a flow period of 60 to 90 minutes, followed by recovery of hydrostatic pressure once the valve was closed. The pressure transducer automated the collection of pressure data. Flow data (gpm) was collected by timing the discharge to fill a five gallon bucket. Photos of the instrument installations are provided in **Appendix A**.

The test data enabled calculation of hydraulic conductivity by applying the Theis recovery solution. The results of the analyses are presented in **Table 4**. Analytical plots of the test data, and the calculations, are shown in **Appendix B-2**.

Table 4: Summary of the Results of Hydraulic Tests

Underground Drillhole	Coordinates		Collar Elev. (ft. amsl)	Type of Test	Test No.	Flow Rate (gpm)	Transmis-sivity (ft^2/day)	Hydraulic Conduc-tivity (ft/day)
	Easting	Northing						
13Hydro-01	1815297	3821248	1,215	Shut-In	1	0.5	0.026	5.60E-05
				Shut-In	2	1.2	0.37	8.10E-04
13Hydro-02	1812596	3821217	1,090	Shut-In	1	3.1	0.26	5.20E-04
				Shut-In	2	1.0	0.57	1.10E-03
13Hydro-03	1814608	3821731	887	Shut-In	1	2.4	3.66	1.70E-02
				Shut-In	2	0.7	0.73	3.30E-03
13Hydro-04	1815296	3821254	1,217	Shut-In	1	2.5	0.29	6.90E-04
				Shut-In	2	0.9	1.11	2.60E-03
13Hydro-05	1815302	3821243	1,218	Shut-In	1	0.4	0.014	2.30E-05
				Shut-In	2	1.2	0.14	2.40E-04
13Hydro-06A	1812199	3822644	1,067	Shut-In	1	3.3	3.89	1.90E-02
				Shut-In	2	1.2	12.54	6.20E-02
13Hydro-06B	1812207	3822663	1,062	Shut-In	1	6.4	0.57	1.30E-03
				Shut-In	2	1.4	1.29	2.80E-03
							Geometric Mean	1.3E-03
							Minimum	2.3E-05
							Maximum	6.2E-02

The values calculated for hydraulic conductivity ranged between $2x10^{-5}$ and $6x10^{-2}$ ft/day, with a geometric mean value of $1x10^{-3}$ ft/day. These values are within the general range of values for the rock mass at any location in the mine, based on the compiled results from previous testing. The conclusion reached from the testing of the coreholes within the features in the workings thought to be most conductive of water, is that the fault and diorite features are not consistently or pervasively conductive. Rather, the high spot-inflows encountered in the workings are a result of specific locations where the features are particularly conductive due to the structural geology proximal to those locations. For example, the Graphite and Liese faults have produced some of the larger point-flows, but they do not have enhanced conductivity over large distances.

2.3 Water Quality Samples

Samples were collected by SRK or the Pogo Environmental department from all the underground coreholes. The samples were prepared and shipped using standard methods for environmental compliance used by Pogo Environmental. The samples were analyzed for Pogo's compliance suite 12g, and the results input into Pogo's EDMS database.

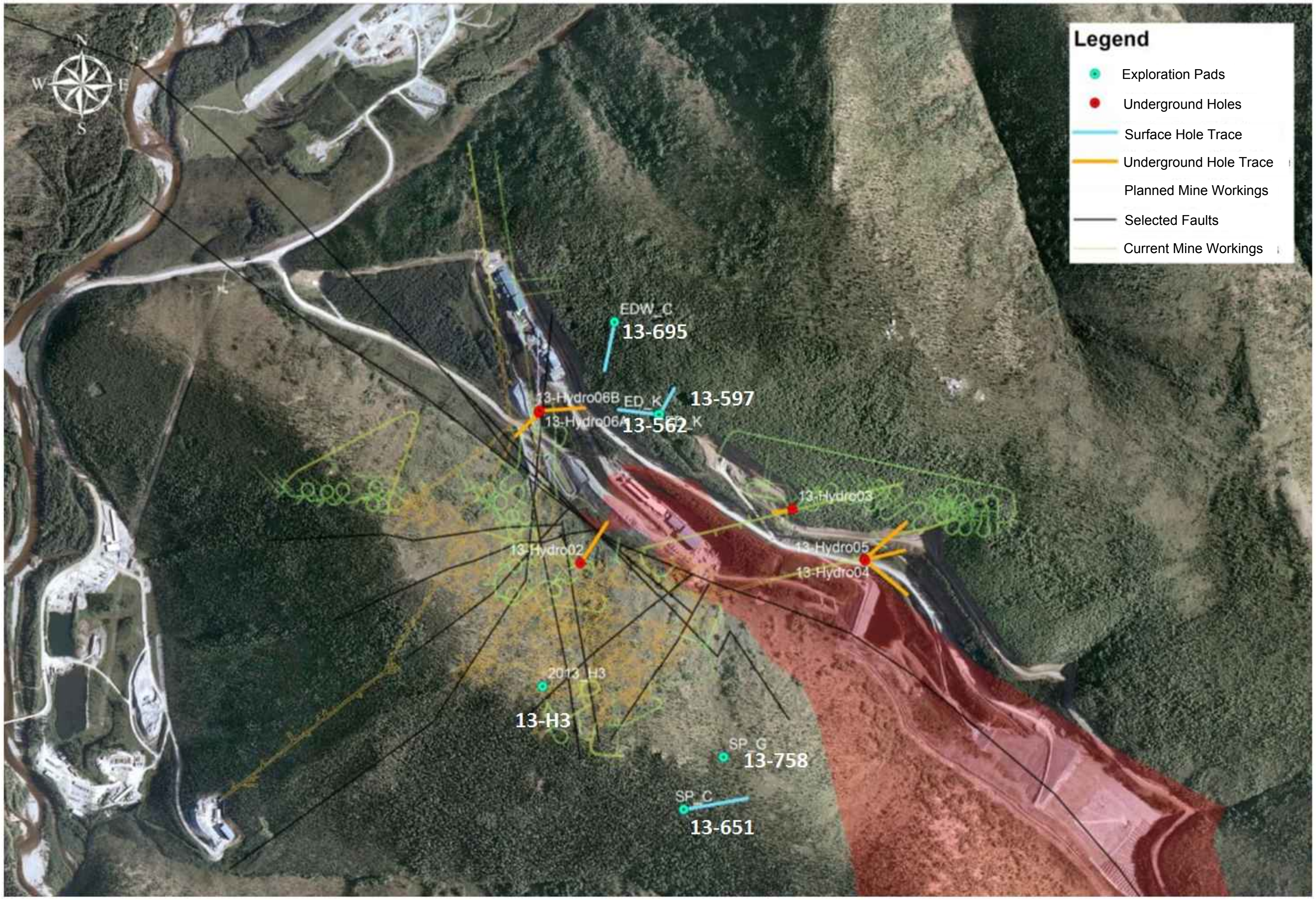
Water quality sample results are presented in **Table 5**. The results are compared in the tables to standards for drinking water quality, aquatic life for fresh water (chronic), and for permitted discharge effluent limits (Outfall 001). The samples contained few concentrations above the discharge limits for metals. Review of the site environmental database (EDMS) indicates that high concentrations are common from underground and monitoring wells when initially sampled after drilling. Later sample results in the database show a trend of lower concentrations with time, perhaps due to disturbance and grinding of rock materials by drilling. Cuttings remaining in the drillholes are initially oxidized during drilling and flushing and yield the elevated concentrations of metals. Decreasing concentrations might be expected from subsequent periodic samples.

Table 5: Water Quality Results of Samples Collected from Underground Drillholes

Ground Water			Drinking Water Quality Standard	Aquatic Life for Fresh Water - Chronic	Outfall 001 Effluent Limits (Mon. Avg)	UG Corehole	UG Corehole	UG Corehole	UG Corehole	UG Corehole	UG Corehole	UG Corehole	UG Corehole	UG Corehole
Site Name						**13U283**	**12U201**	**13HYDRO-01**	**13HYDRO-02**	**13HYDRO-03**	**13HYDRO-04**	**13HYDRO-05**	**13HYDRO-06A**	**13HYDRO-06B**
Sample Date						**9/8/2013**	**8/20/2013**	**8/20/2013**	**8/19/2013**	**8/19/2013**	**8/19/2013**	**8/20/2013**	**8/19/2013**	**8/20/2013**
Sample Time						**11:30**	**20:50**	**21:20**	**20:55**	**20:30**	**19:50**	**21:40**	**21:25**	**19:35**
Alkalinity, Total	(Total)	mg/L		20000		310	220	160	140	140	260	120	190	120
Antimony	(Dissolved)	ug/L				0.78	0.0511	1.89	0.613	98.3	0.101	0.245	117	2.72
Antimony	(Total)	ug/L	6			0.77	-0.44	1.96	0.602	97.6	-0.44	-0.44	118	2.72
Arsenic	(Dissolved)	ug/L				4.7	455	314	125	69.1	963	520	42.7	4.78
Arsenic	(Total)	ug/L	10	150		7.84	564	366	124	67.4	1160	598	44.7	5.46
Cadmium	(Dissolved)	ug/L		0.969787 Hardness dependent	0.2	-0.045	-0.045	-0.045	-0.045	-0.045	-0.045	-0.045	**0.217**	-0.045
Cadmium	(Total)	ug/L	5			-0.066	-0.66	-0.66	-0.066	-0.066	-0.66	-0.66	0.0778	-0.066
Calcium	(Dissolved)	mg/L				100	95	73	36	36	72	69	120	55
Calcium	(Total)	mg/L				84	97	62	35	38	79	72	120	59
Carbonate		mg/L				-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2
Chloride		mg/L		230000		0.919	0.899	0.395	2.36	1.42	0.261	0.58	9.01	1.22
Chromium	(Dissolved)	ug/L				0.244	0.0925	-0.049	-0.049	0.0491	0.11	-0.049	0.295	-0.049
Chromium	(Total)	ug/L	100			-0.2	-2	-2	-0.2	-0.2	-2	-2	0.583	-0.2
Copper	(Dissolved)	ug/L		6.862 Hardness dependent		0.619	0.549	1.1	1.12	1.41	0.198	0.814	1.56	1.16
Copper	(Total)	ug/L			2.2	0.345	-0.76	-0.76	0.517	0.548	-0.76	-0.76	1.11	0.603
Cyanide, Weak Acid Dissociable		ug/L				-1.2	-1.2	-1.2	1.8	-1.2	-1.2	-1.2	5.8	-1.2
Fluoride		mg/L	4000			1.25	0.107	0.157	0.779	0.188	0.251	0.135	0.253	0.745
Hardness, Total	(Total)	mg/L				2800	93	270	140	110	74	56	120	49
Iron	(Dissolved)	ug/L				350	310	-14	-14	-14	-14	-14	110	-14
Iron	(Total)	ug/L		1000		580	1300	240	91	39	1300	240	310	72
Lead	(Dissolved)	ug/L		29.468 Hardness dependent		-0.03	-0.03	-0.03	0.0488	0.138	-0.03	0.032	0.361	0.0423
Lead	(Total)	ug/L			0.5	-0.073	-0.73	-0.73	-0.073	0.22	-0.73	-0.73	**0.692**	0.218
Magnesium	(Dissolved)	mg/L				75	57	22	13	5.7	48	26	79	26
Magnesium	(Total)	mg/L				73	56	26	14	6.2	49	24	71	25
Manganese	(Dissolved)	ug/L				6.33	58.1	54.5	32.2	28	39.6	59.1	94.2	34.2
Manganese	(Total)	ug/L				5.78	57	54.9	31	26.4	40.3	58.6	93.1	33.6
Mercury	(Dissolved)	ug/L	2	0.77	0.01	-0.00014		0.000248	0.000532	0.000341	0.000188	-0.00014		
Nickel	(Dissolved)	ug/L		173.347 Hardness dependent		4.61	6.07	4.74	3.13	7.29	3.75	4.95	9.73	12.2

Ground Water			**Drinking Water Quality Standard**	**Aquatic Life for Fresh Water - Chronic**	**Outfall 001 Effluent Limits (Mon. Avg)**	**UG Corehole**	**UG Corehole**	**UG Corehole**	**UG Corehole**	**UG Corehole**	**UG Corehole**	**UG Corehole**	**UG Corehole**	**UG Corehole**
Site Name						**13U283**	**12U201**	**13HYDRO-01**	**13HYDRO-02**	**13HYDRO-03**	**13HYDRO-04**	**13HYDRO-05**	**13HYDRO-06A**	**13HYDRO-06B**
Sample Date						**9/8/2013**	**8/20/2013**	**8/20/2013**	**8/19/2013**	**8/19/2013**	**8/19/2013**	**8/20/2013**	**8/19/2013**	**8/20/2013**
Sample Time						**11:30**	**20:50**	**21:20**	**20:55**	**20:30**	**19:50**	**21:40**	**21:25**	**19:35**
Nickel	(Total)	ug/L				2.97	2.27	-1.97	1.38	5.86	-1.97	-1.97	7.72	10.8
Nitrate-Nitrite as Nitrogen		mg/L	10000			0.016	-0.015	0.084	0.017	0.549	0.119	0.02	26.8	-0.015
Nitrogen, Total Kjeldahl		mg/L				-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	3.1	-0.5
Potassium	(Dissolved)	mg/L				3.1	1.7	-1.5	-1.5	-1.5	1.9	-1.5	6.7	2
Potassium	(Total)	mg/L				2.9	1.9	1.6	-1.5	-1.5	1.6	-1.5	4.5	1.6
Selenium	(Dissolved)	ug/L				-0.14	-0.14	-0.14	0.185	0.676	-0.14	-0.14	9.27	-0.14
Selenium	(Total)	ug/L	50	5		-0.3	-3	-3	-0.3	0.443	-3	-3	7.95	-0.3
Silver	(Dissolved)	ug/L		0.943 Hardness dependent		-0.028	-0.028	-0.028	-0.028	0.0713	-0.028	-0.028	0.153	0.0529
Silver	(Total)	ug/L				-0.086	-0.86	-0.86	-0.086	-0.086	-0.86	-0.86	-0.086	-0.086
Sodium	(Dissolved)	mg/L				56	23	74	79	75	22	58	150	81
Sodium	(Total)	mg/L				53	23	110	100	90	21	48	130	74
Sulfate		mg/L				256	280	270	149	116	139	241	576	258
Total Dissolved Solids		mg/L				645	620	563	398	368	470	483	1190	525
Zinc	(Dissolved)	ug/L		64.55 Hardness dependent		-0.084	2.75	26.5	2.73	3.16	1.62	3.04	3.37	3.01
Zinc	(Total)	ug/L			16.8	1.05	-5.5	**31.7**	1.07	0.764	-5.5	8.6	1.78	2.01

Note: Values that exceed effluent limits are bolded and shaded.



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SUMITOMO METAL MINING CO., LTD.

HYDROGEOLOGICAL STUDY

LOCATIONS OF 2013 SURFACE PIEZOMETERS AND UNDERGROUND TEST HOLES

SRK JOB NO.: 147900.020	POGO UNDERGROUND MINE IN ALASKA	DATE: MAR. 2014	APPROVED: LC	FIGURE: 2	REVISION NO. A
FILE NAME: 147900.020.Rev.A.Figure.2.Location.Of.2013.Piezometers.2014-03-28.dwg					

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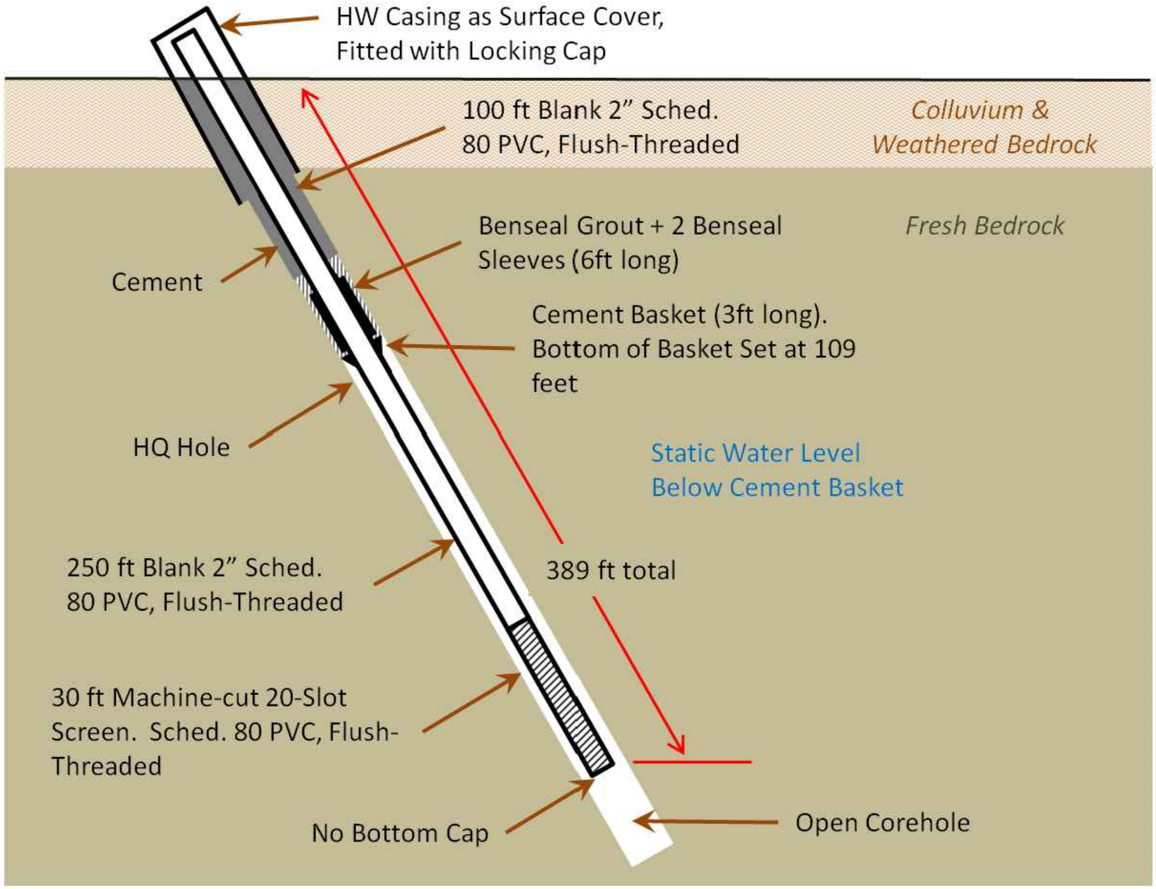

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HYDROGEOLOGICAL STUDY

SCHEMATIC OF SURFACE PIEZOMETER CONSTRUCTION

POGO UNDERGROUND MINE IN ALASKA

SRK JOB NO.:	147900.020
FILE NAME:	147900.020.Rev.A.Figure.3.Schematic.Piezometer.Construction.2014-03-28.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
MAR. 2014	LC	3	A

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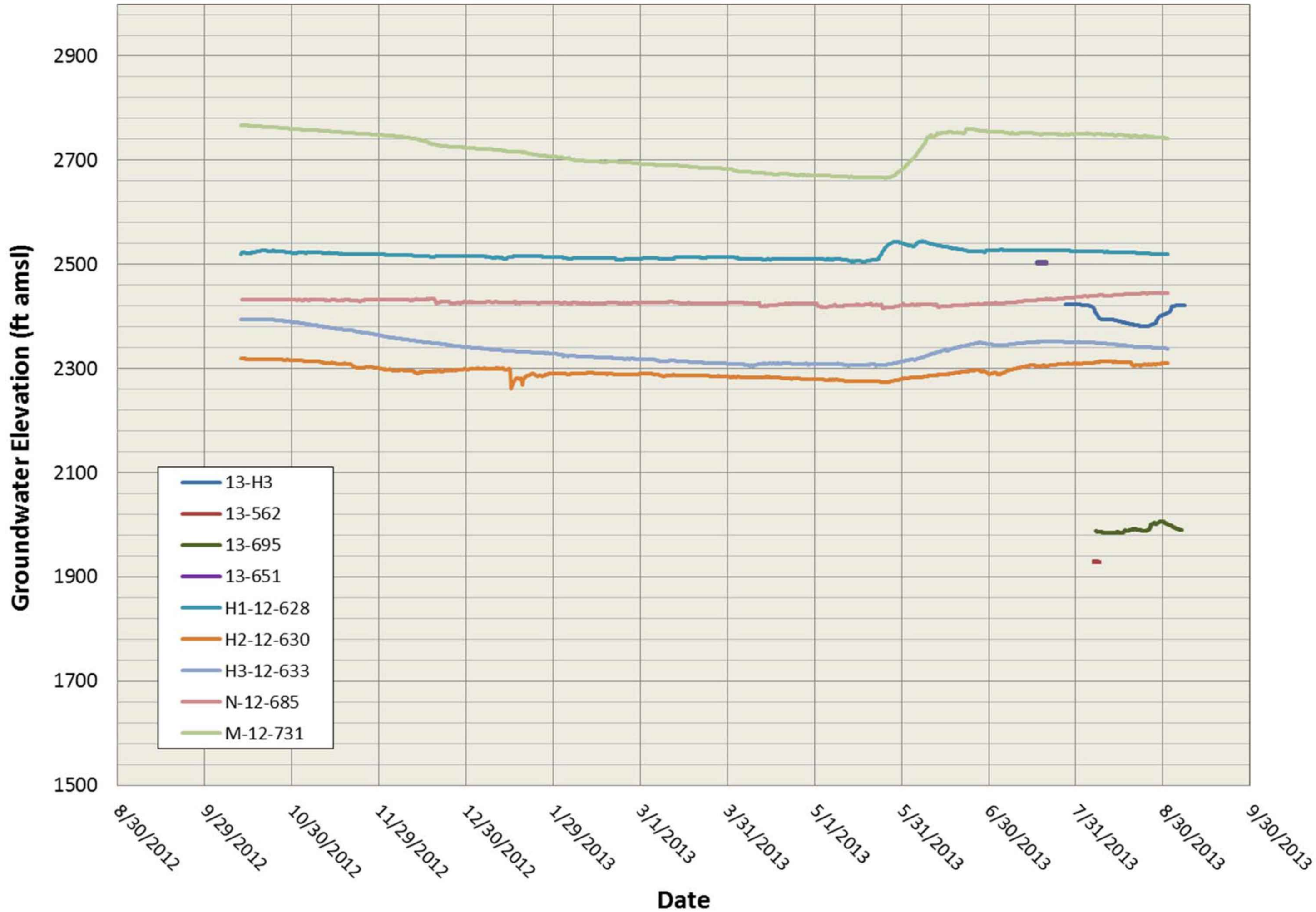

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HYDROGEOLOGICAL STUDY

POTENTIOMETRIC ELEVATIONS FROM INSTRUMENTED SURFACE PIEZOMETERS

POGO UNDERGROUND MINE IN ALASKA

SRK JOB NO.: 147900.020	DATE: MAR. 2014	APPROVED: LC	FIGURE: 4	REVISION NO. A

FILE NAME: 147900.020.Rev.A.Figure.4.Potentiometric.Elevations.From.Piezometers.2014-03-31.dwg

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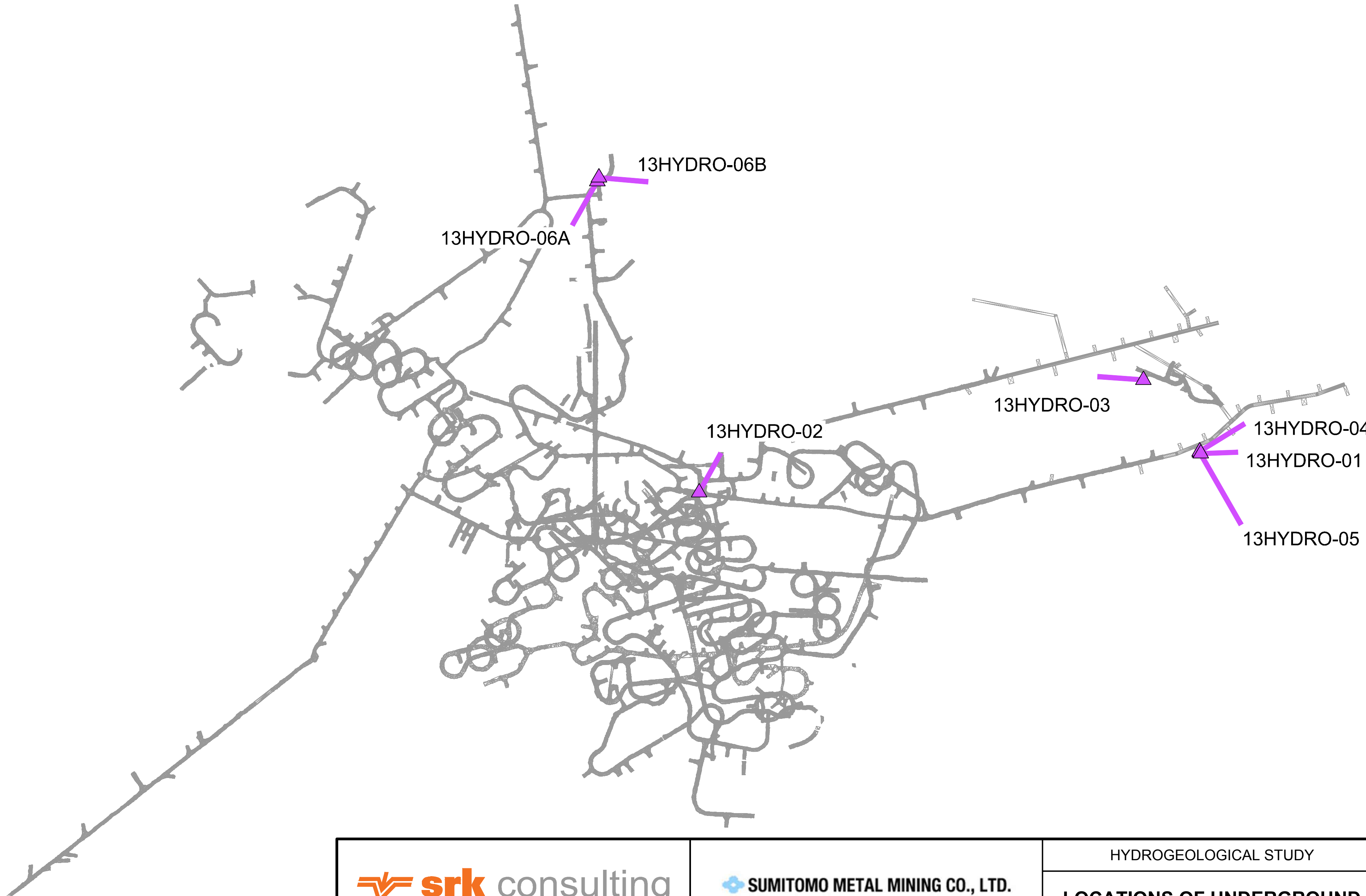

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HYDROGEOLOGICAL STUDY

LOCATIONS OF UNDERGROUND HYDRAULIC TEST HOLES

SRK JOB NO.: 147900.020

FILE NAME: 147900.020.Rev.A.Figure.5.Location.Underground.Hydro.Test.Holes.2014-03-28.dwg

POGO UNDERGROUND MINE IN ALASKA

DATE:	APPROVED:	FIGURE:	REVISION NO.
MAR. 2014	LC	5	A

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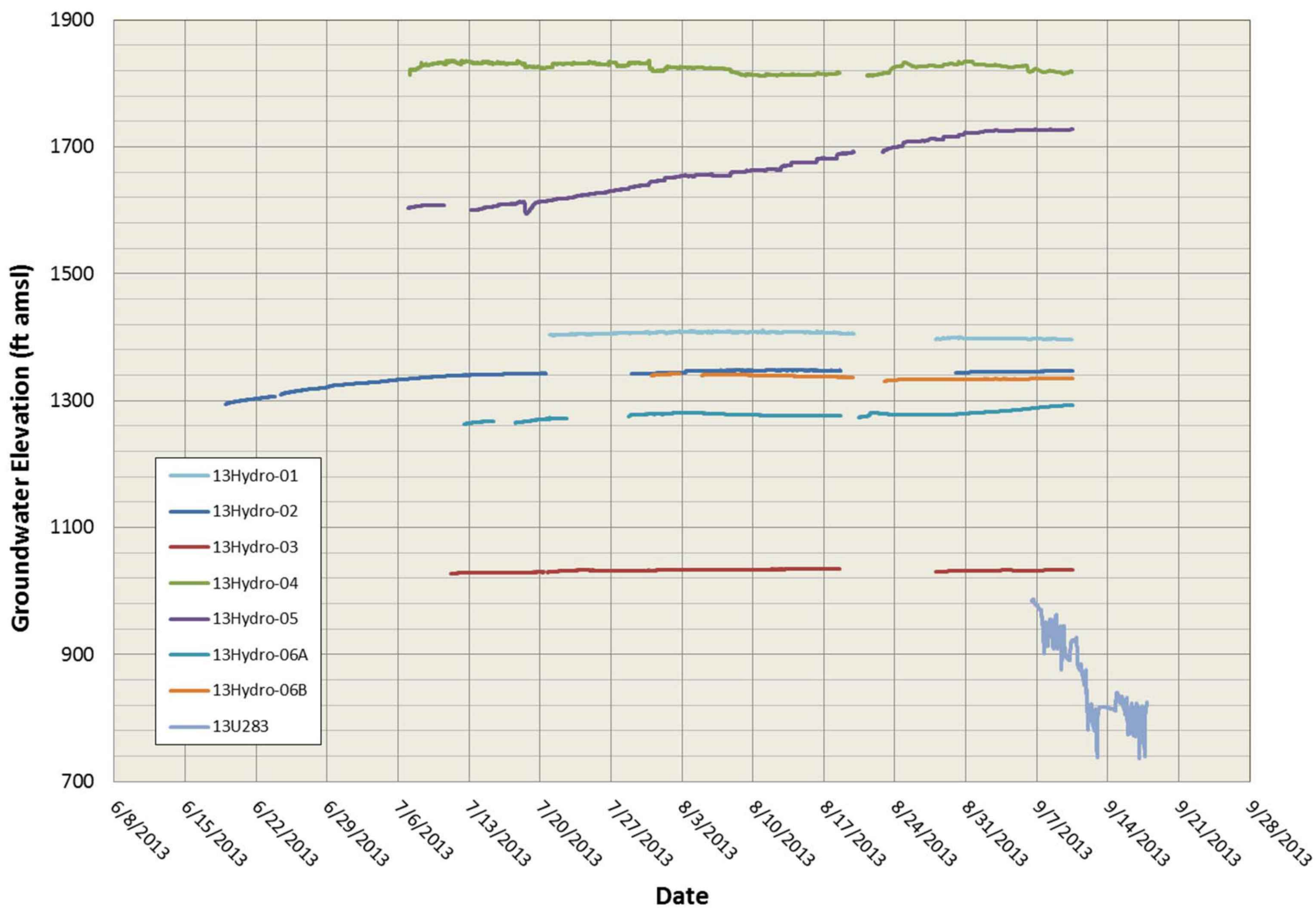

srk consulting	SUMITOMO METAL MINING CO., LTD.	HYDROGEOLOGICAL STUDY **POTENTIOMETRIC ELEVATIONS FROM INSTRUMENTED UNDERGROUND CORE HOLES**
SRK JOB NO.: 147900.020 FILE NAME: 147900.020.Rev.A.Figure.6.Potentiometric.Elevations.From.Coreholes.2014-03-31.dwg	POGO UNDERGROUND MINE IN ALASKA	DATE: MAR. 2014 · APPROVED: LC · FIGURE: 6 · REVISION NO. A

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3 Conclusions

The 2013 field program advanced the understanding of the mechanisms of the groundwater flow system that control inflow to the underground workings. The data obtained and the analysis conducted resolved some of the uncertainties identified during the development and calibration of the preliminary numerical groundwater flow model.

The results of hydraulic testing of piezometers further supported the conclusion presented in the 2012 field report (SRK, 2013) that the saturated bedrock of Liese Ridge in the area of the East Deep expansion are on the average no more permeable than those of Pogo Ridge and the current mine. However, more discrete large inflows were encountered as workings encroached and intersected the margins of the diorite intrusive and East Deep area. These inflows, shown to be of larger rate and higher pressure than had been previously encountered in the older Liese mine workings, occur to date as isolated discrete points of inflow, rather than extensive structural features that consistently drain across a large area.

Though the 2013 field program sought to locate and test pervasive hydraulic features, testing confirmed the results from the previous year's field program. That is, no particularly large permeabilities were encountered in the underground or surface drillholes. The two order of magnitude range in values is similar to the range in values calculated from testing in 2012. Further, the range is similar to the range exhibited by the saturated bedrock to the extensive testing conducted by prior investigations (Golder, 1998). The relatively high potentiometric surface in Pogo and Liese Ridges serves to confirm that (to date) there has been no large persistent drainage feature that cannot be effectively plugged by the ongoing grouting program.

The 2013 field program provides the information needed to evaluate the hydraulic behavior of those features and to more reliably simulate them with the groundwater flow model.

The numerical groundwater flow model was calibrated to steady-state conditions, which provides an estimate of groundwater flow conditions in the study area prior to mining. Mine-induced influences include the effect dewatering of the mine has on the groundwater system within Pogo and Liese ridges, and the degree to which drainage of the local discrete flow features has on the flow system at a site-wide scale. The effects of these transient influences were evaluated so that the numerical model can be defended during the agency review process. The data that were collected in 2013 were necessary to complete the transient calibration and to provide more robust predictions of inflow to the planned East Deep workings by:

- Documenting the change in the elevation of the water table in Pogo Ridge since mining commenced. This was done during the 2013 field program by installing a groundwater well into Pogo Ridge above the current workings; and
- Evaluating the drainage rates and hydraulic conductivities of the more significant discrete features of inflow in the flow system.

4 References Cited

AGRA, 2000. Hydrology Section in Volume 3 of Pogo Environmental Baseline Document, March 20, 2000.

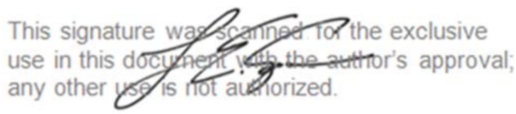
Golder Associates Ltd, 1998. Draft report on hydrogeological investigations Pogo Project, Alaska, February 1998.

SRK 2013. 2013 Field Hydrogeology Report, Pogo Mine, Alaska, July 29, 2013.

5 Date and Signature Page

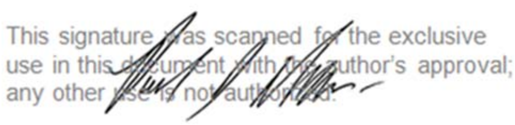
Signed on this 1st Day of April, 2014.

Prepared by



Larry Cope, Principal Consultant, Hydrogeologist

Reviewed by



Paul Williams, Principal Consultant, Hydrogeologist

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted industry practices.

Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (U.S.), Inc. (SRK) by Sumitomo Metal Mining Pogo LLC (Pogo). These opinions are provided in response to a specific request from Pogo to do so, and are subject to the contractual terms between SRK and Pogo. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report.

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Appendices

Appendix A: Surface Corehole Photos

A-1: Piezometer Installation

13-H3 Drill Pad, Hole H3

SP-C Drill Pad, Hole 13-561

Installation of piezometer showing 2-inch pvc tubing and cement basket with Benseal sleeves

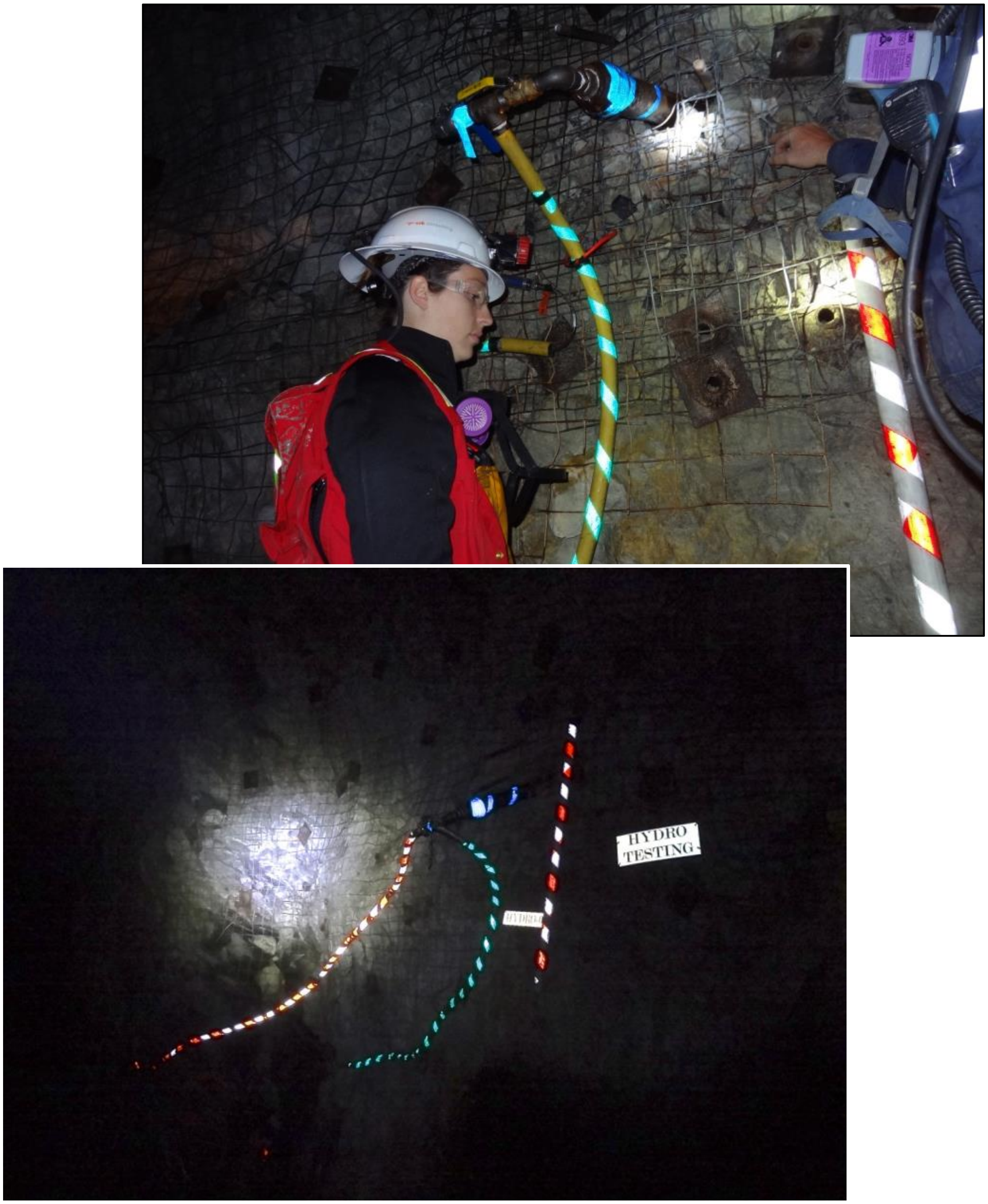
Surface Completion Piezometer ED-K 13-695

Mixing EZMud polymer grout for seal in cement basket and around benseal sleeves

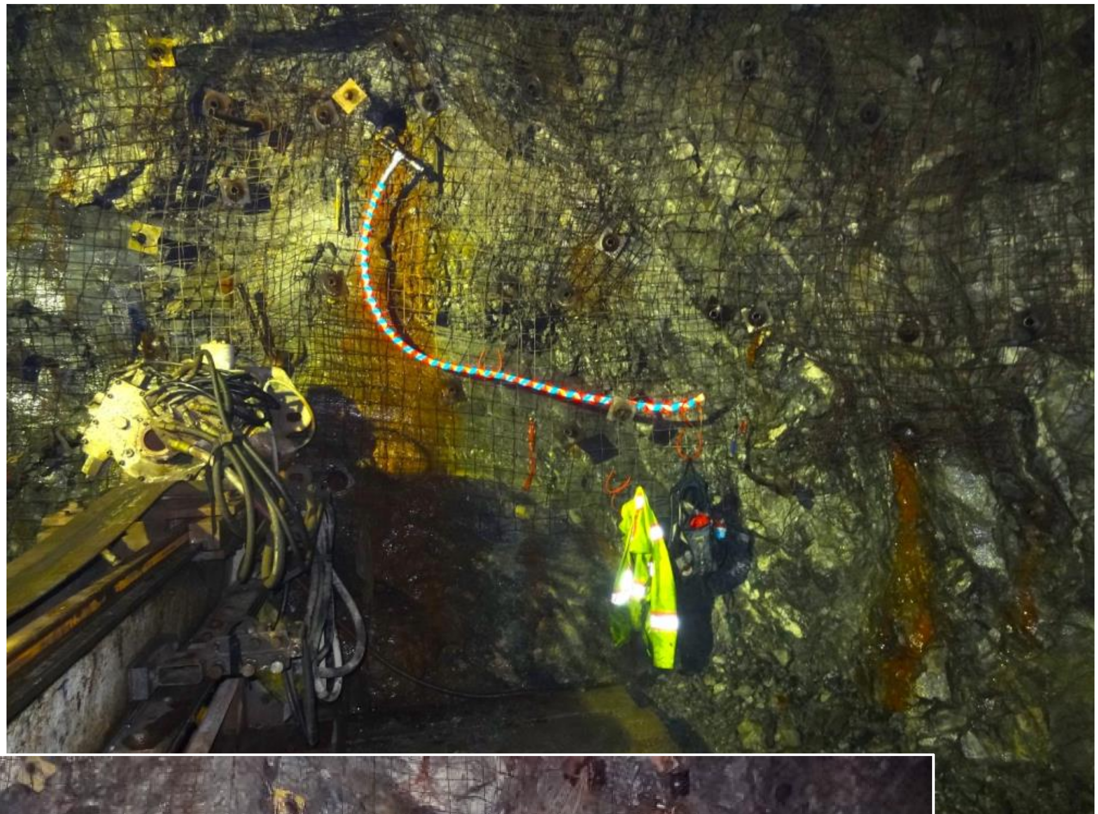
A-2: Hydraulic Testing

UG 13Hydro-01, 13Hydro-04 and 13Hydro-05.

Note reflective tape on datalogger cables and discharge hoses. Signage at all installation protect equipment from inadvertent place in muck at those locations.



UG 13Hydro-02



UG 13Hydro-03
Note water discharging from hose during purging prior to collecting water quality sample.

UG 13Hydro-06A
(on right side of drift)

and

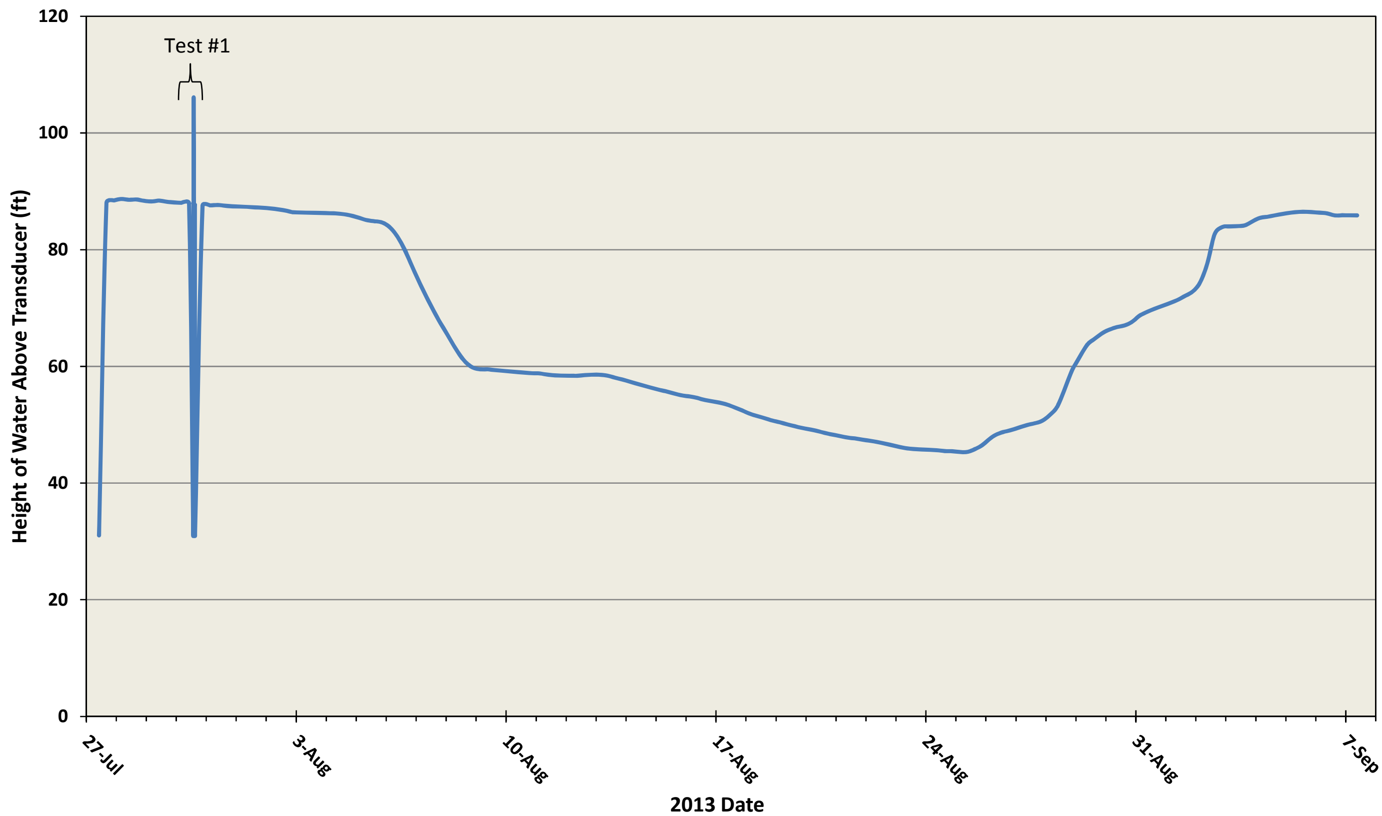
UG 13Hydro-6B
(on left side)

UG 13-U283

Appendix B:
Hydraulic Test Plots and Analyses

Appendix B-1:
Falling Head Slug Tests in Surface Parameters

Raw Data



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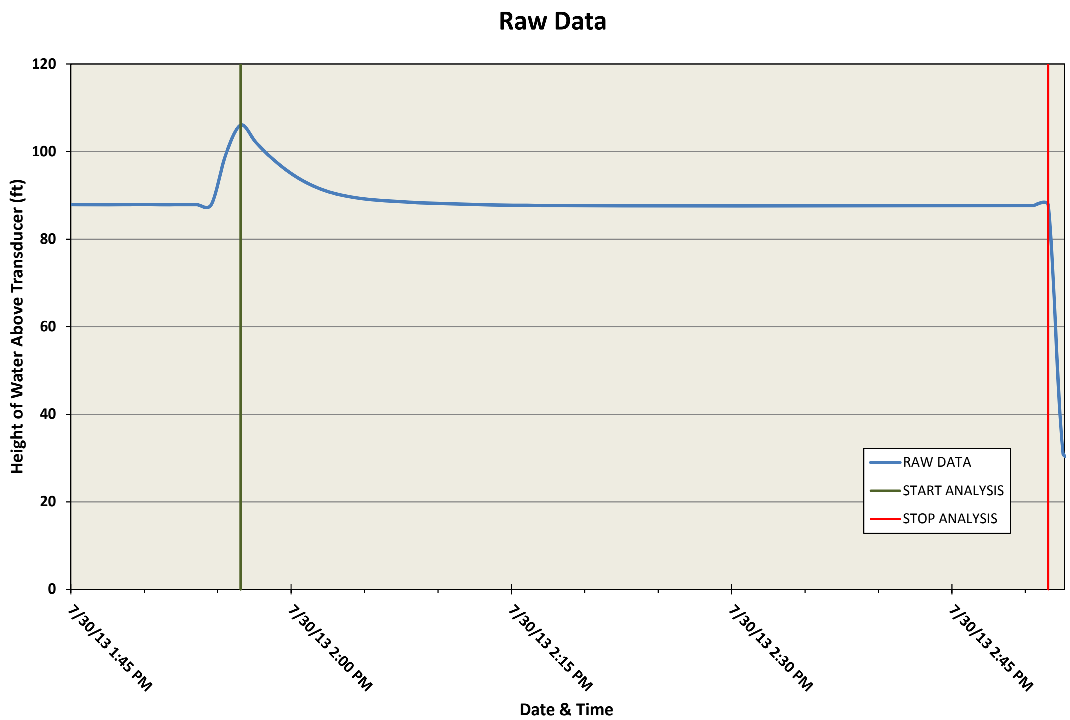
147900.02	October, 2013	1.0

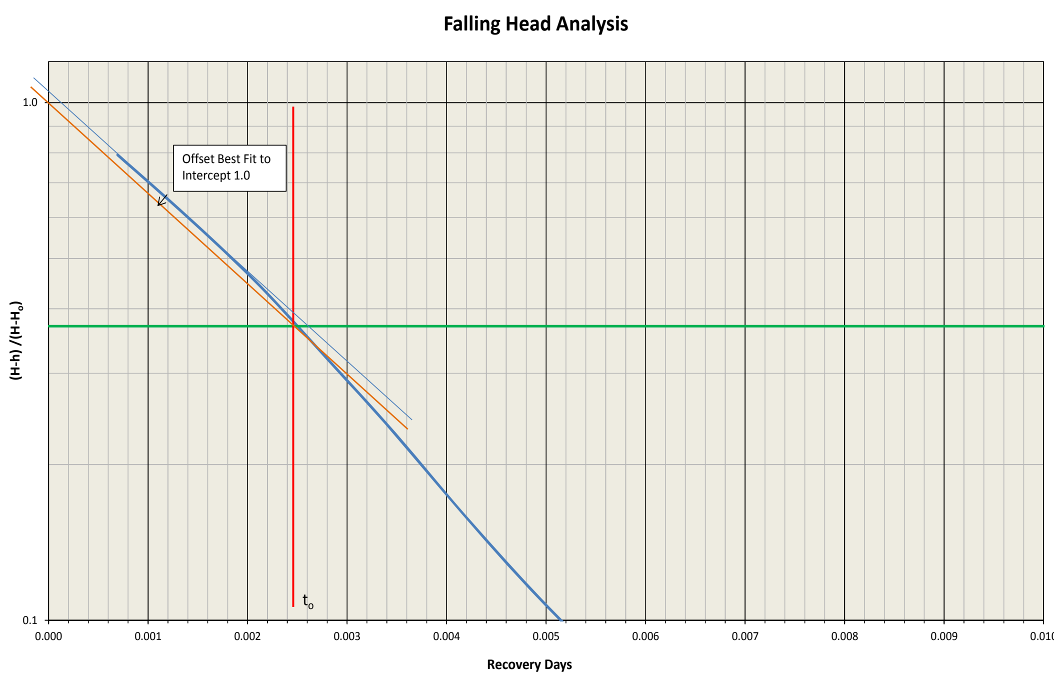
FIGURE B-1
Overview of Test Data
Surface Drillhole 13-H3



Depth of Test Interval:
149 – 718 ft (TD)

Thickness of Test Interval: 569 ft

Recovery Duration: 55 mins



Hvorslev Equation:

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LTo}$$

Where:
K = Estimate of Hydraulic Conductivity (ft/d)
r = Radius of Well Casing (ft)
R = Radius of Well Screen (ft)
L = Length of Test Interval (ft)
T_o = Time for Water Level to Fall 37% of Initial Change (days)

$$K = \frac{(0.129')^2 \ln(569'/0.158')}{2(569')(0.00243)}$$

***K* = 4.9x10^{-2} ft/d**

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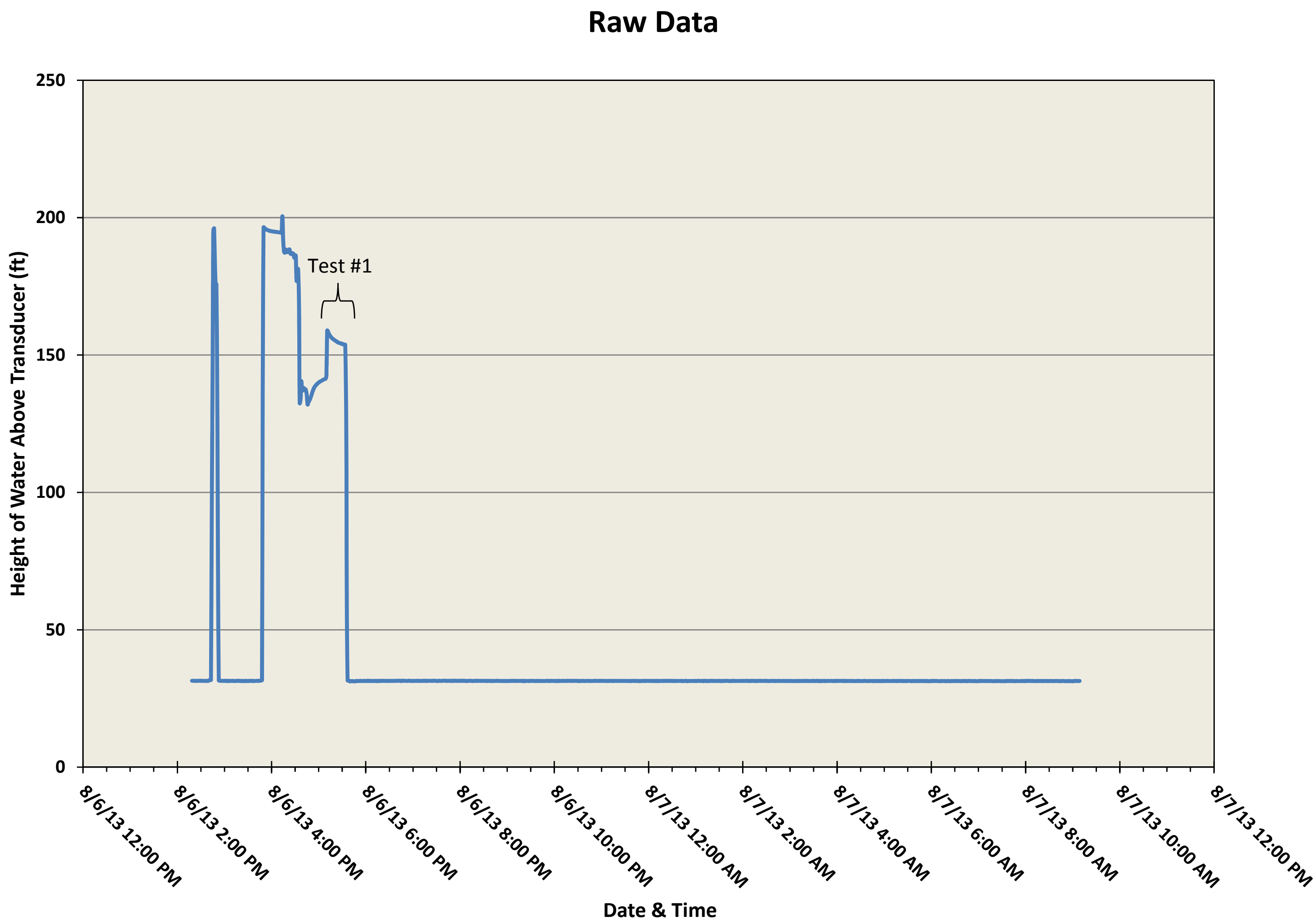
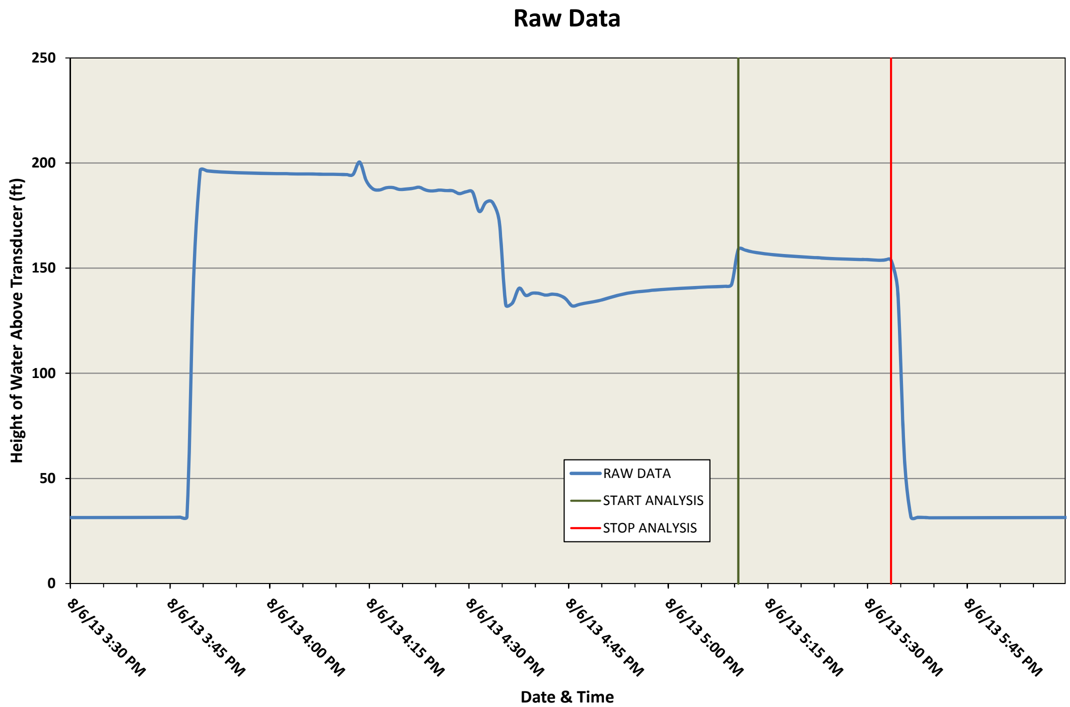
FIGURE B-2
Falling Head Test
Surface Drillhole 13-H3



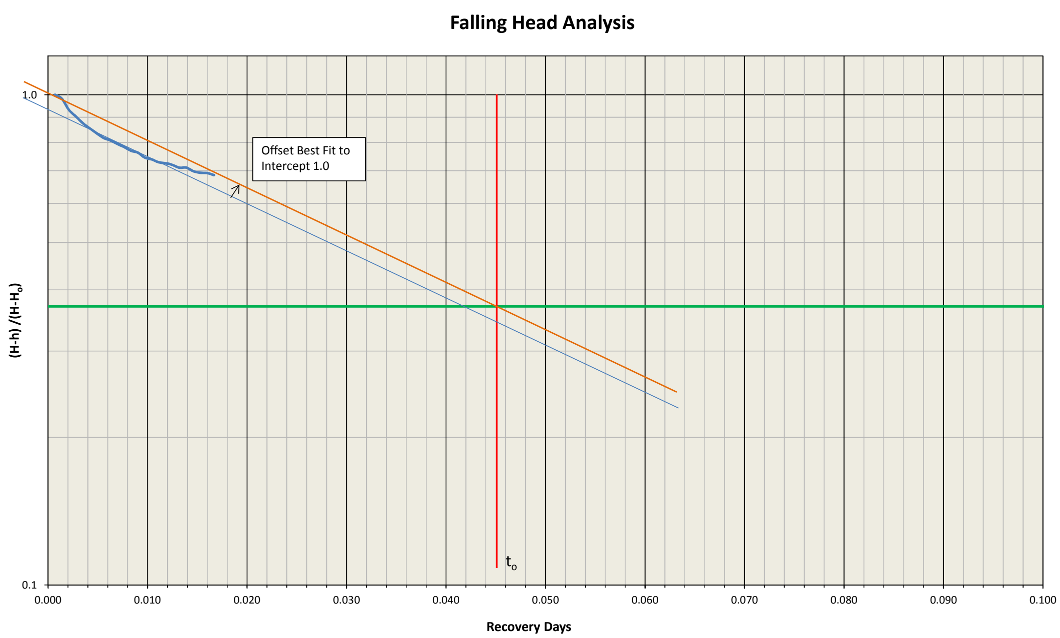
Pogo Mine	srk consulting			**FIGURE B-3** **Overview of Test Data** **Surface Drillhole 13-562**
	PROJECT NO. 147900.02	DATE October, 2013	VERSION 1.0	



Depth of Test Interval:
238 – 2,773 ft (TD)

Thickness of Test Interval: 2,535 ft

Recovery Duration: 23 mins



Hvorslev Equation:

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LTo}$$

Where:
K = Estimate of Hydraulic Conductivity (ft/d)
r = Radius of Well Casing (ft)
R = Radius of Well Screen (ft)
L = Length of Test Interval (ft)
T_o = Time for Water Level to Fall 37% of Initial Change (days)

$$K = \frac{(0.129')^2 \ln(2{,}535'/0.158')}{2(2{,}535')(0.045)}$$

***K* = 7.1x10^-4^ ft/d**

$K = 7.1 \times 10^{-4}$ ft/d

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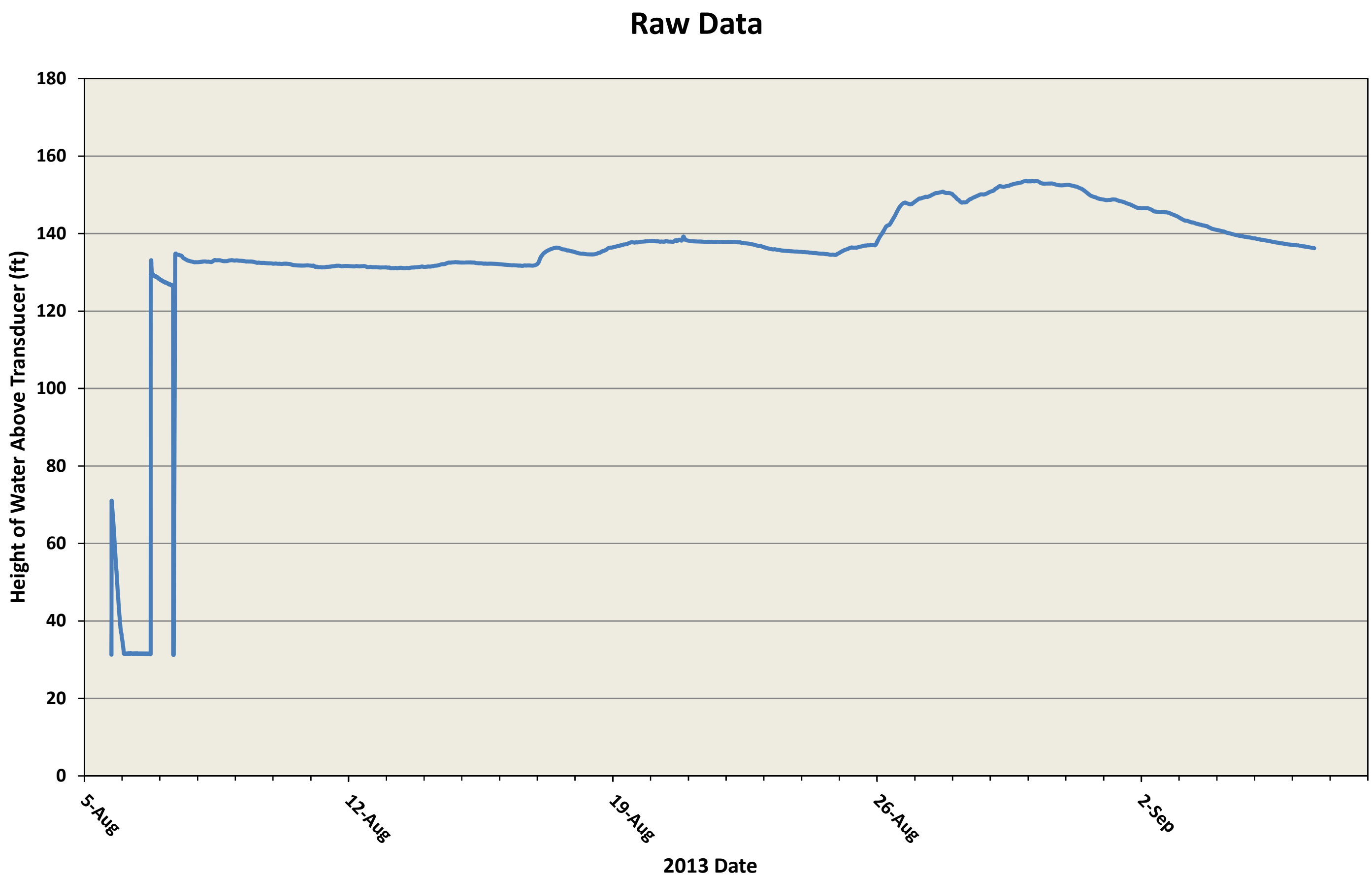
FIGURE B-4
Falling Head Test
Surface Drillhole 13-562



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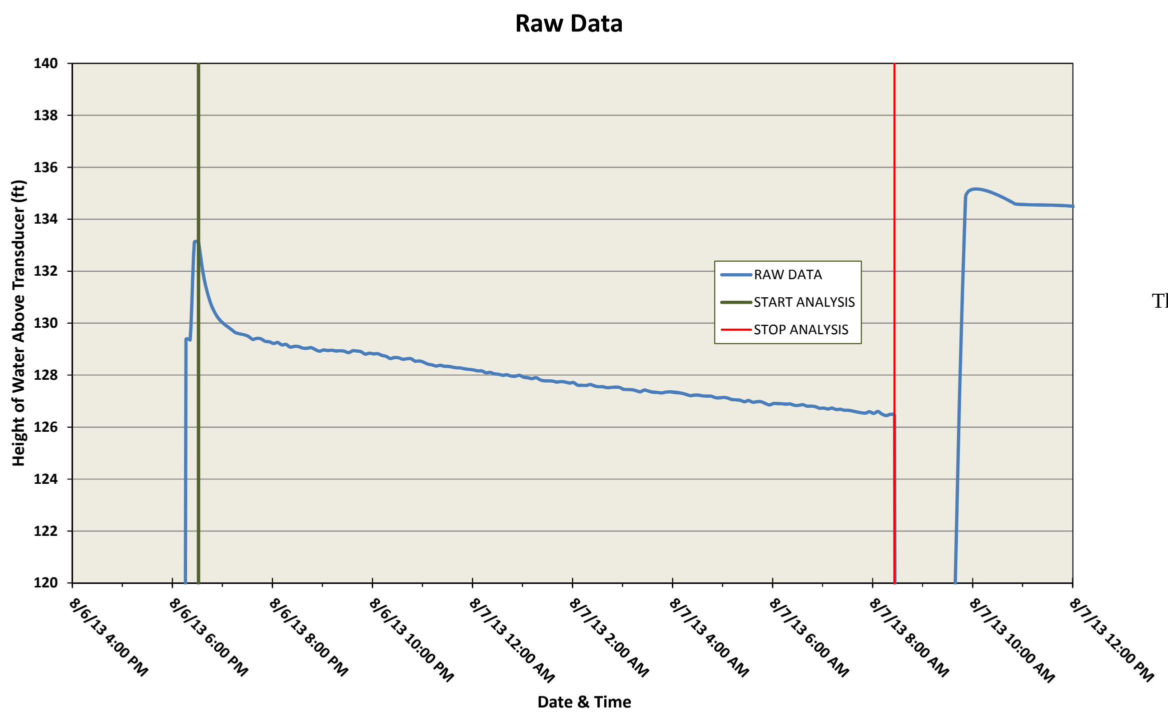
147900.02	October, 2013	1.0

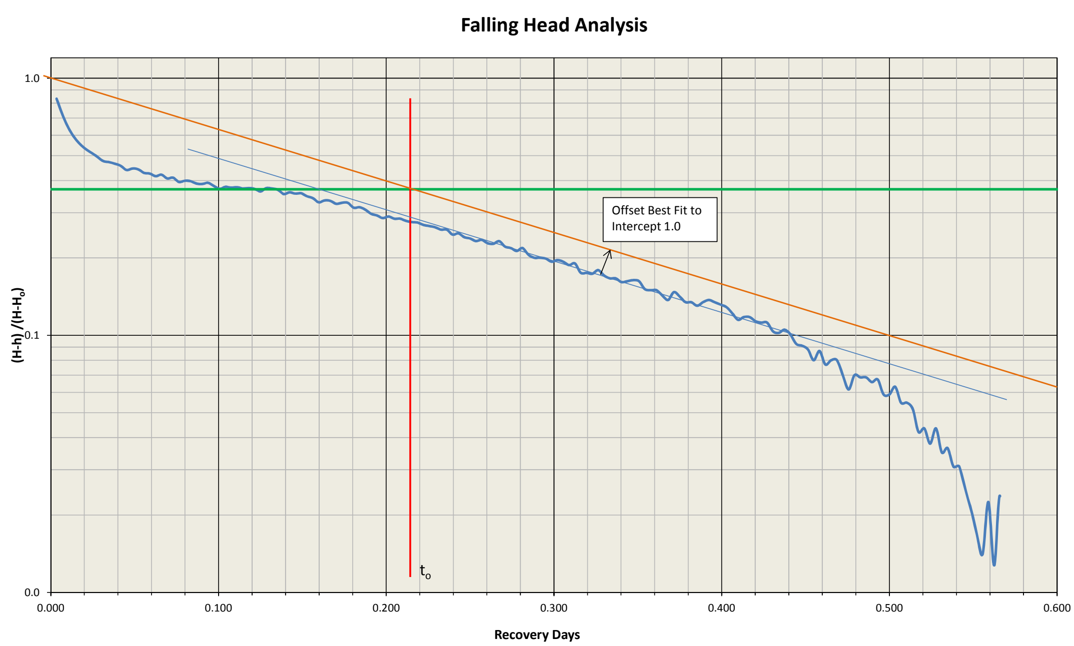
FIGURE B-5
Overview of Test Data
Surface Drillhole 13-695



Depth of Test Interval:
229 – 2,963 ft (TD)

Thickness of Test Interval: 2,734 ft

Recovery Duration: 13.9 hours



Hvorslev Equation:

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LTo}$$

Where:

K = Estimate of Hydraulic Conductivity (ft/d)

r = Radius of Well Casing (ft)

R = Radius of Well Screen (ft)

L = Length of Test Interval (ft)

T_o = Time for Water Level to Fall 37% of Initial Change (days)

$$K = \frac{(0.129')^2 \ln(2{,}734'/0.158')}{2(2{,}734')(0.218)}$$

K **= 1.4x10^{-4} ft/d**

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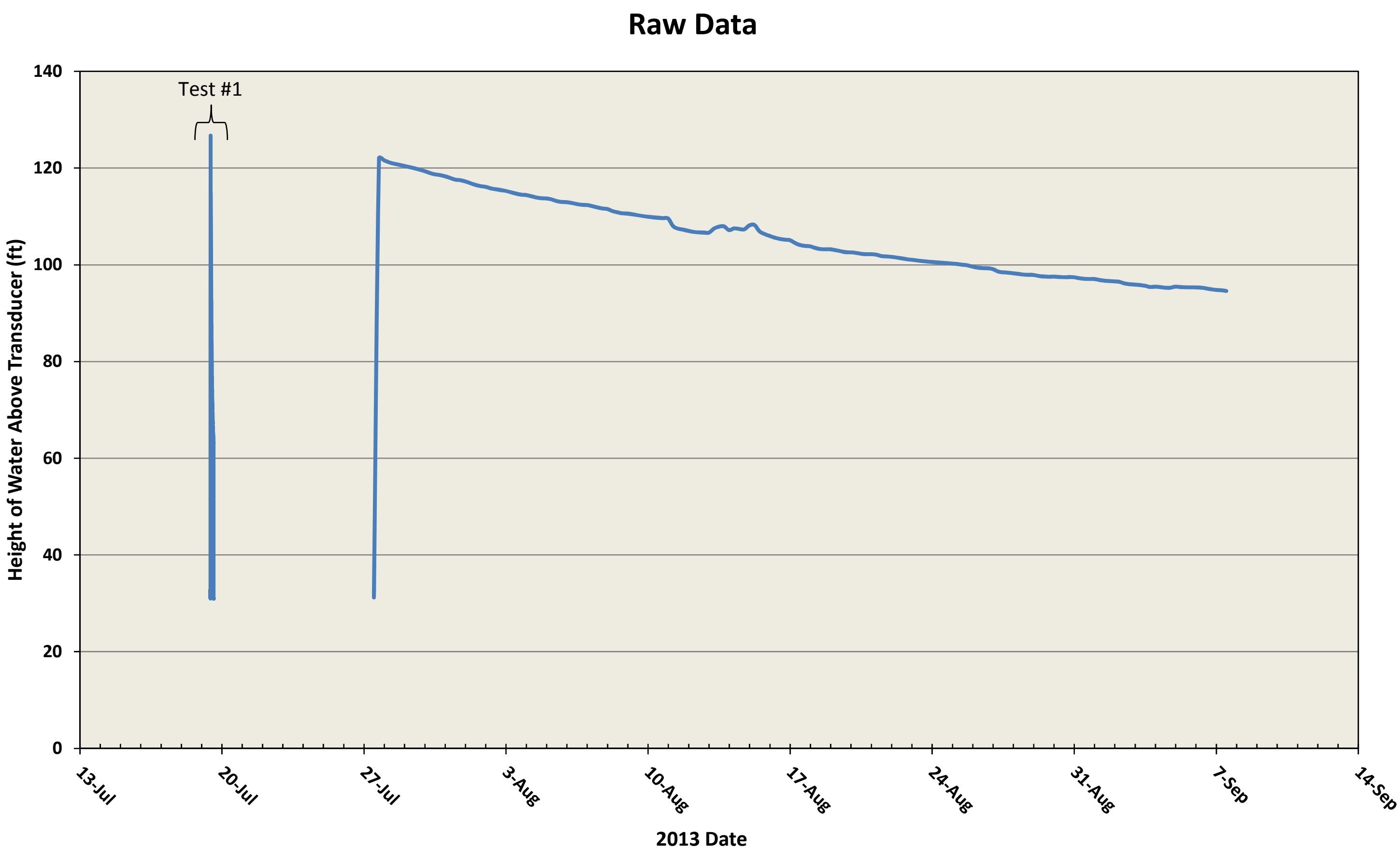
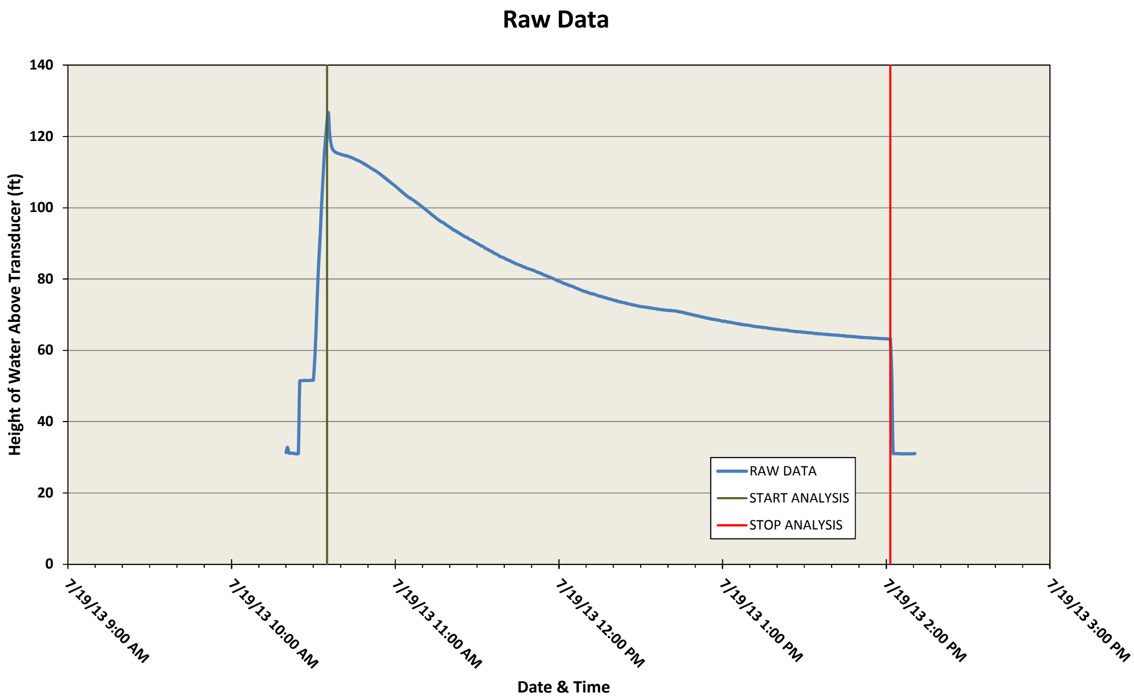
FIGURE B-6
Falling Head Test
Surface Drillhole 13-695



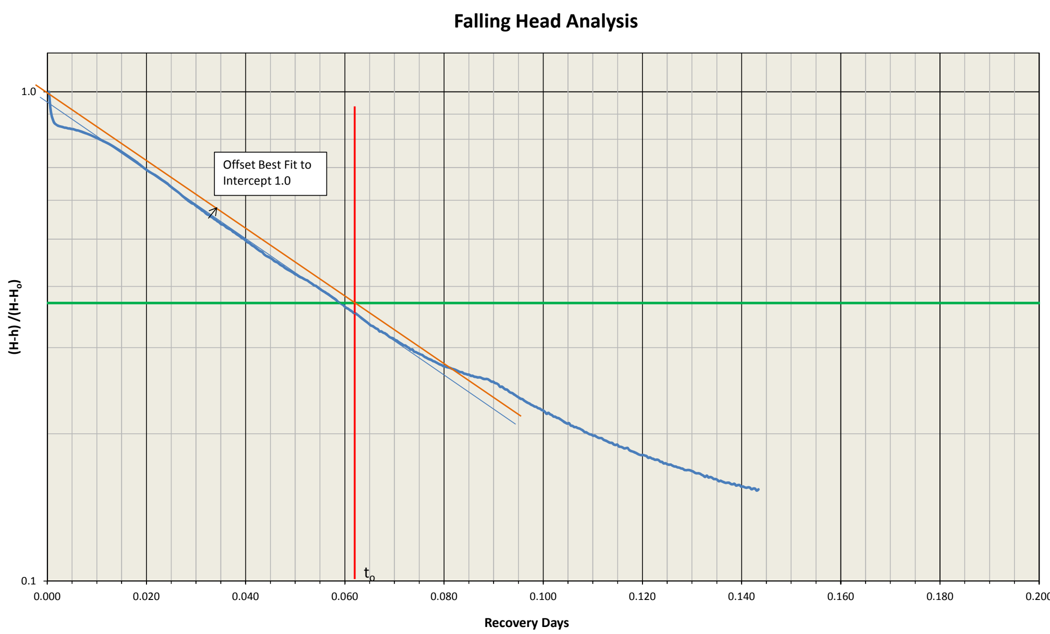
Pogo Mine	srk consulting		FIGURE B-7 Overview of Test Data Surface Drillhole 13-651
PROJECT NO. 147900.02	DATE October, 2013	VERSION 1.0	



Depth of Test Interval:
111 – 1,778 ft (TD)

Thickness of Test Interval: 1,667 ft

Recovery Duration: 3.4 hours



Hvorslev Equation:

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LTo}$$

Where:
K = Estimate of Hydraulic Conductivity (ft/d)
r = Radius of Well Casing (ft)
R = Radius of Well Screen (ft)
L = Length of Test Interval (ft)
T_o = Time for Water Level to Fall 37% of Initial Change (days)

$$K = \frac{(0.129')^2 \ln(1{,}667'/0.158')}{2(1{,}667')(0.062)}$$

K = 7.5x10^{-4} ft/d

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FIGURE B-8
Falling Head Test
Surface Drillhole 13-651

Appendix B-2:
Flow and Shut-In Recovery Tests in Underground Drillholes

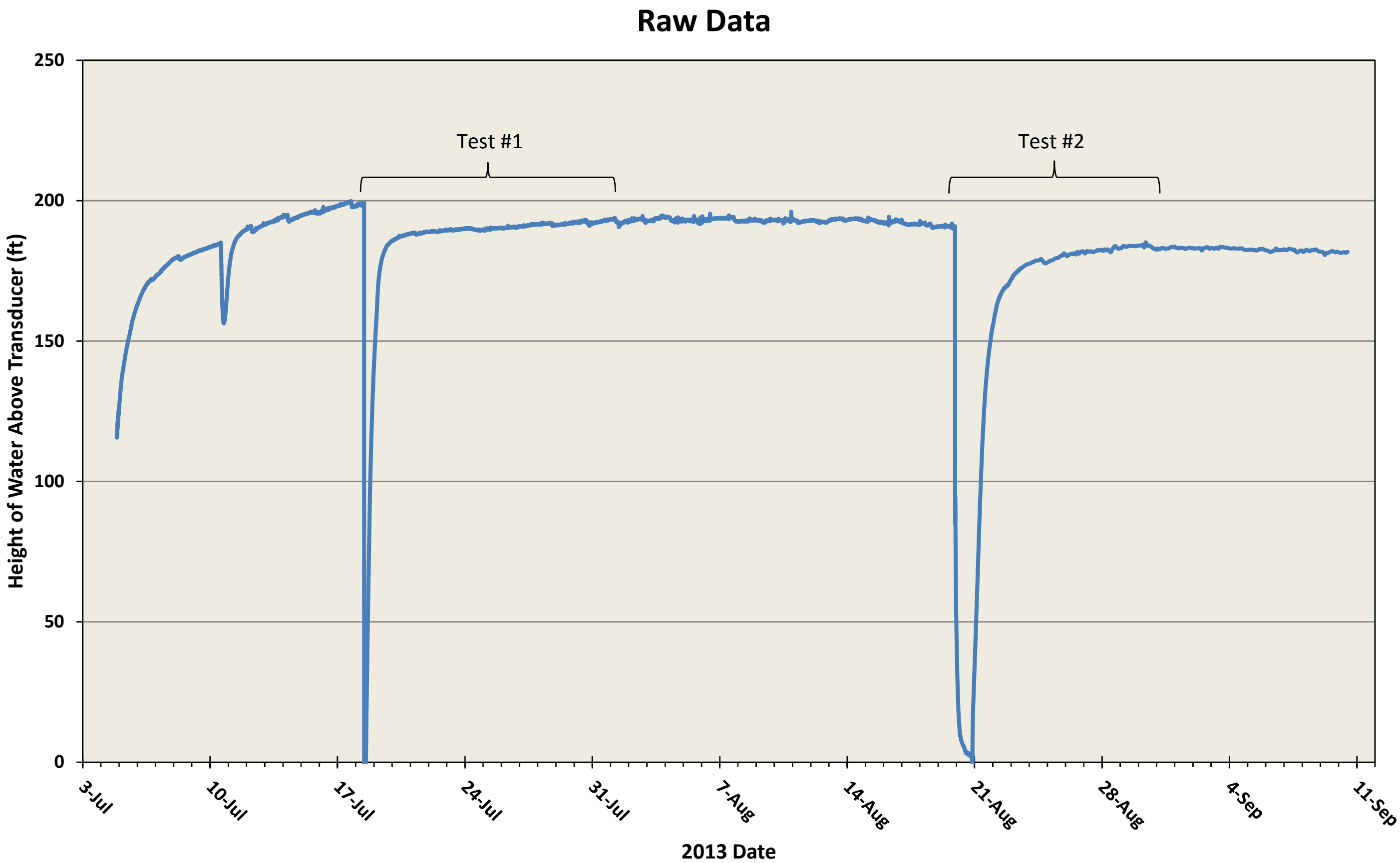

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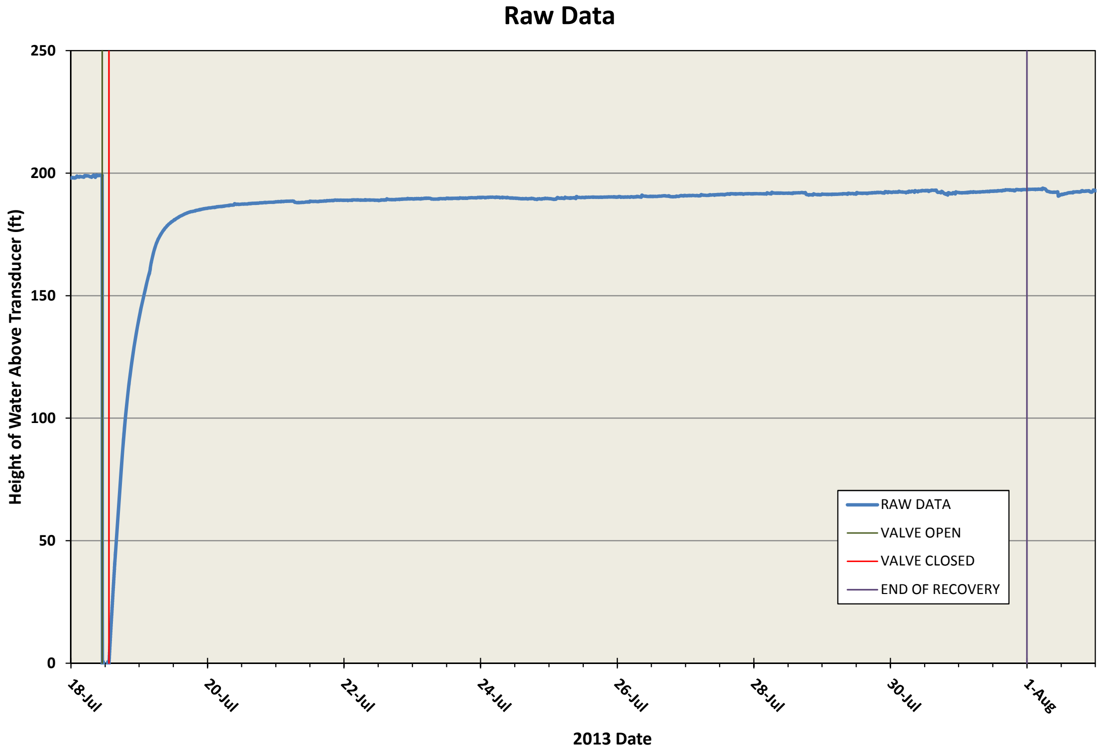
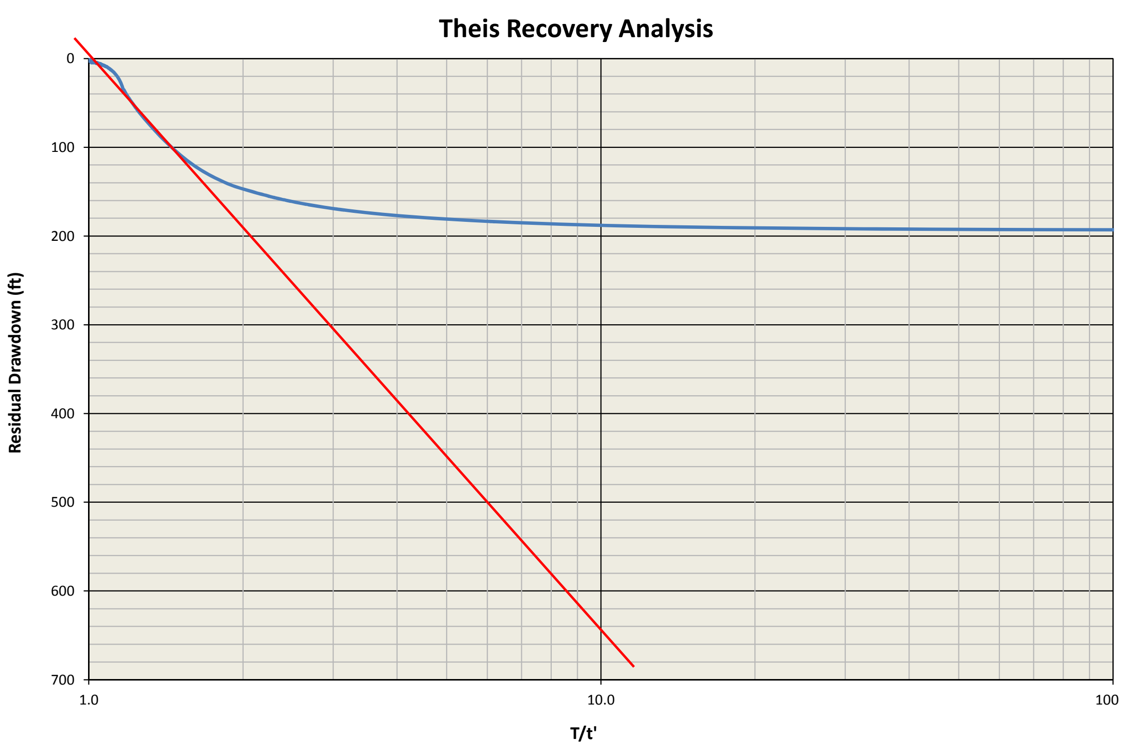
FIGURE B-9
Overview of Test Data
Underground Drillhole 13Hydro-01



Depth of Test Interval:
0 – 464 ft (TD)

Flow Duration: 143 mins
Recovery Duration: 13 days

Flow Rate (Q) = 0.48 gpm
Flow Rate (Q) = 92.4 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\ (92.4)}{4\pi(650)} = 0.026\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(0.026)}{(464)} = 5.6x10^{-5}\ ft/d$$

T = 0.026 ft^2/d
K = 5.6x10^{-5} ft/d

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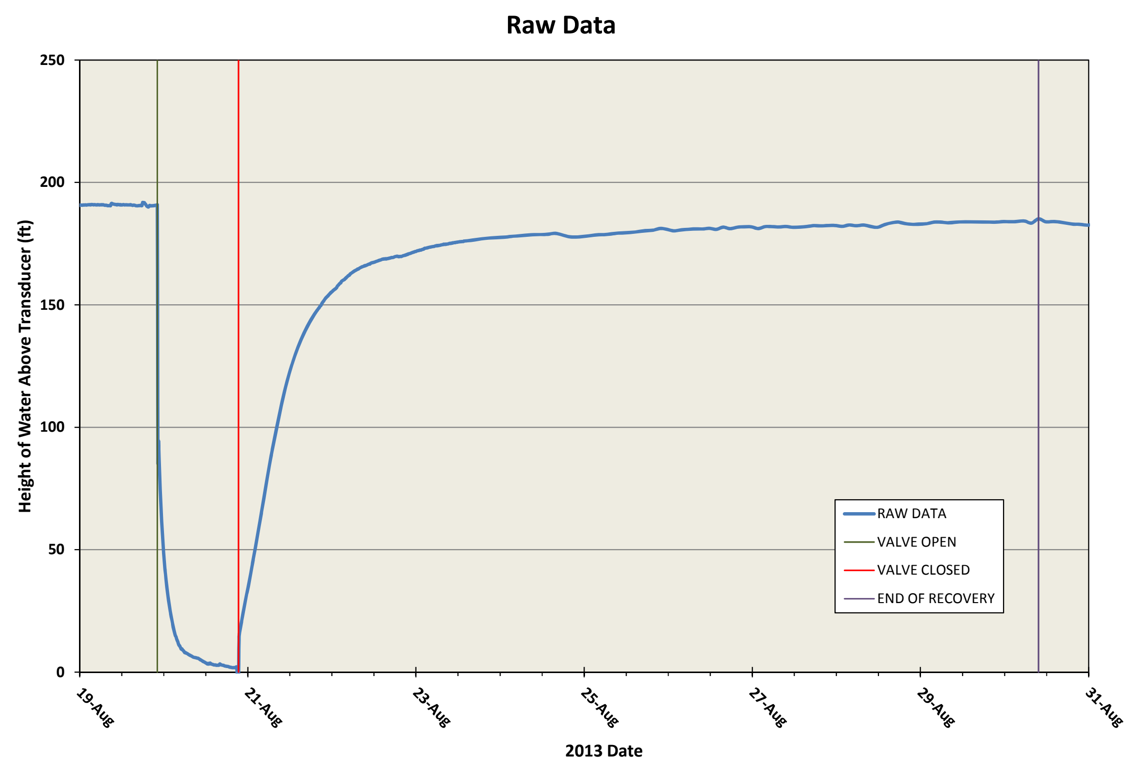
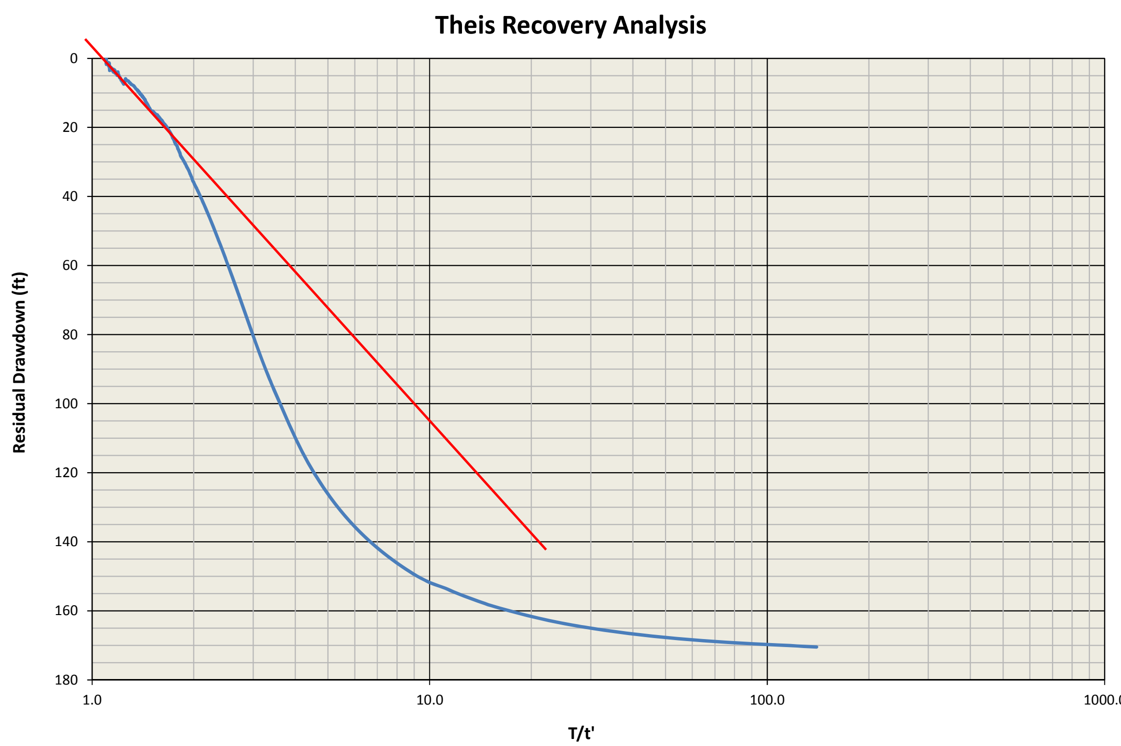
FIGURE B-10
Shut-In Test
Underground Drillhole Hydro-01 Test No.1



Depth of Test Interval:
0 – 464 ft (TD)

Flow Duration: 23.17 hours
Recovery Duration: 9.5 days

Flow Rate (Q) = 1.17 gpm
Flow Rate (Q) = 225.2 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(225.2)}{4\pi(110)} = 0.37\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(0.37)}{(464)} = 8.1x10^{-4}\ ft/d$$

T = 0.37 ft^2/d
K = 8.1x10^{-4} ft/d

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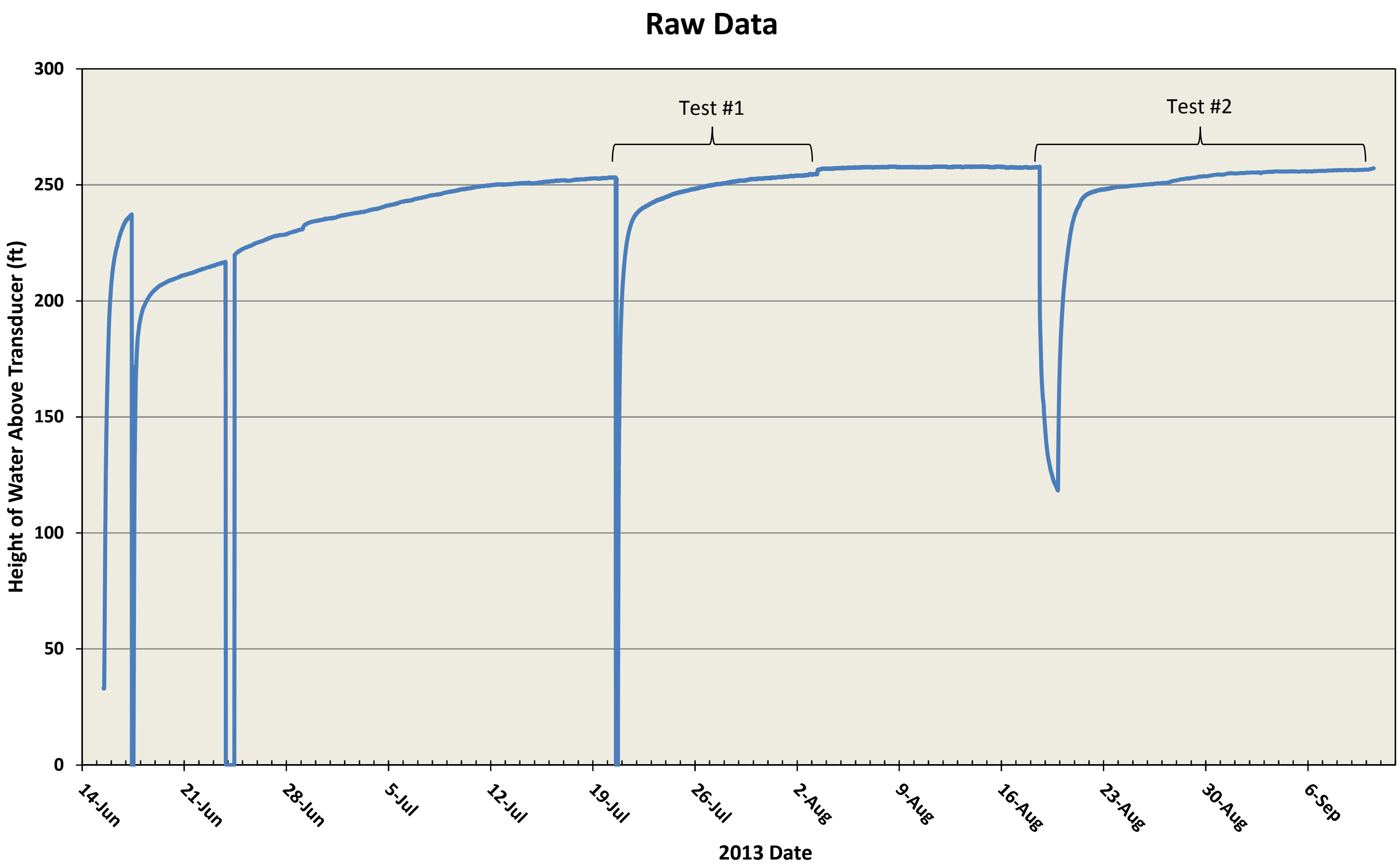
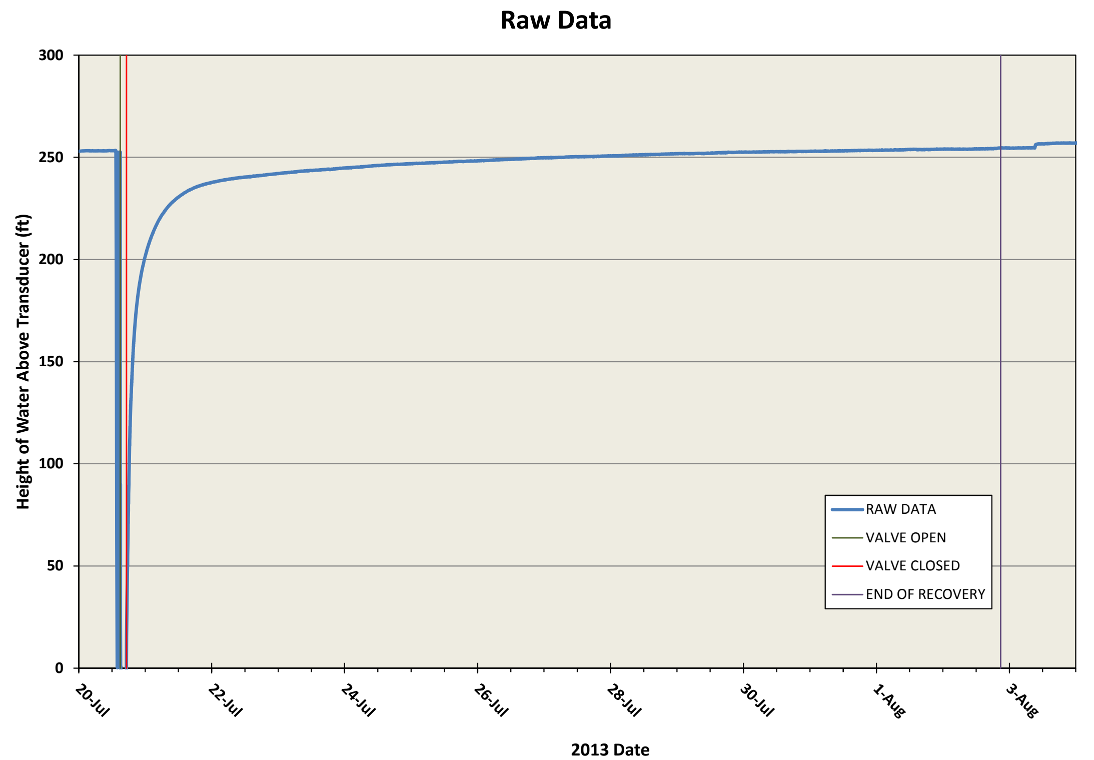
FIGURE B-11
Shut-In Test
Underground Drillhole Hydro-01 Test No.2



PROJECT NO.	DATE	VERSION
147900.02	October, 2013	1.0

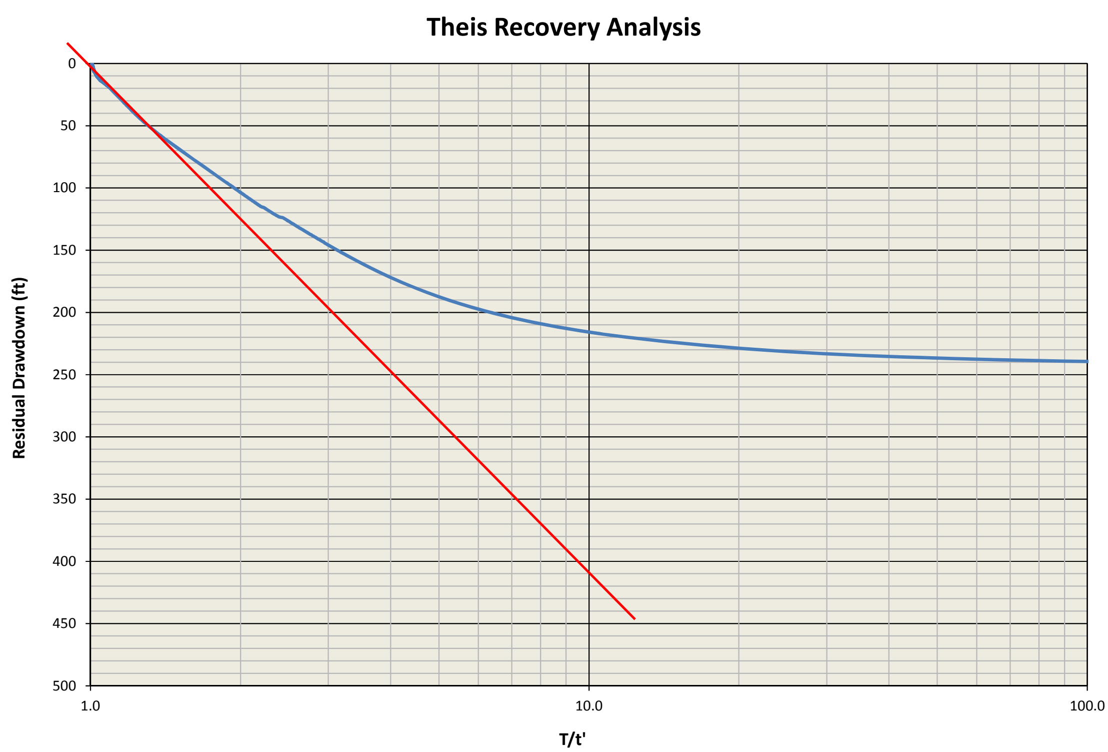
FIGURE B-12
Overview of Test Data
Underground Drillhole 13Hydro-02



Depth of Test Interval:
0 – 500 ft (TD)

Flow Duration: 136 mins
Recovery Duration: 13.2 days

Flow Rate (Q) = 3.05 gpm
Flow Rate (Q) = 587.1 ft³/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(587.1)}{4\pi(410)} = 0.26 \text{ ft}^2\text{/d}$$

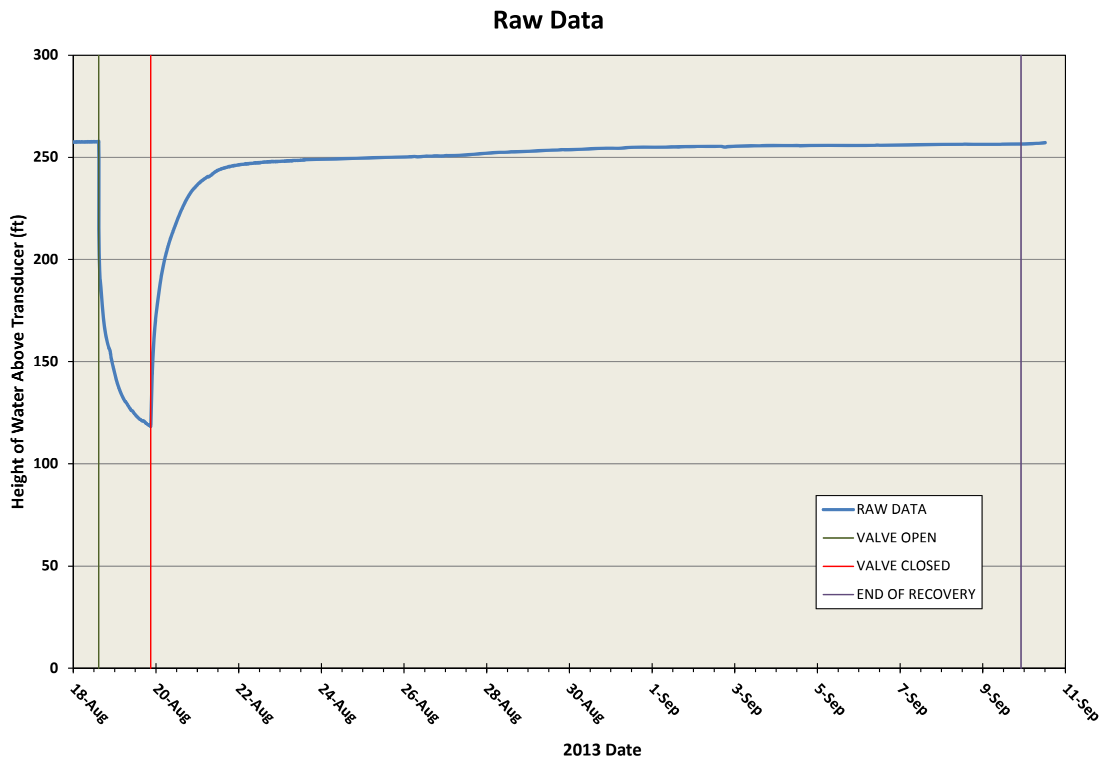
$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(0.26)}{(500)} = 5.2\text{x}10^{-4} \text{ ft/d}$$

T = 0.26 ft^2/d
K = 5.2x10^{-4} ft/d

Pogo Mine	srk consulting			FIGURE B-13 Shut-In Test Underground Drillhole Hydro-02 Test No.1
	PROJECT NO. 147900.02	DATE October, 2013	VERSION 1.0	



Depth of Test Interval:
0 – 500 ft (TD)

Flow Duration: 30.2 hours
Recovery Duration: 21.1 days

Flow Rate (Q) = 0.97 gpm
Flow Rate (Q) = 186.7 ft^3/d

Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(186.7)}{4\pi(60)} = 0.57\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(0.57)}{(500)} = 1.1x10^{-3}\ ft/d$$

T = 0.57 ft^2/d
K = 1.1x10^{-3} ft/d

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FIGURE B-14
Shut-In Test
Underground Drillhole Hydro-02 Test No.2

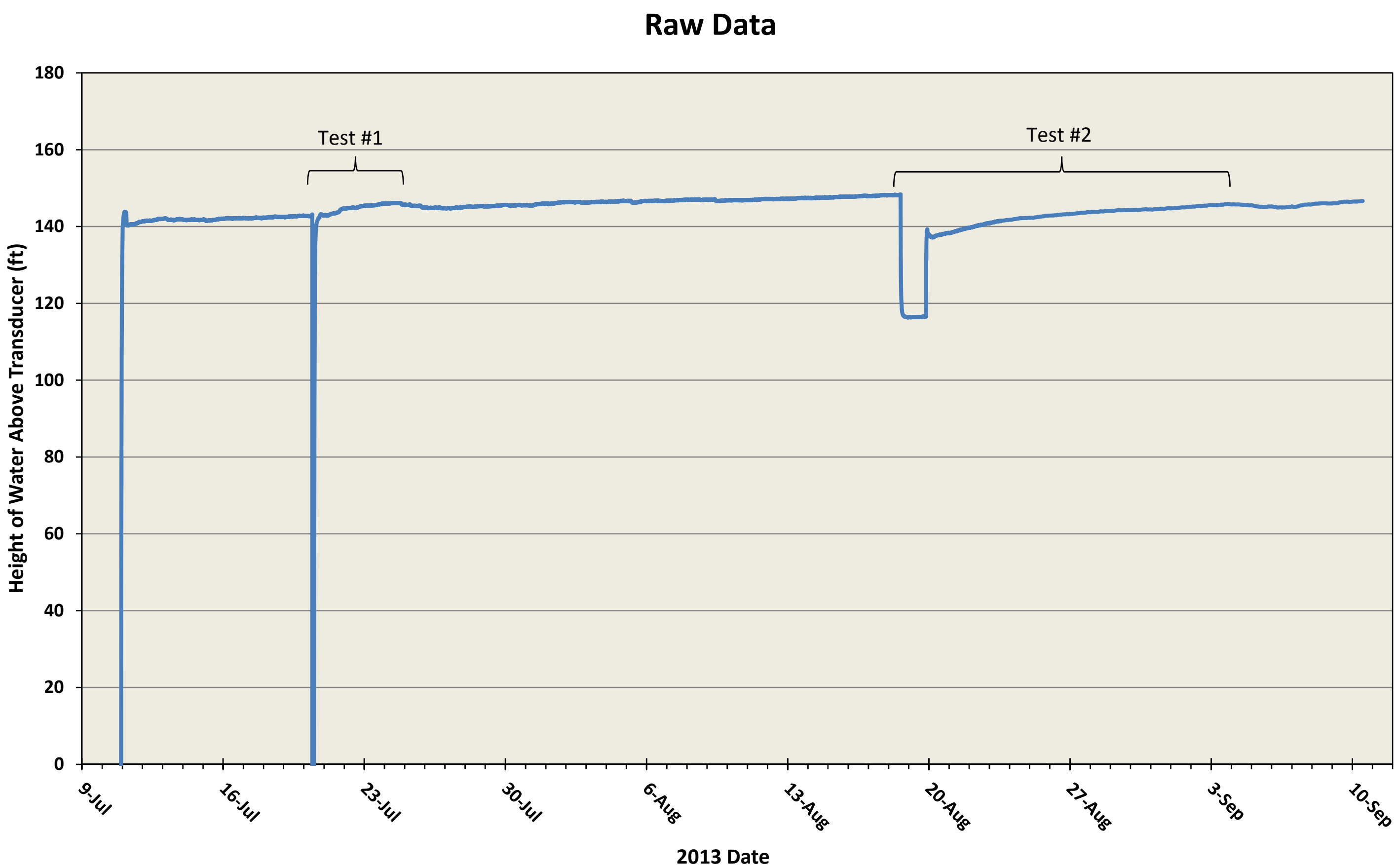

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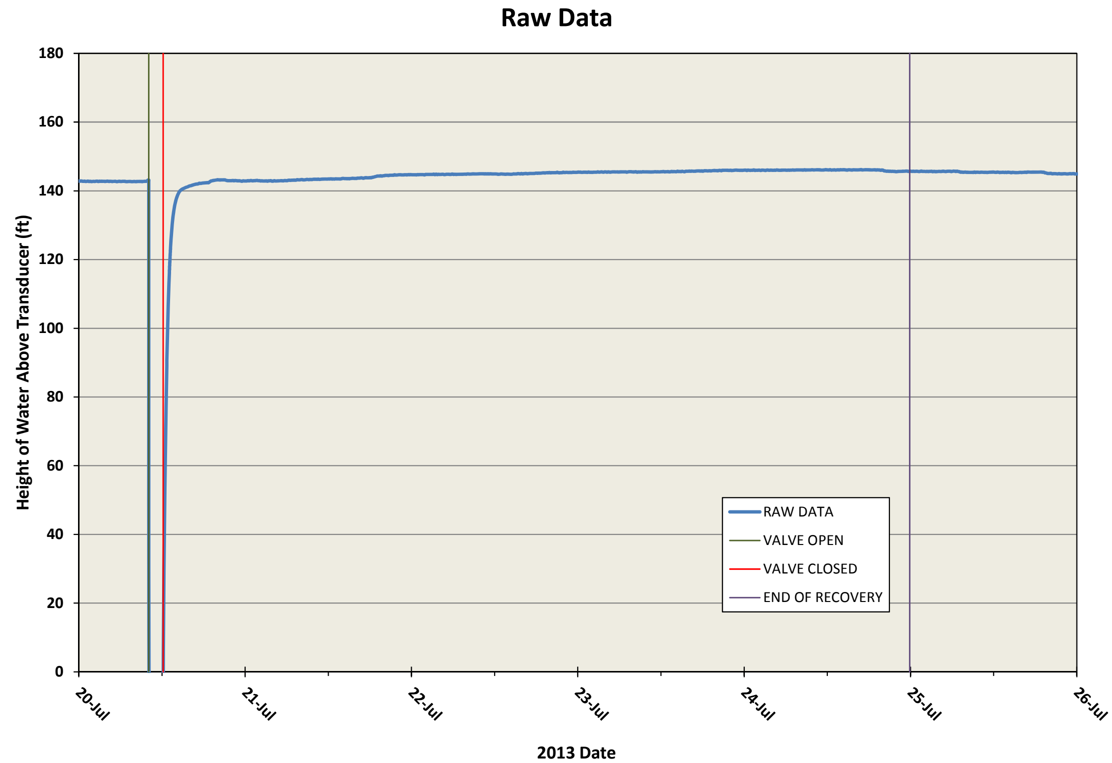
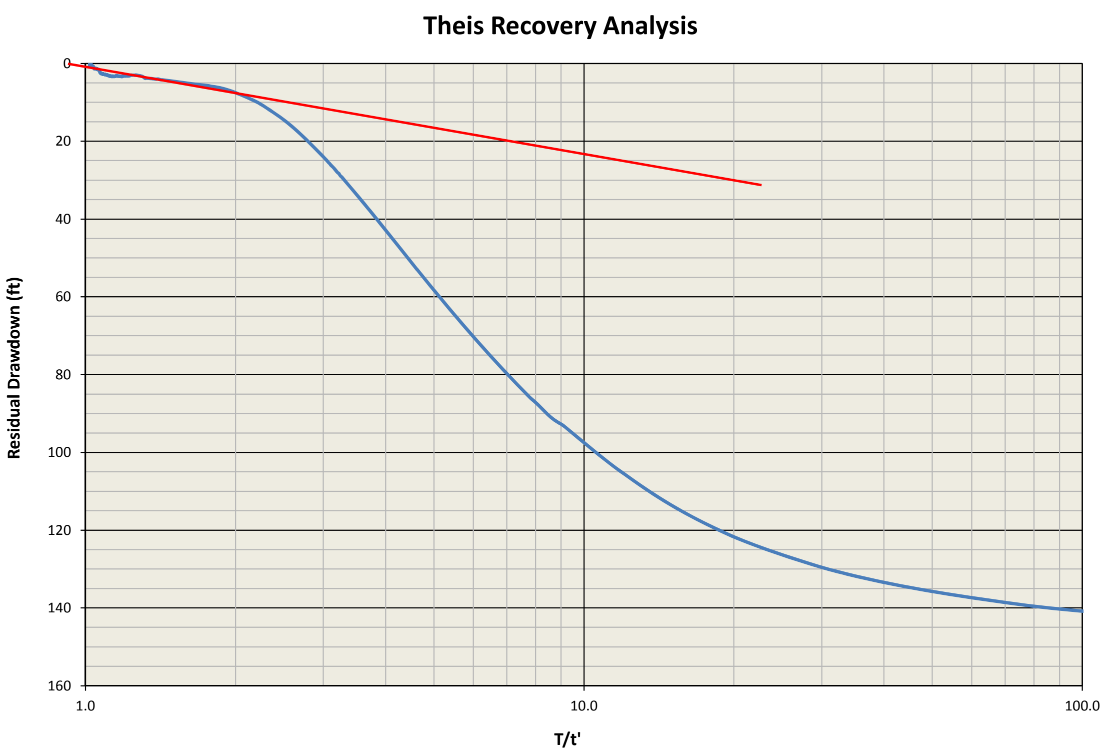
FIGURE B-15
Overview of Test Data
Underground Drillhole 13Hydro-03



Depth of Test Interval:
0 – 218 ft (TD)

Flow Duration: 125 mins
Recovery Duration: 4.5 days

Flow Rate (Q) = 2.39 gpm
Flow Rate (Q) = 460.1 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(460.1)}{4\pi(23)} = 3.66\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(3.66)}{(218)} = 1.7x10^{-2}\ ft/d$$

T = 3.66 ft^2/d
K = 1.7x10^{-2} ft/d

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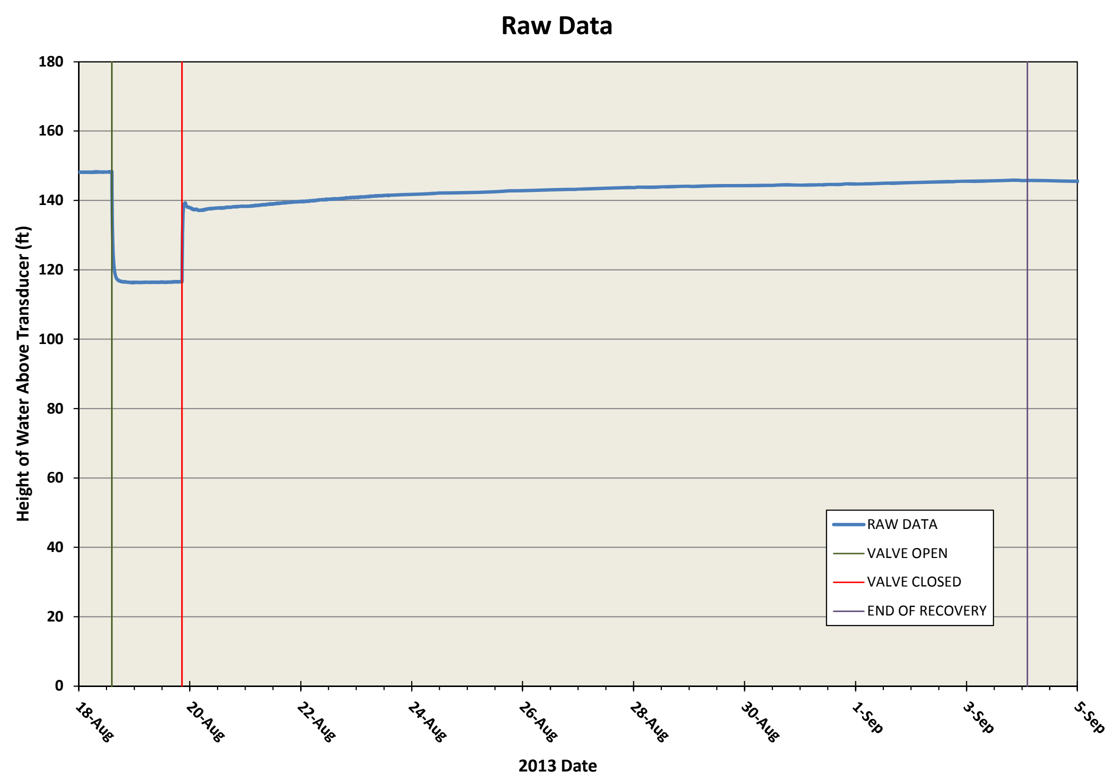
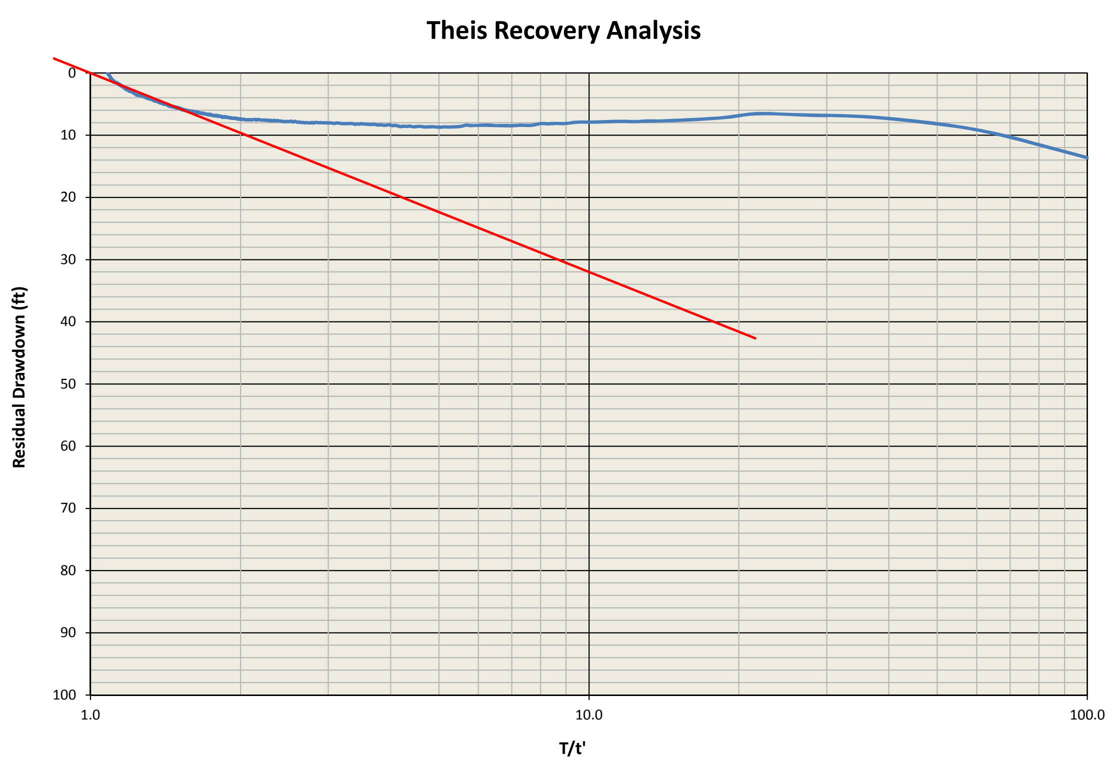
FIGURE B-16
Shut-In Test
Underground Drillhole Hydro-03 Test No.1



Depth of Test Interval:
0 – 218 ft (TD)

Flow Duration: 30.3 hours
Recovery Duration: 15.2 days

Flow Rate (Q) = 0.66 gpm
Flow Rate (Q) = 127.1 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(127.1)}{4\pi(32)} = 0.73\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(0.73)}{(218)} = 3.3\times10^{-3}\ ft/d$$

T = 0.73 ft^2/d
K = 3.3x10^{-3} ft/d

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FIGURE B-17
Shut-In Test
Underground Drillhole Hydro-03 Test No.2

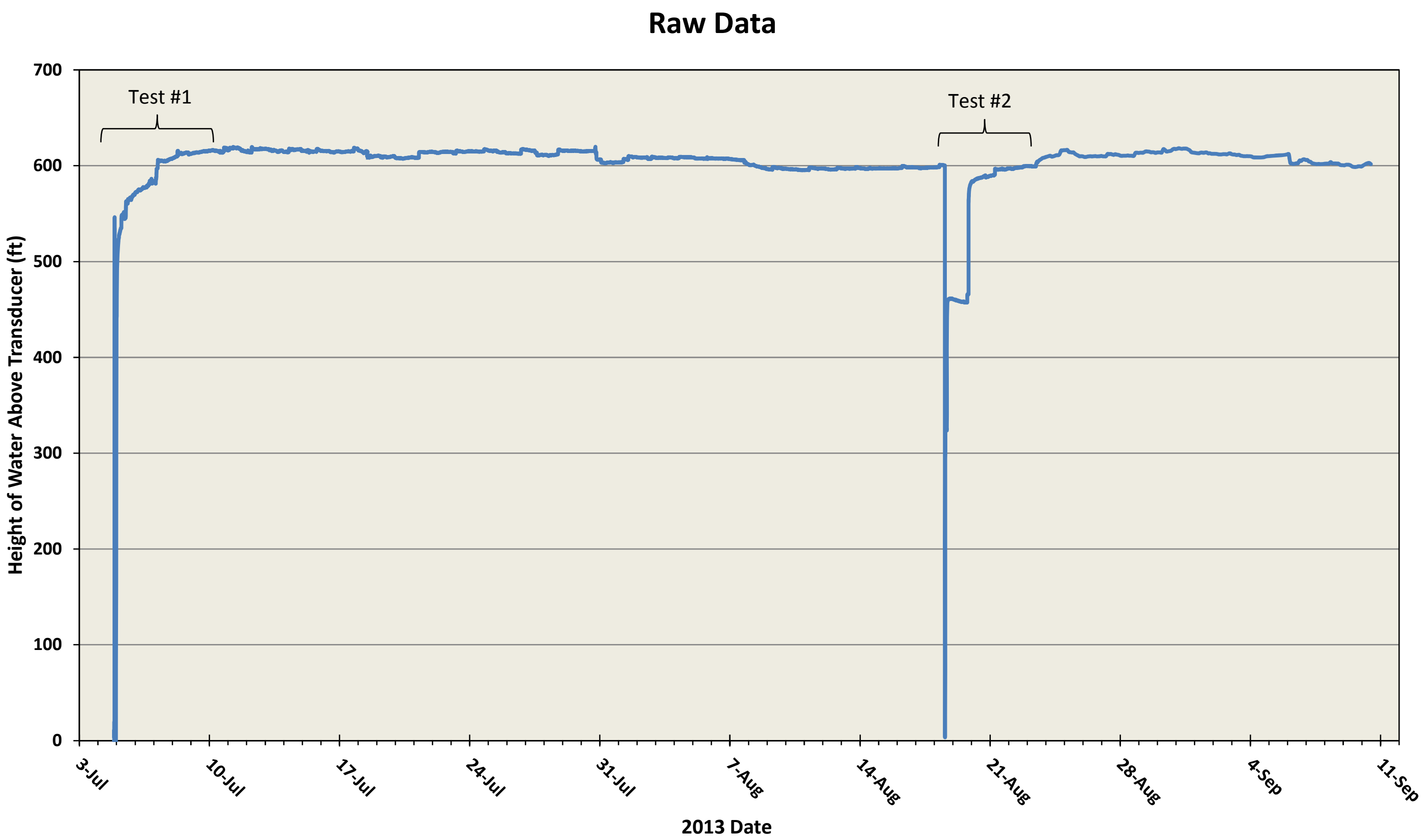

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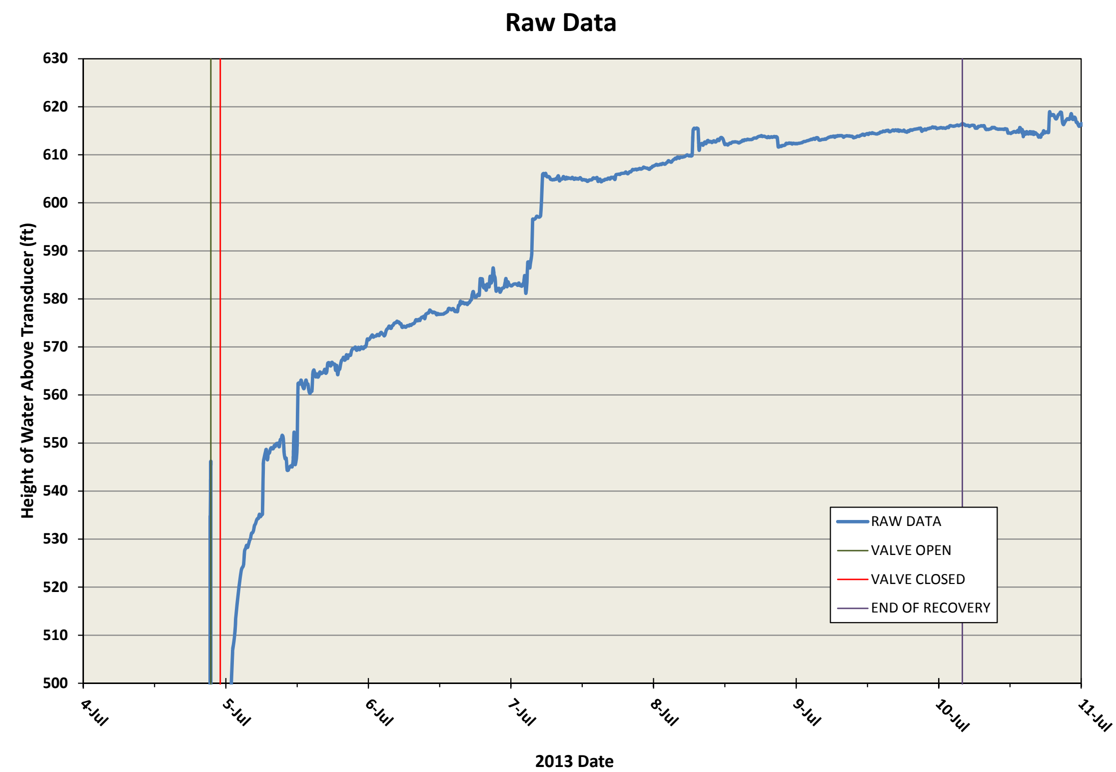
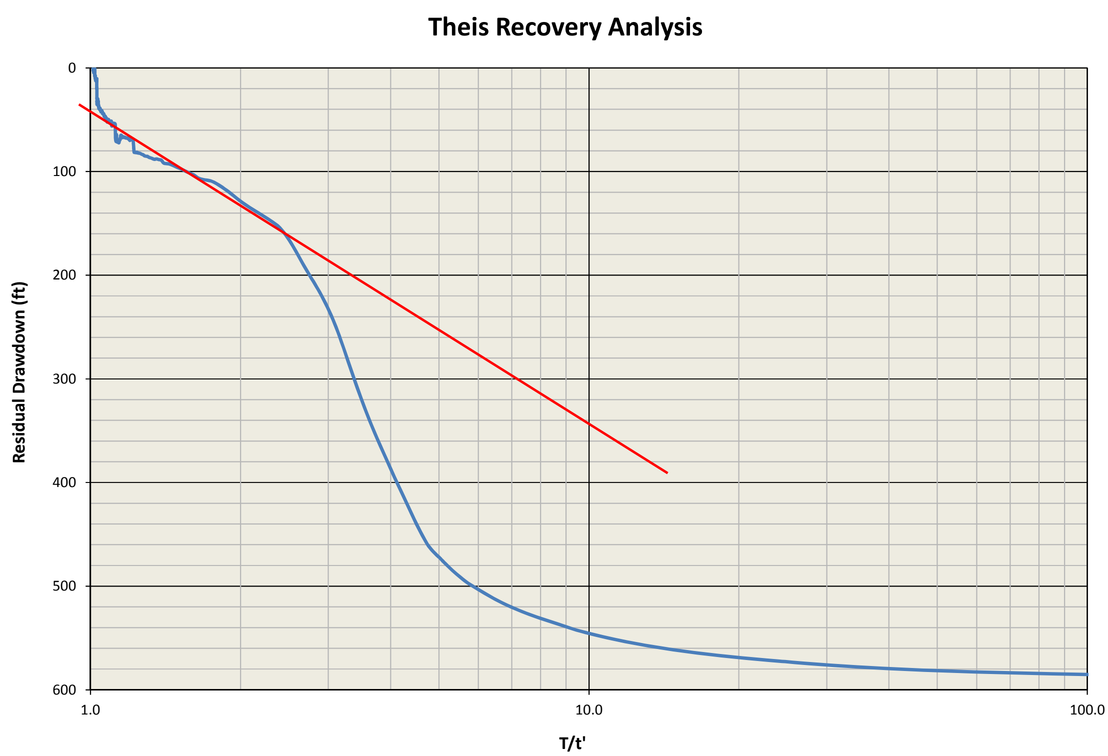
FIGURE B-18
Overview of Test Data
Underground Drillhole 13Hydro-04



Depth of Test Interval:
0 – 425 ft (TD)

Flow Duration: 95 mins
Recovery Duration: 5.2 days

Flow Rate (Q) = 2.50 gpm
Flow Rate (Q) = 481.3 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(481.3)}{4\pi(300)} = 0.29\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(0.29)}{(425)} = 6.9 \times 10^{-4}\ ft/d$$

T = 0.29 ft^2/d
K = 6.9×10^{-4} ft/d

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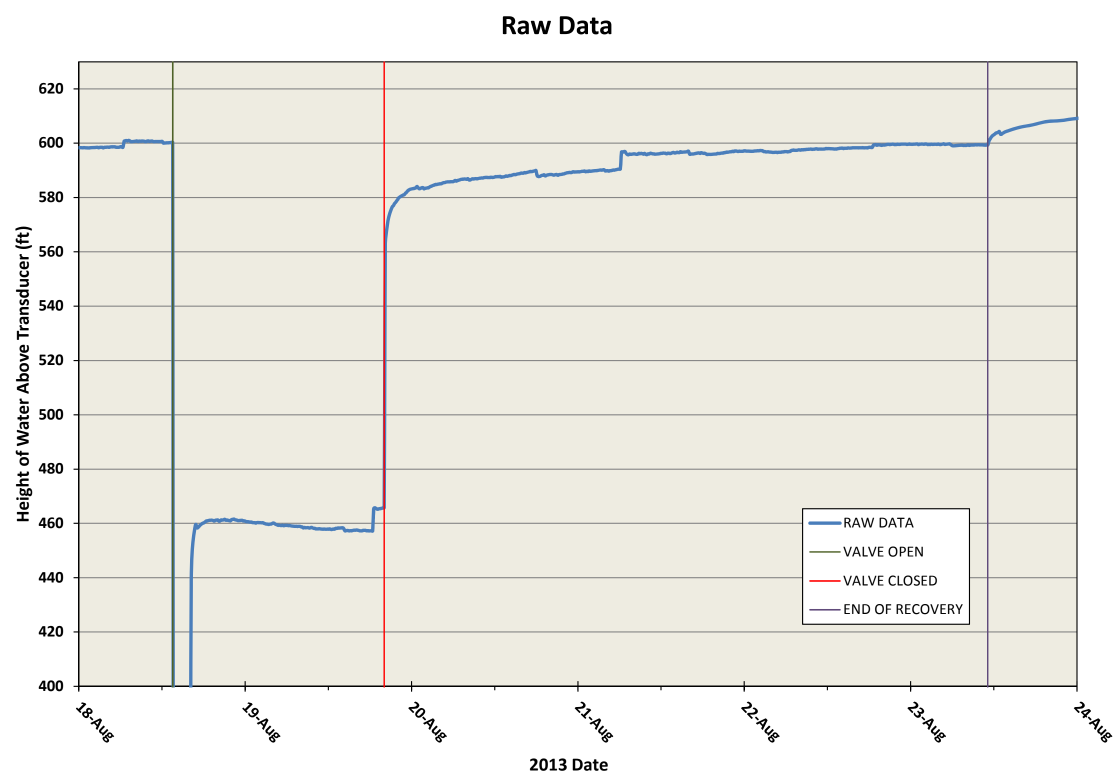
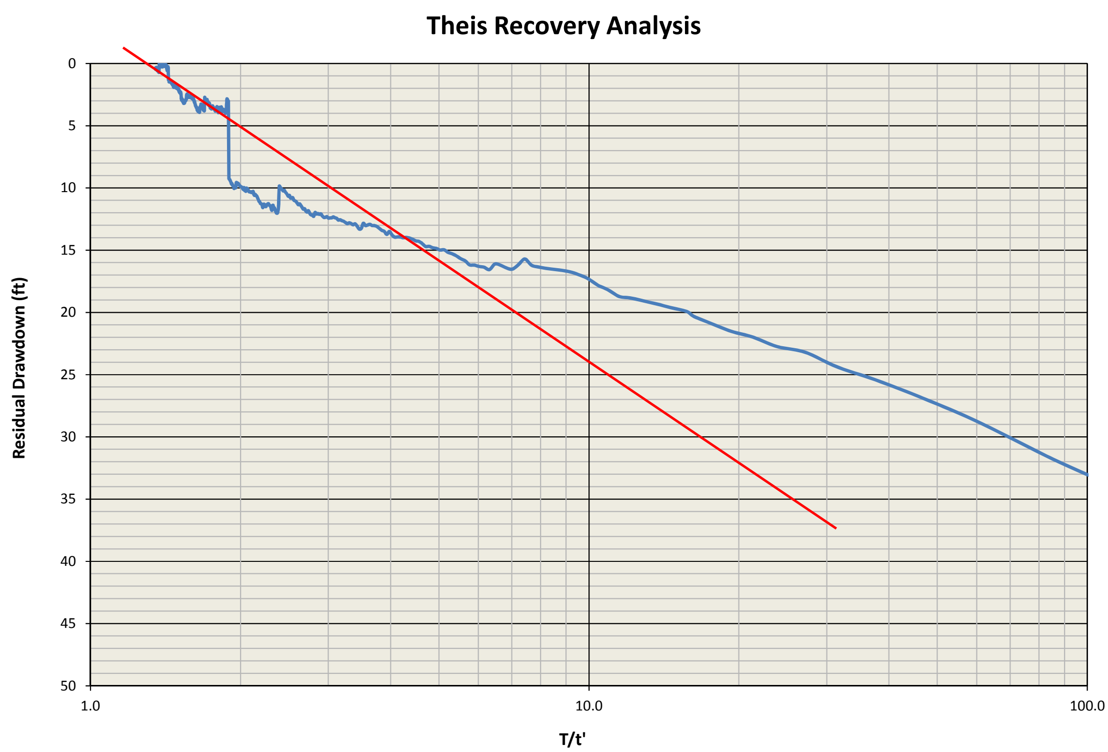
FIGURE B-19
Shut-In Test
Underground Drillhole Hydro-04 Test No.1



Depth of Test Interval:
0 – 425 ft (TD)

Flow Duration: 30.5 hours
Recovery Duration: 3.6 days

Flow Rate (Q) = 0.85 gpm
Flow Rate (Q) = 163.6 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(163.6)}{4\pi(27)} = 1.11\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(1.11)}{(425)} = 2.6 \times 10^{-3}\ ft/d$$

T = 1.11 ft^2/d
K = 2.6x10^{-3} ft/d

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FIGURE B-20
Shut-In Test
Underground Drillhole Hydro-04 Test No.2

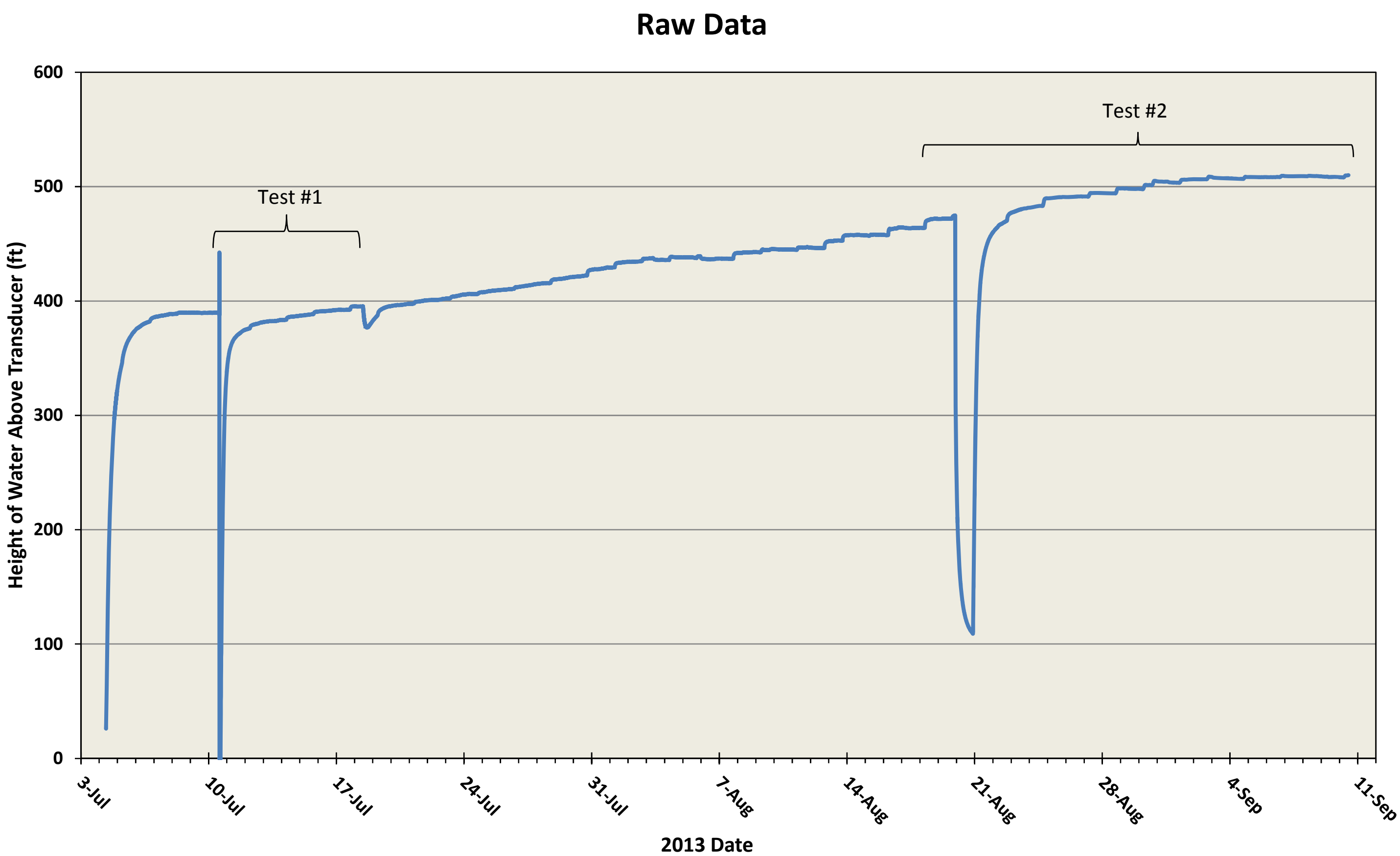

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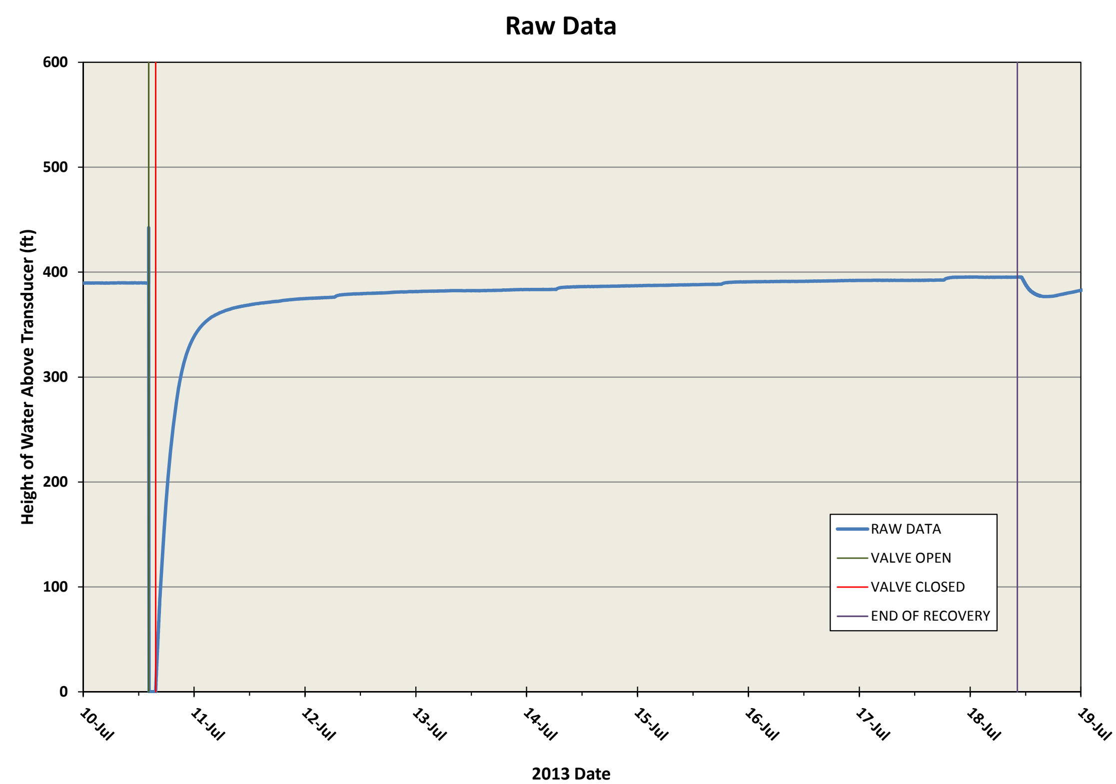
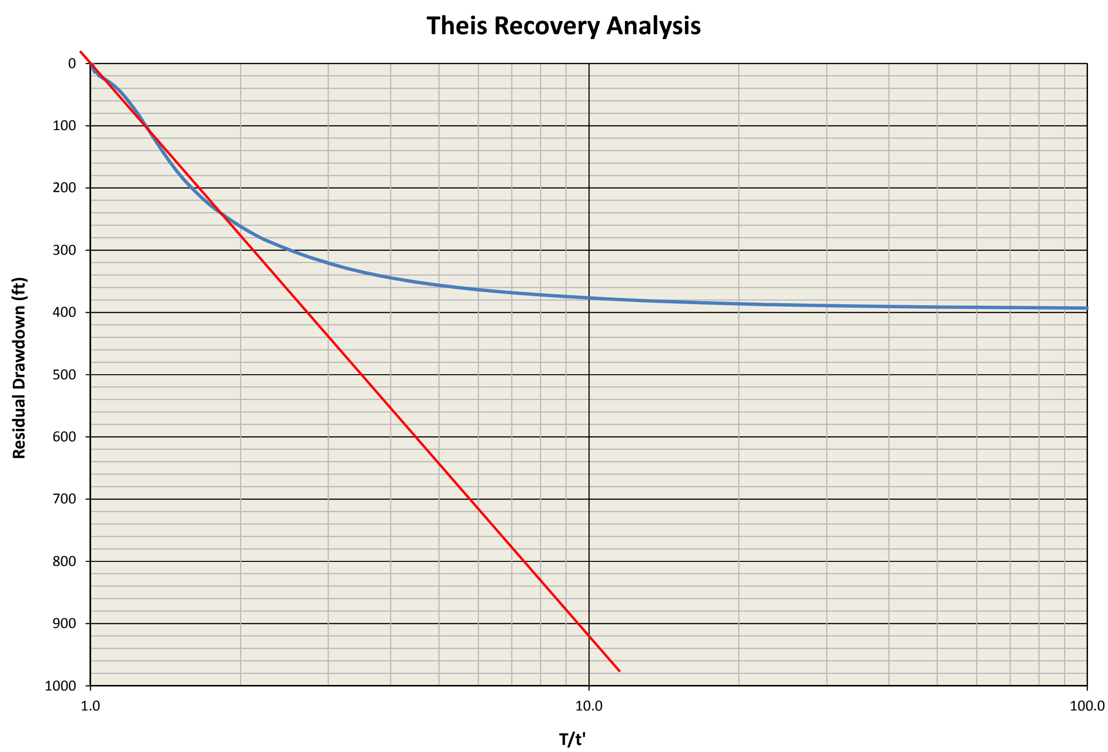
FIGURE B-21
Overview of Test Data
Underground Drillhole 13Hydro-05



Depth of Test Interval:
0 – 600 ft (TD)

Flow Duration: 91 mins
Recovery Duration: 7.8 days

Flow Rate (Q) = 0.36 gpm
Flow Rate (Q) = 69.3 ft³/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft²/d)
Q = Pumping Rate (ft³/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\ (69.3)}{4\pi(920)} = 0.014\ \text{ft}^2/\text{d}$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(0.014)}{(600)} = 2.3\text{x}10^{-5}\ \text{ft/d}$$

T = 0.014 ft²/d
K = 2.3x10⁻⁵ ft/d

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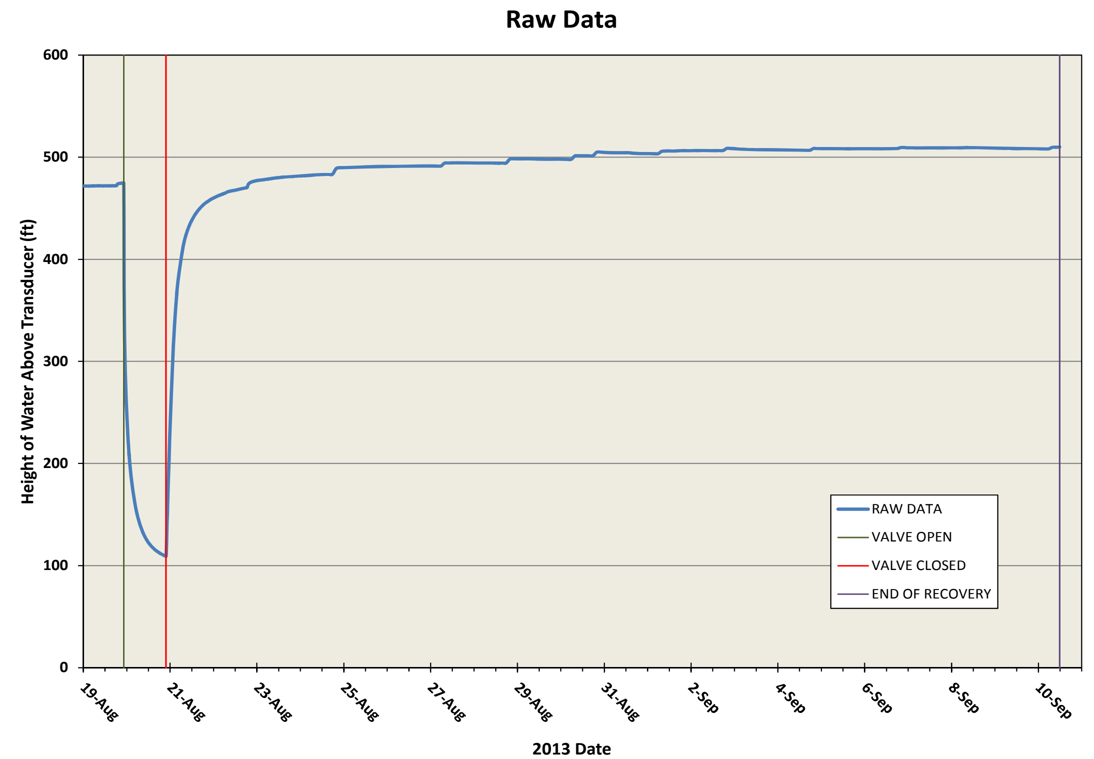
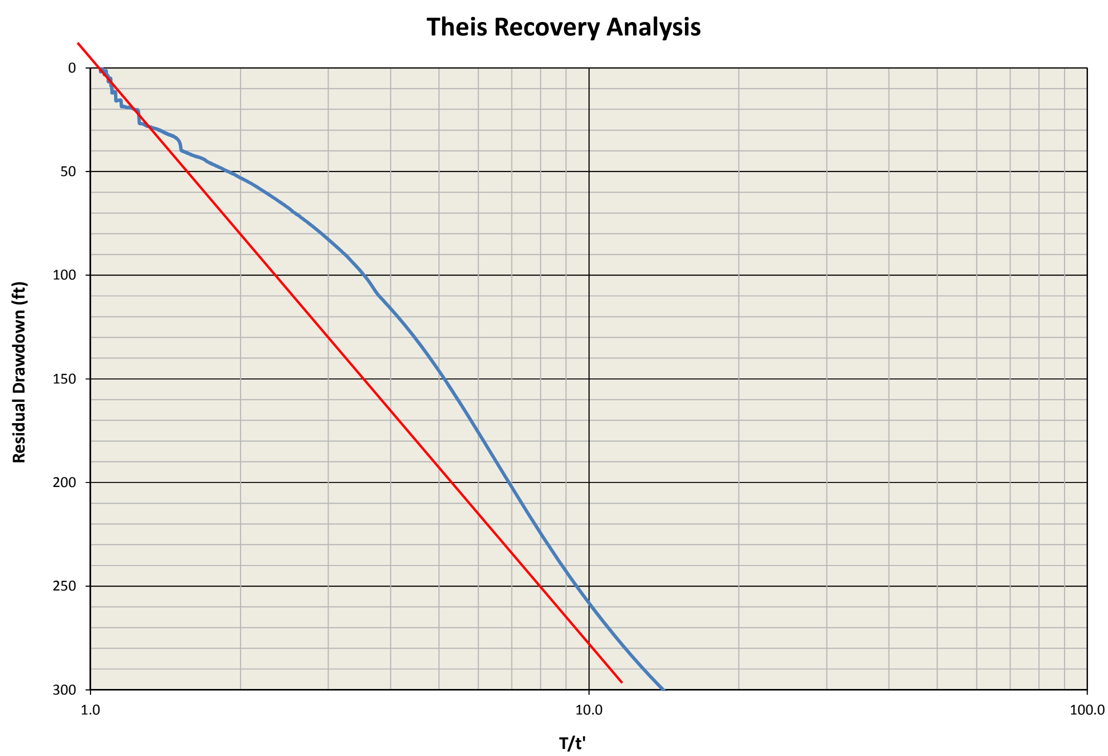
FIGURE B-22
Shut-In Test
Underground Drillhole Hydro-05 Test No.1



Depth of Test Interval:
0 – 600 ft (TD)

Flow Duration: 23.3 hours
Recovery Duration: 20.6 days

Flow Rate (Q) = 1.15 gpm
Flow Rate (Q) = 221.4 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(221.4)}{4\pi(285)} = 0.14\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(0.14)}{(600)} = 2.4x10^{-4}\ ft/d$$

T = 0.14 ft^2/d
K = 2.4x10^{-4} ft/d

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FIGURE B-23
Shut-In Test
Underground Drillhole Hydro-05 Test No.2

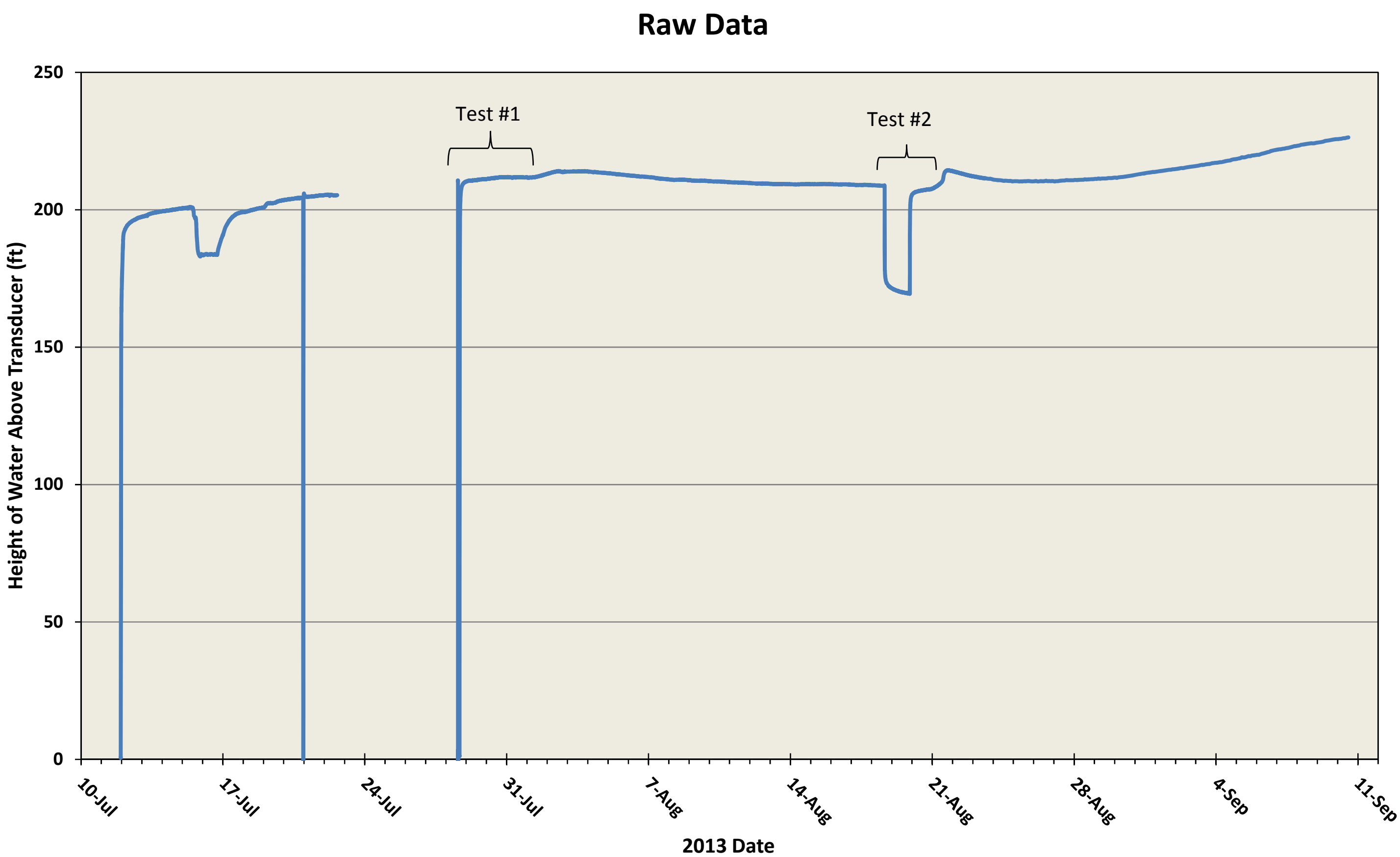

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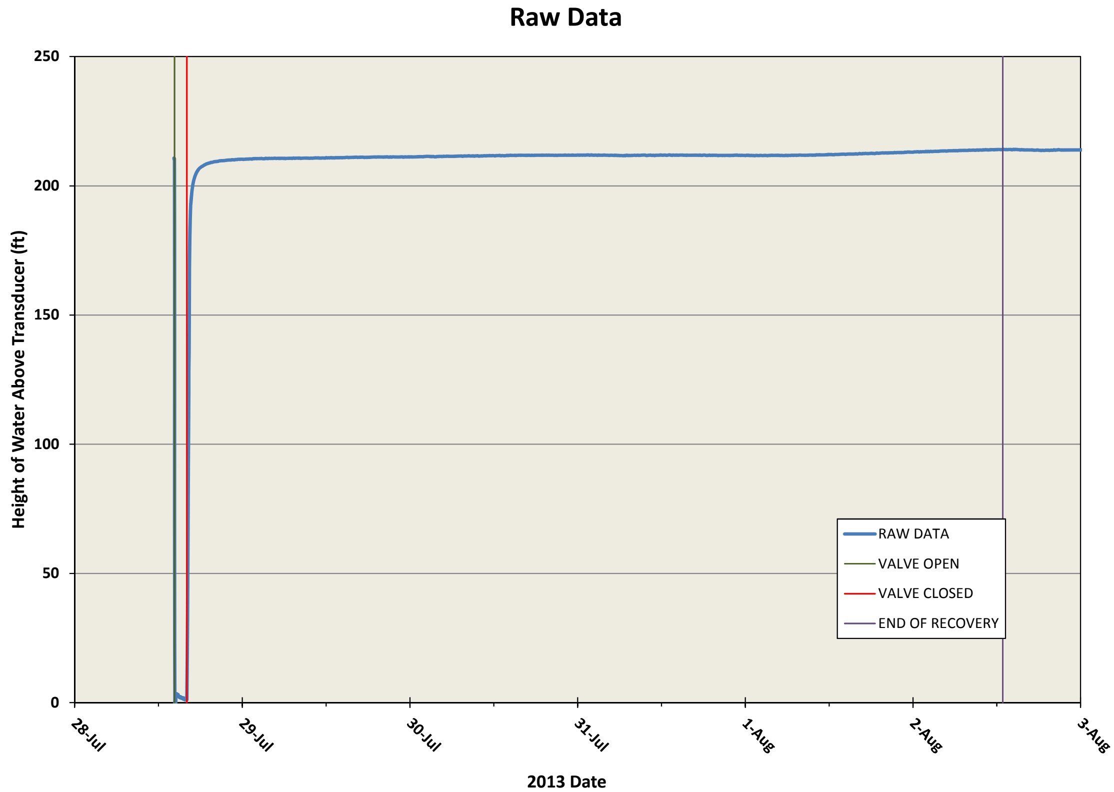
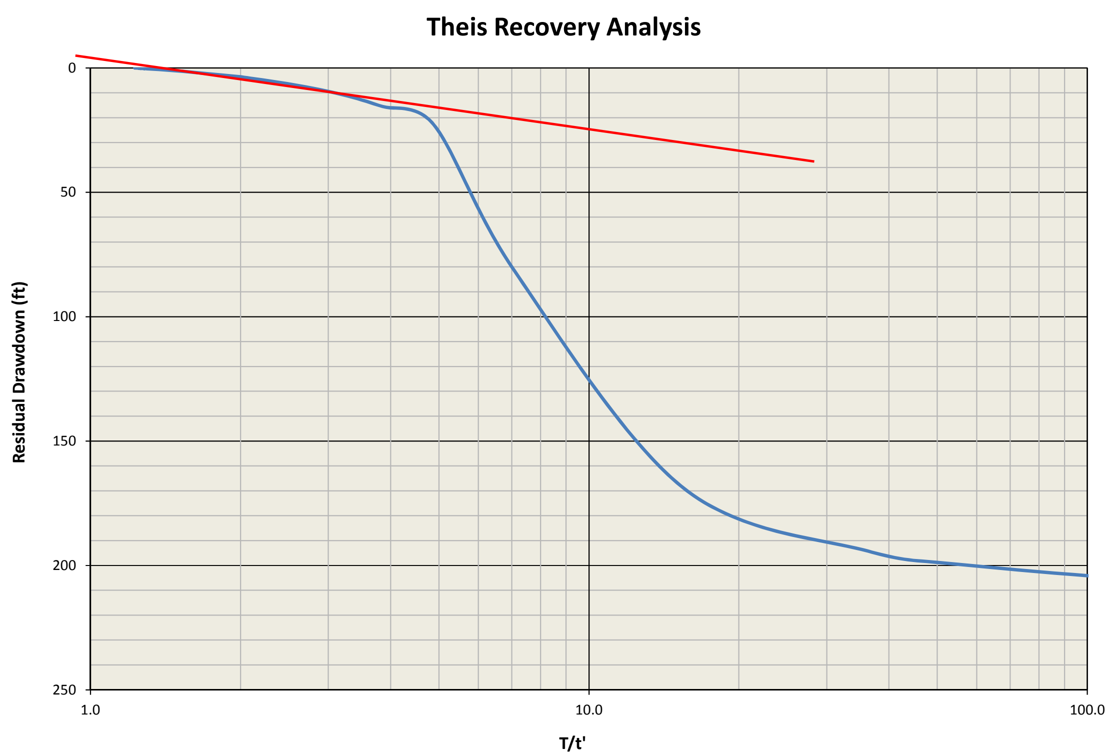
FIGURE B-24
Overview of Test Data
Underground Drillhole 13Hydro-06A



Depth of Test Interval:
0 – 202 ft (TD)

Flow Duration: 106 mins
Recovery Duration: 4.9 days

Flow Rate (Q) = 3.31 gpm
Flow Rate (Q) = 637.2 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(637.2)}{4\pi(30)} = 3.89\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(3.89)}{(202)} = 1.9\text{x}10^{-2}\ ft/d$$

T = 3.89 ft^2/d
K = 1.9x10^{-2} ft/d

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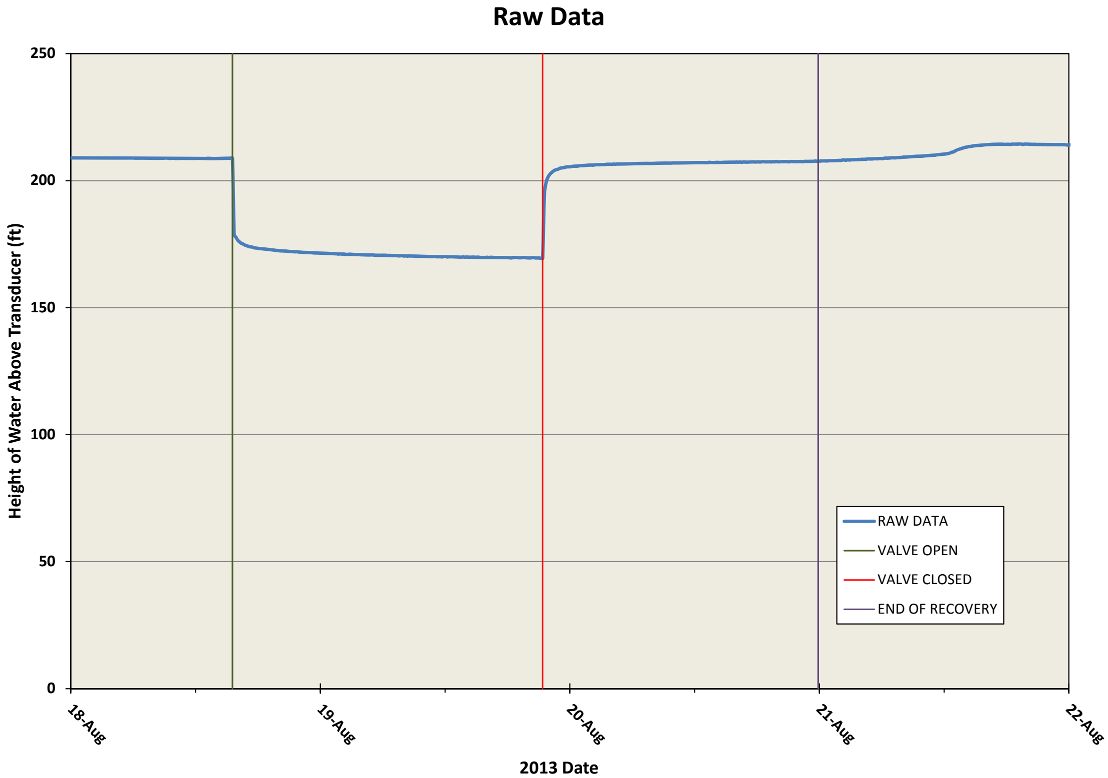
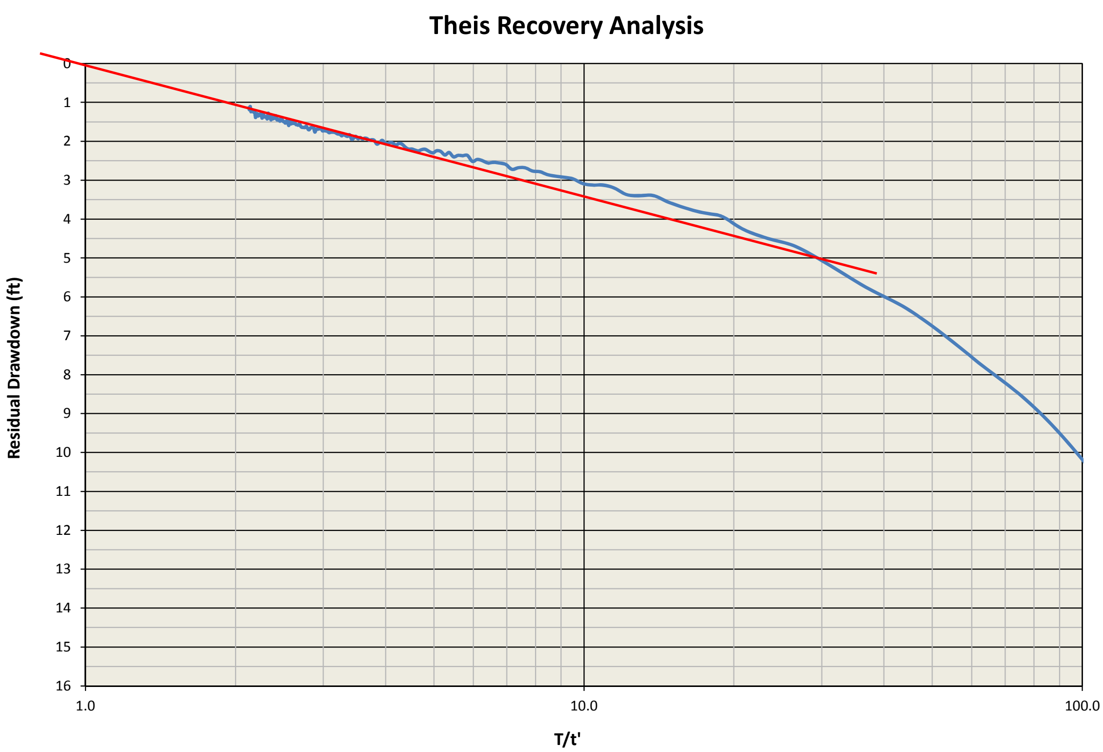
FIGURE B-25
Shut-In Test
Underground Drillhole Hydro-06A Test No.1



Depth of Test Interval:
0 – 202 ft (TD)

Flow Duration: 29.8 hours
Recovery Duration: 26.5 hours

Flow Rate (Q) = 1.21 gpm
Flow Rate (Q) = 232.9 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(232.9)}{4\pi(3.4)} = 12.54 \text{ ft}^2/\text{d}$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(12.54)}{(202)} = 6.2\text{x}10^{-2} \text{ ft/d}$$

T = 12.54 ft^2/d
K = 6.2x10^{-2} ft/d

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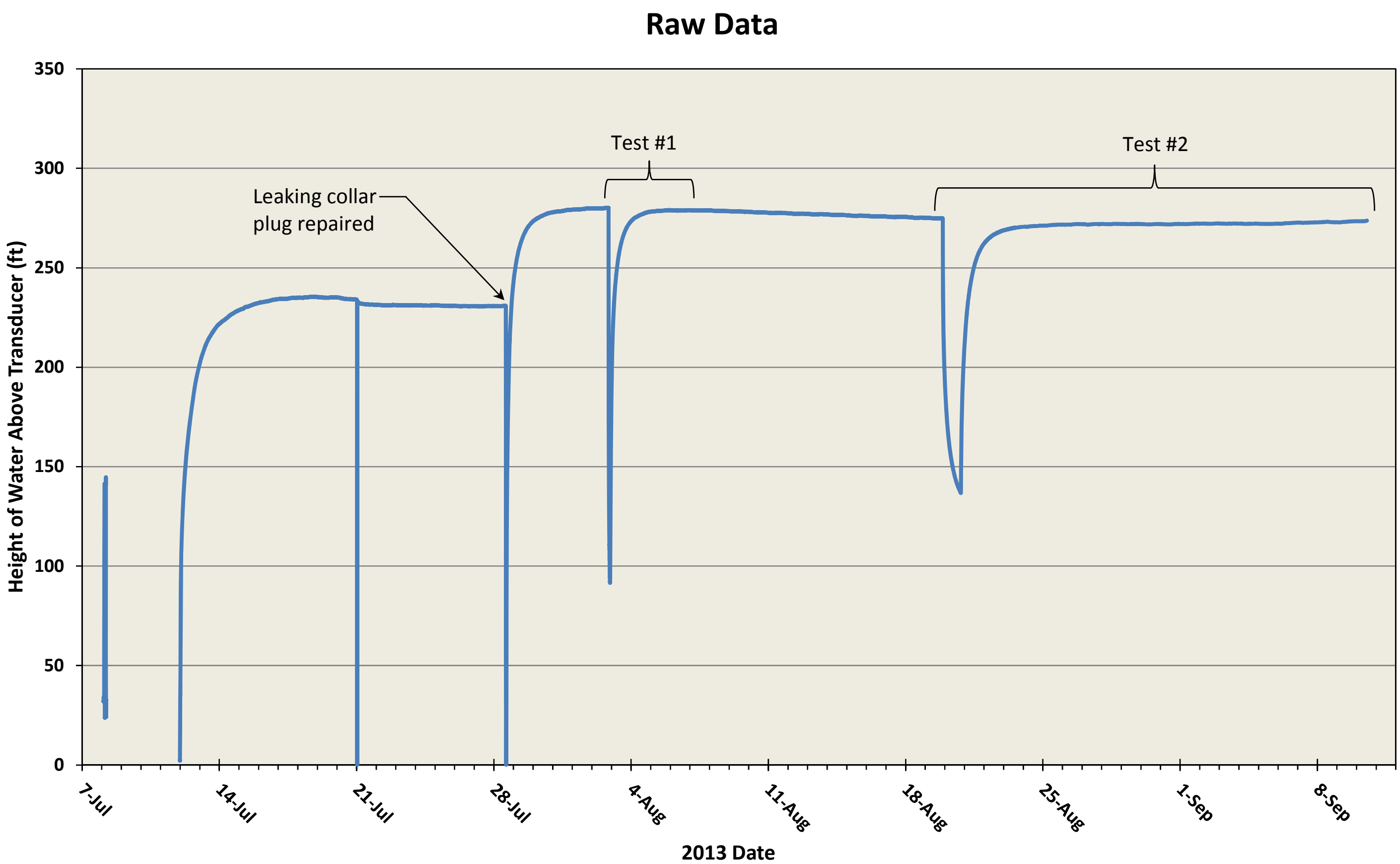

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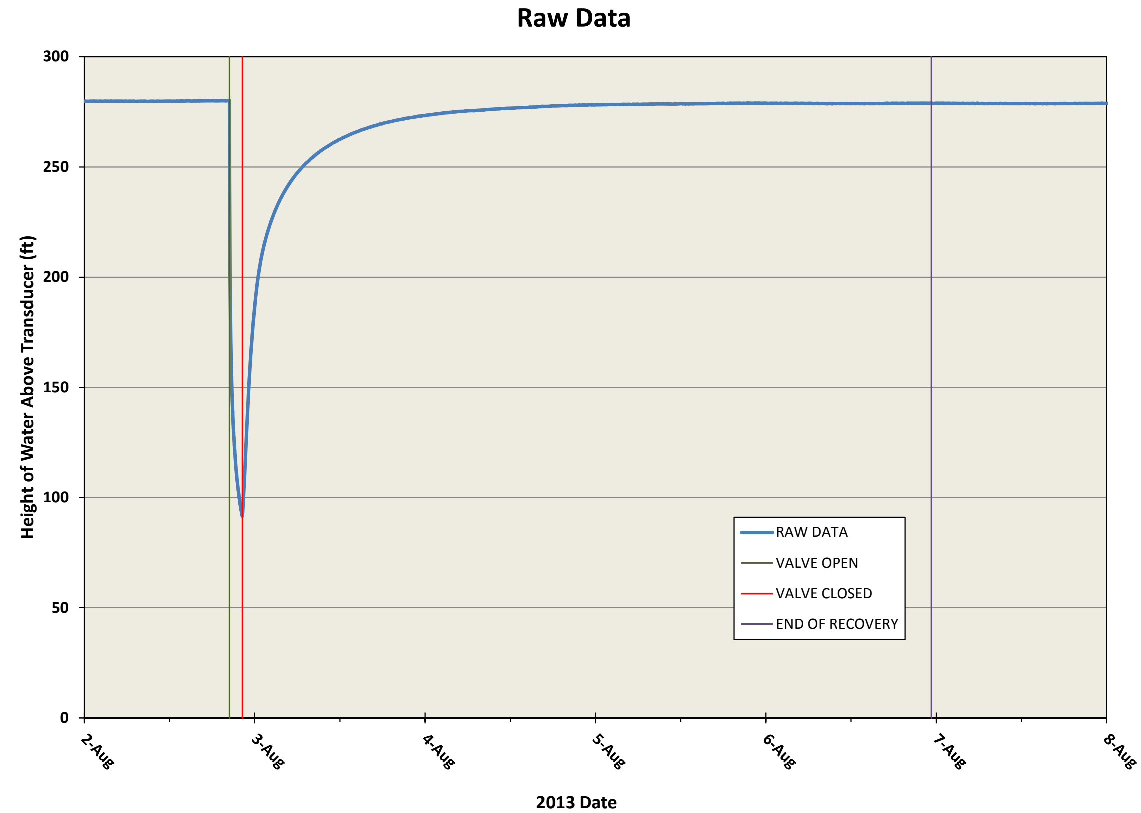
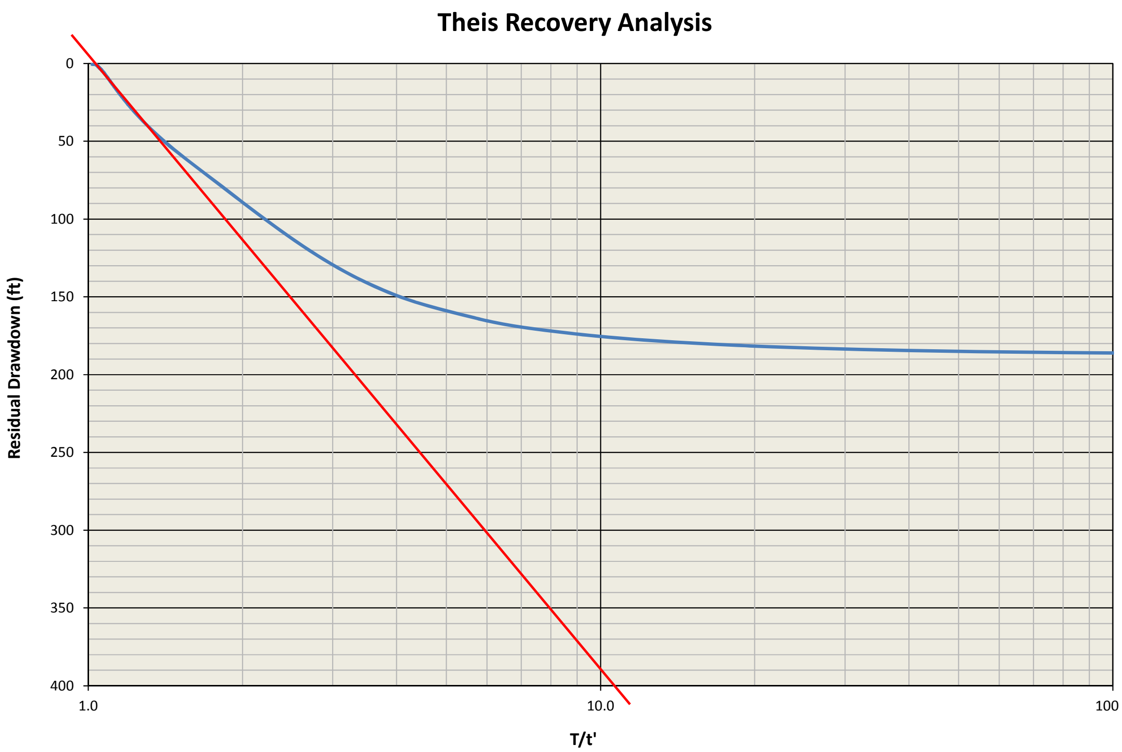
FIGURE B-27
Overview of Test Data
Underground Drillhole 13Hydro-06B



Depth of Test Interval:
0 – 453 ft (TD)

Flow Duration: 109 mins
Recovery Duration: 4.0 days

Flow Rate (Q) = 6.43 gpm
Flow Rate (Q) = 1237.8 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(1237.8)}{4\pi(400)} = 0.57\ ft^2/d$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(0.57)}{(453)} = 1.3x10^{-3}\ ft/d$$

T = 0.57 ft^2/d
K = 1.3x10^{-3} ft/d

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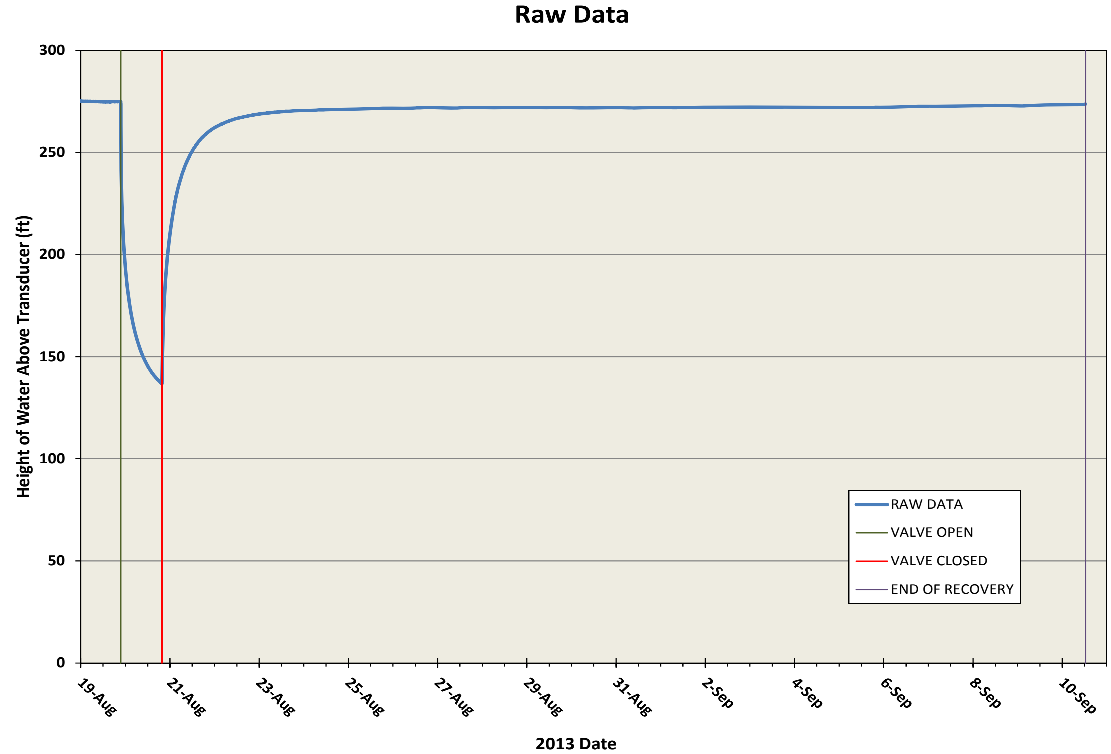
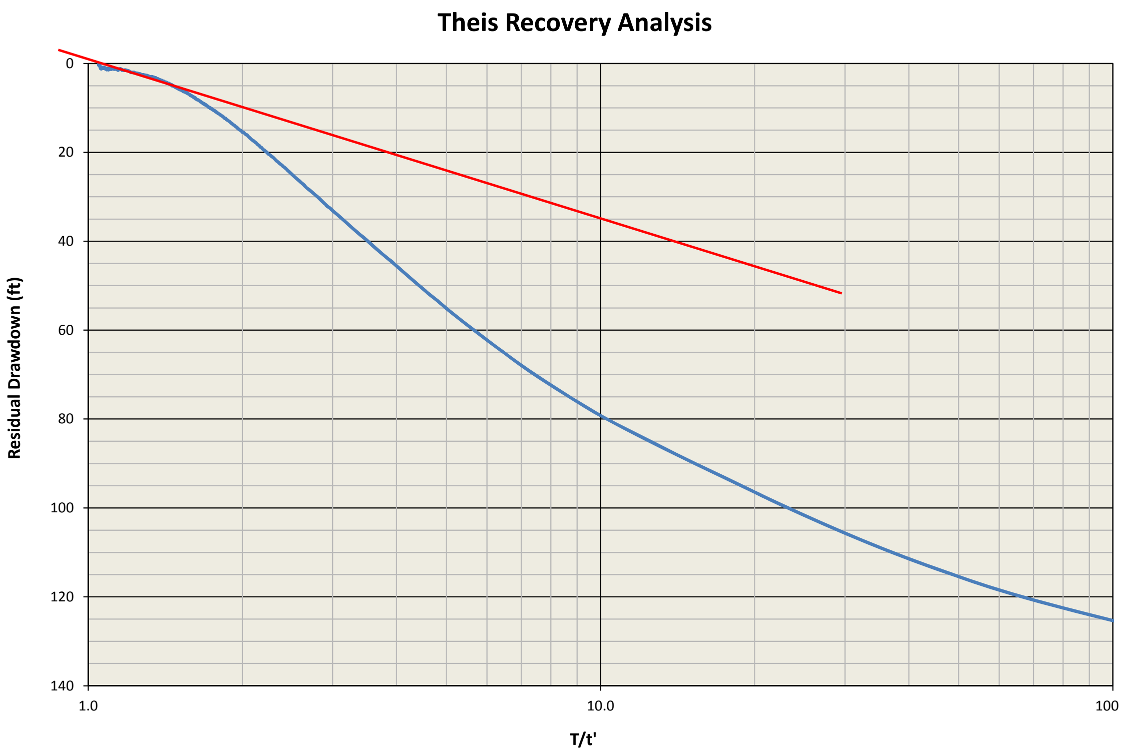


Depth of Test Interval:
0 – 453 ft (TD)

Flow Duration: 22.2 hours
Recovery Duration: 20.7 days

Flow Rate (Q) = 1.35 gpm
Flow Rate (Q) = 259.9 ft^3/d



Theis Equation:

$$T = \frac{2.3\,Q}{4\pi\Delta s}$$

Where:
T = Transmissivity (ft^2/d)
Q = Pumping Rate (ft^3/d)
$\Delta(s)$ = Drawdown per Log Cycle (ft)

$$T = \frac{2.3\,(259.9)}{4\pi(37)} = 1.29 \text{ ft}^2/\text{d}$$

$$K = \frac{T}{b}$$

Where:
K= Estimate for Hydraulic Conductivity (ft/d)
b = Test Interval Length (ft)

$$K = \frac{(1.29)}{(453)} = 2.8\text{x}10^{-3} \text{ ft/d}$$

T = 1.29 ft^2/d
K = 2.8x10^{-3} ft/d

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FIGURE B-29
Shut-In Test
Underground Drillhole Hydro-06B Test No.2