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TECHNICAL MEMORANDUM

DATE: December 22, 2011 **Project 605.31**

TO: Greg Ghidotti
RESOLUTION COPPER MINING LLC

FROM: Charlie King, Janis Blainer-Fleming, Kate Duke, and Todd Keay
MONTGOMERY & ASSOCIATES

SUBJECT: RESULTS OF DRILLING, CONSTRUCTION, AND TESTING AT HYDROLOGIC TEST WELLS DHRES-12 AND DHRES-13, RESOLUTION COPPER MINING, PINAL COUNTY, ARIZONA

In accordance with a request from Mr. Greg Ghidotti, Resolution Copper Mining LLC (RCM), Montgomery & Associates (M&A) has prepared this Technical Memorandum to summarize results of drilling, construction, and testing at hydrologic test wells DHRES-12 and DHRES-13. Borehole DHRES-12 was drilled to characterize hydrogeologic conditions in the deep groundwater system in Cross Canyon, west of the Apache Leap escarpment, and to provide a monitoring location for the deep groundwater system during ongoing dewatering operations. DHRES-12 was abandoned prior to completion due to lost circulation and borehole instability. Well DHRES-13 was drilled at the same site to replace abandoned borehole DHRES-12. Monitoring data obtained from DHRES-13 has been incorporated into the RCM hydrologic monitoring program.

DHRES-12 SUMMARY

A summary of drilling and abandonment operations at DHRES-12 is provided below:

1. Borehole DHRES-12 is located in Township 2 South, Range 12 East, in the NE ¼ of the NW ¼ of the SE ¼ of Section 2 ((D-2-12)02dba), east of the Town of Superior, in Cross Canyon.
2. DHRES-12 was drilled during the period December 4 through December 7, 2010.
3. Total drilled depth is 191.7 meters below land surface (bls).

4. Geologic units encountered during drilling from land surface to total depth include Devonian Martin Formation (Dm), and younger Precambrian diabase (pCdiab) and Troy Quartzite (pCt).
5. Drilling fluid circulation was lost and the borehole became unstable on December 7, 2010. The well was abandoned by filling the borehole with cement from total drilled depth to land surface on December 8, 2010.

DHRES-13 SUMMARY

A summary of drilling, construction, and testing operations and results for DHRES-13 is provided below:

1. Hydrologic test well DHRES-13 is located in Township 2 South, Range 12 East, in the NE ¼ of the NW ¼ of the SE ¼ of Section 2 ((D-2-12)02dba), east of the Town of Superior, in Cross Canyon, approximately 3 meters east of DHRES-12.
2. DHRES-13 was drilled and constructed during the period December 10, 2010 through February 12, 2011.
3. Total drilled depth is 1,088.4 meters bls.
4. Geologic units encountered during drilling from land surface to total depth include: Paleozoic Dm; younger Precambrian pCdiab, pCt, Apache Group rock units including basalt (pCbas), Mescal Limestone (pCmls), Upper Dripping Spring Quartzite (pCdsu), Lower Dripping Spring Quartzite (pCdsl), and Pioneer Shale (pCp); and older Precambrian Pinal Schist (pCpi).
5. An intermediate casing string and four grouted vibrating-wire pressure transducers were installed in the upper part of the borehole in the interval from land surface to 459.9 meters bls.
6. The well was completed in pCdiab, Apache Group rock units, and pCpi with two perforated intervals from 539.0 to 699.7 meters bls and 748.9 to 1,076.0 meters bls; non-pumping water level was 203.28 meters bls on November 17, 2011.
7. A 9-hour airlift test was conducted to develop the well and provide hydraulic parameters in the deep groundwater system at this location. Results of the test indicate a transmissivity of 0.6 meters squared per day (m^2/d).
8. DHRES-13 was equipped with dedicated pump and water level recording equipment on June 10, 2011.
9. A 24-hour constant-rate pumping test was conducted in the cased well; recovery data yielded an estimated transmissivity of 0.6 m^2/d and an estimated hydraulic conductivity of 1 x 10^{-6} centimeters per second (cm/s).
10. Water samples were collected for laboratory chemical and isotopic analyses near the end of each test.

INTRODUCTION

Hydrologic test wells DHRES-12 and DHRES-13 were drilled and constructed during the period December 4, 2010 through February 12, 2011. Following loss and abandonment of the borehole for DHRES-12, well DHRES-13 was drilled to:

- evaluate groundwater conditions in Paleozoic and Precambrian units east of the Concentrator Fault and west of the Apache Leap escarpment and a north-trending regional fault that predates the Tal
- characterize lithology west of the proposed block-cave zone
- provide a groundwater level and groundwater quality monitoring location in the deep groundwater system during dewatering of existing mine workings

Well DHRES-12 was drilled into the pCt and abandoned due to borehole instability and lost circulation. Well DHRES-13 was drilled into the pCpi and completed to permit hydrologic testing within the Precambrian Apache Group rocks, pCdiab, and pCpi. Wells DHRES-12 and DHRES-13 are located in Township 2 South, Range 12 East, in the NE ¼ of the NW ¼ of the SE ¼ of Section 2 ((D-2-12)02dba)). **Photograph 1** shows the layout for DHRES-13 during drilling operations. The well locations are shown on **Figure 1**. Schematic diagrams summarizing borehole and well construction details are shown on **Figures 2 and 3**. Other data summarized on the schematic diagrams include: hydrogeologic units, fracture summary logs, drilling penetration rate, water production rate during air drilling operations, drilling methods, borehole geophysical logs, and groundwater level. Detailed lithologic logs for the wells are provided in **Appendix A**.

Photograph 1. Site layout at DHRES-13 during drilling operations

DRILLING OPERATIONS

Hydrologic test wells DHRES-12 and DHRES-13 were drilled and constructed by Boart Longyear Drilling Services (Boart Longyear) of Salt Lake City, Utah, using a Lang LM-140 (Rig LK35A) top-head drive rotary drill rig. DHRES-13 was drilled in accordance with technical specifications prepared by M&A. RCM personnel coordinated drilling contractor activities and purchase of well construction materials. Daily drilling reports were prepared by Boart Longyear personnel and were submitted to RCM for review. M&A personnel described drill cuttings samples and provided on-site monitoring during critical phases of drilling and construction of the wells. RCM provided daily summaries of drilling progress. Daily summary data are provided in **Appendix B**.

Well DHRES-12 was drilled to 191.7 meters bls where the borehole became unstable and was abandoned. The DHRES-12 borehole was filled with cement to land surface, and surface casing was cut off at ground level. The drill rig was moved about 3 meters east of DHRES-12, and drilling of DHRES-13 commenced. Well DHRES-13 was drilled and constructed in two stages. During the first stage, the borehole was drilled to 459.9 meters bls, and casing and instrumentation were installed and grouted in place. During the second stage, the borehole was drilled to total depth, and blank and perforated casing were installed to a depth of 1,082.0 meters bls. Final completion of the well was designed by M&A based on review of lithologic conditions encountered during drilling operations and results of borehole geophysical logs.

Drilling Method

The borehole for well DHRES-13 was drilled using the conventional air rotary drilling method for the surface casing borehole, the conventional mud rotary and flooded reverse circulation mud rotary methods for the intermediate borehole, and flooded reverse circulation and dual wall conventional mud rotary methods for the production interval of the borehole. Depths, drilling methods, and bit types and sizes are summarized in **Table 1**.

TABLE 1. SUMMARY OF DRILLING METHODS AND BOREHOLE DIAMETERS HYDROLOGIC TEST WELLS DHRES-12 AND DHRES-13

Well	Depth Interval (meters bls)	Drilling Method	Bit Type	Borehole Diameter (inches)
DHRES-12	0 – 6.1	conventional air rotary	tricone	17-½
	6.1 – 191.7	dual-wall air reverse	hammer	10
DHRES-13	0 –12.2	conventional air rotary	tricone	19
	12.2 – 243.7	conventional mud rotary	tricone	12-¼
	243.7 – 459.9	flooded reverse mud rotary	tricone	12-¼
	459.9 – 1,009.8	flooded reverse mud rotary	tricone	6-¾
	1,009.8 – 1,088.4	dual-wall conventional mud rotary	tricone	6-¾

At DHRES-12, the dual-wall air reverse circulation method was used to allow for measurement of groundwater production during drilling. At DHRES-13, the conventional mud rotary drilling method was initially used for the intermediate borehole due to borehole instability experienced at DHRES-12. At a depth of 243.7 meters bls, the drilling method was changed from conventional mud rotary to flooded reverse circulation mud rotary as a result of increased fluid loss and poor circulation. For the production portion of the borehole, the flooded reverse circulation mud rotary method was used to maintain circulation. However, at a depth of 1,009.8 meters bls, fluid circulation was lost due to plugging of the drill string by cuttings, and the drilling method was changed to dual-wall conventional mud rotary from 1,009.8 to total depth of 1,088.4 meters bls.

Drilling Fluid and Drill Cuttings Management

Air, water, and polymer/bentonite-based drilling fluids were used during drilling operations. Lost circulation material was added to the borehole in zones where large fractures and a fault caused fluid circulation problems. The drilling fluid and cuttings were discharged to a cyclone to remove air from the fluid stream. The remaining drilling fluid and cuttings then flowed through a vibrating screen to remove coarse cuttings. All drilling fluids, formation fluids, and drill cuttings produced during drilling and airlift testing were contained in portable tanks, removed from the site using vacuum trucks, and deposited at a designated storage facility at the RCM West Plant site.

Monitoring of Drilling Conditions

During drilling operations, drill penetration rate was monitored by Boart Longyear by recording drill start and stop times for each 6.1-meter drill rod. A summary of drill penetration rate data is shown on **Figures 2 and 3**. In addition to drill penetration rate, rotational torque was monitored by drilling personnel, and zones of variable or increasing torque were noted as a potential indicator of fracturing. The field data recorded by Boart Longyear are on file at M&A.

Borehole deviation surveys were conducted on a regular basis using a Totco mechanical drift recorder. At DHRES-12, borehole deviation was less than 0.5 degrees from land surface to total depth. At DHRES-13, borehole deviation was less than 3 degrees for the depth interval from land surface to 487.7 meters bls using conventional mud rotary and flooded reverse circulation drilling methods. Borehole deviation increased substantially from less than 3 degrees to 8 degrees for the depth interval from 487.7 to 1,005.8 meters bls using flooded reverse circulation and dual-wall conventional mud rotary drilling methods. Maximum borehole deviation was 8 degrees at a depth of 1,005.8 meters bls.

Monitoring of Lithologic Conditions

Drill cuttings samples were collected at 10-foot intervals and placed in labeled bags. Lithologic descriptions for each sample were prepared in the field by M&A personnel. Splits of each sample were placed in plastic chip trays and were provided to RCM. Bulk cuttings samples

have been palletized and are stored by RCM. Detailed lithologic descriptions for each well are given in **Appendix A**.

Monitoring of Groundwater Conditions

At DHRES-12, the depth interval from 6.1 meters bls to total depth was drilled using the dual-wall air reverse circulation method, making it possible to monitor the production of groundwater and to determine approximately where groundwater inflow was encountered. Observations of natural groundwater production were made after drilling each 6.1-meter drill rod. Prior to measurement of production rate, injection water was cut off from the airstream, and air circulation was continued for 10 to 15 minutes. When discharge stabilized, discharge rate was measured using a 2-gallon bucket and stop watch.

Results of flow measurements for well DHRES-12 are summarized on **Figure 2**. The first and only measurable water production rate at DHRES-12 was 0.6 L/s at a depth of 187.4 meters bls. The discharge water at DHRES-12 had a temperature of 21.4 degrees Celsius (°C), specific conductance of 516 microsiemens per centimeter (µS/cm), and pH of 7.75.

Water production could not be monitored during flooded reverse mud rotary or conventional mud rotary drilling at DHRES-13.

BOREHOLE GEOPHYSICAL LOGGING

Borehole geophysical logging was not conducted at DHRES-12 due to borehole instability. Borehole geophysical logging was conducted in three stages at well DHRES-13. The first stage of logging was conducted just prior to shut-down for the winter break at a depth of 400 meters bls. The second stage of logging was conducted for the depth interval from 12 to 460 meters bls following completion of the intermediate borehole. The third stage of logging was conducted for the depth interval from 460 to total depth of 1,089 meters bls. Borehole geophysical logging services were provided by Southwest Exploration Services, LLC (SWE) of Gilbert, Arizona and Schlumberger Water Services (SWS) of Farmington, New Mexico.

The first suite of geophysical logs was obtained by SWE on December 21, 2010; logs included: natural gamma ray, 3-arm caliper, temperature, fluid resistivity, spontaneous potential, electrical resistivity (E-logs), and sonic. The second suite of geophysical logs was obtained by SWS on January 16, 2011; logs included: borehole deviation, gamma ray, 4-arm caliper, temperature, fluid resistivity, sonic, array induction (AIT), and formation micro-resistivity imaging (FMI). The third suite of geophysical logs was obtained by SWE on February 10, 2011; logs included: natural gamma ray, 3-arm caliper, temperature, fluid resistivity, E-logs, sonic, and acoustic borehole imaging (ABI). **Table 2** shows logs obtained and depth intervals for each type of log. SWE and SWS provided field and final digital format logs to RCM staff. SWS analyzed and interpreted the logs for the upper portion of the DHRES-13 borehole and prepared a

summary log montage for RCM (SWS, 2011). The borehole geophysical logs obtained by SWE are shown on **Figure 3**.

TABLE 2. SUMMARY OF BOREHOLE GEOPHYSICAL LOGS OBTAINED AT HYDROLOGIC TEST WELL DHRES-13

Log	SWS Depth Interval (meters bls)	SWE Depth Interval (meters bls)
Caliper	12 – 460	0 – 400 460 – 1,089
Temperature	12 – 460	0 – 400 460 – 1,089
Gamma ray/ Natural Gamma ray	12 – 460	0 – 400 460 – 1,089
Fluid resistivity	12 – 460	0 – 400 460 – 1,089
Imaging	FMI 12 – 460	ABI 460 – 1,089
Induction / Electric	12 – 460	0 – 400 460 – 1,089
Sonic	12 – 460	0 – 400 460 – 1,089
Spontaneous potential	N/A	0 – 400 460 – 1,089
Borehole deviation	12 – 460	N/A

ABI – Acoustic borehole image; FMI – Formation micro-resistivity image; N/A – not obtained

ANALYSIS OF GEOLOGIC CONDITIONS

Geologic Contacts

Geologic contacts were identified based on analysis of drill cuttings samples, geophysical logs, and information obtained during drilling. **Table 3** is a summary of geologic contacts at DHRES-12 and DHRES-13. Detailed lithologic descriptions based on drill cuttings samples are provided in **Appendix A**. At well DHRES-13 geophysical logs provided by SWS and SWE were used to confirm the formation depth intervals (**Table 3; Figure 3**).

TABLE 3. SUMMARY OF GEOLOGIC UNITS ENCOUNTERED AT HYDROLOGIC TEST WELLS DHRES-12 AND DHRES-13		
Well	**Depth Interval (meters bls)**	**Geologic Formation**
DHRES-12	0 – 3.1	Fill
	3.1 – 73.2	Martin Formation (Dm)
	73.2 – 115.8 128.0 – 182.8	Troy Quartzite (pCt)
	115.8 – 128.0 182.8 – 191.7	Diabase sills (pCdiab)
DHRES-13	0 – 3.1	Fill
	3.1 – 80.0	Martin Formation (Dm)
	94.5 – 112.8	No samples
	112.8 – 131.1 187.9 – 229.3 433.6 – 465.7 518.5 – 537.9 553.4 – 568.1 574.3 – 591.0 694.1 – 777.7 862.6 – 865.6 995.2 – 1,052.8 1,065.3 – 1,088.4	Diabase sills (pCdiab)
	80.0 – 94.5 131.1 – 187.9 229.3 – 324.6	Troy Quartzite (pCt)
	324.6 – 381.2	Precambrian basalt (pCbas)
	381.2 – 429.0	Mescal Limestone (pCmls)
	429.0 – 433.6 465.7 – 518.5 537.9 – 553.4 568.1 – 574.3 591.0 – 632.2	Upper Dripping Spring Quartzite (pCdsu)
	632.2 – 680.5	Lower Dripping Spring Quartzite (pCdsl)
	680.5 – 694.1 777.7 – 862.6 865.6 – 884.1	Pioneer Shale (pCp)
	884.1 – 995.2 1,052.8 – 1,065.3	Pinal Schist (pCpi)

Paleozoic sedimentary units

The Dm was the only Paleozoic unit encountered during drilling at DHRES-12 and DHRES-13. Detailed descriptions are provided in **Appendix A**. The Cambrian Bolsa Quartzite is absent at this location.

Devonian Martin Formation (Dm)

The Dm at DHRES-12 and DHRES-13 is 70.1 meters and 76.9 meters thick, respectively. It consists of well lithified, interbedded limestone, siltstone, calcareous siltstone, and silty sandstone. At DHRES-13, the AIT and gamma logs were used to confirm the contact between the Dm and the underlying pCt at a depth of 80.0 meters bls. Moderate to major fracturing was noted based on inspection of the FMI log for the depth interval from 73.8 to 86.5 meters bls which spans the contact between the Dm and pCt.

Younger Precambrian units

The younger Precambrian units encountered at DHRES-12 include pCt and pCdiab. At DHRES-13 they include the pCt, pCdiab, pCbas, pCmls, pCdsu, pCdsl, and pCp. At DHRES-13, the younger Precambrian sequence is 804.1 meters thick and occurs in the depth interval from 80.0 to 884.1 meters bls. The sequence includes diabase sills which intrude the younger Precambrian sedimentary units. Diabase dikes also intrude the older pCpi.

Diabase (pCdiab)

The diabase at DHRES-12 and DHRES-13 consists of fine clinopyroxene matrix with euhedral plagioclase laths and occurs as thick sills which intruded the pCt, pCdsu, pCdsl, pCp, and pCpi units. The FMI, E-logs, and natural gamma logs were used to confirm the contacts between the diabase and pCdsu, pCdsl, pCp, and pCpi. In general, contacts were most easily identified from the natural gamma log, with the diabase intervals being associated with very low natural gamma ray activity. Because natural gamma ray activity in the pCt and pCdiab was similar, the contacts between these units were refined using the E-logs. The diabase within the pCt is highly oxidized with abundant hematite, manganese oxide staining, and minor calcite veining. In contrast, the diabase encountered within the pCdsu, pCdsl, pCp, and pCpi was much less oxidized and contained trace amounts of alteration minerals including pyrite, epidote, chlorite, and hematite, and zones of weak serpentinization.

Troy Quartzite (pCt)

The pCt at DHRES-13 is divided into three intervals separated by two thick diabase sills. The pCt occurs in the depth intervals from 80.0 to 94.5 meters bls, 131.1 to 187.9 meters bls, and 229.3 to 324.6 meters bls for a total thickness of 166.6 meters. The unit consists of poorly sorted, medium to coarse-grained quartzite. Very little iron oxidation occurs in the pCt in the depth interval 80.0 to 94.5 meters bls. In the intervals from 131.1 to 187.9 meters bls and

229.3 to 324.6 meters bls, common oxidation is present, with increased hematite and manganese oxide staining on grain boundaries. The lowermost 6.1 meters of pCt consists of conglomerate comprised of quartzite, basalt, and red jasper. Only the upper two intervals of pCt were penetrated at DHRES-12, from 73.2 to 115.8 meters bls and from 128.0 to 182.8 meters bls.

Basalt (pCbas)

The pCbas at DHRES-13 is 56.6 meters thick and occurs in the depth interval from 324.6 to 381.2 meters bls. The unit consists of fine-grained, purplish-black basalt lacking amygdules or vesicles. Some iron oxidation is present in the form of hematite, and very trace specular hematite is also present. The pCbas shows only minor alteration including trace orange clay balls, trace calcite veining, and very trace epidote.

Mescal Limestone (pCmls)

The pCmls at DHRES-13 is 47.8 meters thick and occurs in the depth interval from 381.2 to 429.0 meters bls. It comprises interbedded pinkish-tan crystalline limestone, chalky limestone, and some silty limestone. Trace iron oxidation and trace calcite veinlets are present. The contact between the pCmls and pCdsu at the depth of 429.0 meters bls was confirmed using the AIT log which indicates that the resistivity of the pCmls is slightly higher than the underlying pCdsu.

Upper and Lower Dripping Spring Quartzite (pCdsu and pCdsl)

The pCdsu at DHRES-13 occurs in the depth intervals from 429.0 to 433.6, 465.7 to 518.5, 537.9 to 553.4, 568.1 to 574.3, and 591.0 to 632.2 meters bls for a total thickness of 120.3 meters. Thick diabase sills separate the pCdsu intervals. The pCdsu comprises fine to medium-grained, well-sorted, arkosic quartzite, with an interval of black, laminated shale from 600.5 to 624.8 meters bls. Iron oxidation in the form of hematite and limonite staining is common. Trace alteration products of chlorite and pyrite are also present. The contacts between the diabase sills and pCdsu were refined using the natural gamma ray log, because the pCdsu exhibits distinctly higher gamma ray activity.

The pCdsl at DHRES-13 is 48.3 meters thick and occurs immediately below the pCdsu, in the depth interval from 632.2 to 680.5 meters bls. The unit comprises clean, well-sorted, fine to medium-grained slightly arkosic quartzite, and well-sorted, medium-grained arenaceous quartzite. Only trace iron oxidation is present. Alteration products include trace amounts of pyrite and chlorite. The Barnes Conglomerate marker unit (pCdsb) occurs in the depth interval from 673.6 to 680.5 meters bls. The pCdsb at DHRES-13 consists of clasts of quartzite, diabase, and vein quartz. The contact between the pCdsu and pCdsl was confirmed where natural gamma ray activity decreased.

Pioneer Shale (pCp)

The pCp at DHRES-13 occurs in the depth intervals from 680.5 to 694.1 meters, 777.7 to 862.6 meters, and 865.6 to 884.1 meters bls for a total thickness of 117.0 meters. The three intervals of pCp are separated by sills of pCdiab. The unit consists of silty quartzite and very fine-grained arkosic quartzite, with zones of medium-grained quartzite. Minor to trace amounts of iron oxidation is present in the form of hematite and limonite. Alteration includes trace chlorite, very trace pyrite, and occasional quartz and calcite veins. The contact between pCp and pCdsl at 680.5 meters bls was picked using the natural gamma ray log, which shows a slight increase in activity in the pCp. The natural gamma ray log was also used to identify the contacts between the pCp and the pCdiab sills, with the pCp having notably larger gamma ray activity.

Older Precambrian

Pinal Schist (pCpi)

The pCpi is the basement rock at DHRES-13 and occurs in the depth intervals from 884.1 to 995.2 and 1,052.8 to 1,065.3 meters bls. The unit consists of pink, dark green, and silver schist. At DHRES-13, the pCpi is potassically and propylitically altered, containing secondary minerals including orthoclase, quartz veins, magnetite, chlorite, epidote, and pyrite. The contacts between the pCpi and the diabase were picked using the natural gamma logs and E-logs; gamma and resistivity values are slightly larger in the pCpi. The depth interval from 1,052.8 to 1,065.3 meters bls consists of 50 to 90 percent vein quartz, with trace amounts of pyrite and chalcopyrite.

Degree of Fracturing

A fracture summary log was prepared for DHRES-13 using geophysical logs including FMI, ABI, sonic, and E-logs. Where available, the FMI and ABI logs were the primary sources for the fracture summary log. Where imaging logs were not available or were of poor quality, sonic logs were used to classify fractures. E-logs were used to confirm fracture zones. Fractures were qualitatively classified as minor, moderate, or major based on inspection of the logs. Minor fractures include joints and bedding planes which are generally less than 1 inch across and contain no mineral filling. Moderate fractures include joints and faults with mineral filling or open voids ranging from about 1 to 6 inches across. Major fractures include faults or fault zones with mineral filling or open voids larger than about 6 inches across. Where imaging logs are not available, fractures zones were identified using the sonic log where acoustic travel time was larger than background. Intensity of the fracturing was identified based upon thickness of the anomalous zone. Major fractures were assigned to wide zones of slower acoustic travel. The fracture summary log for DHRES-13 is shown on **Figure 3**.

Some major fracture zones at DHRES-13 are associated with large faults in the Superior district. Three noteworthy faults were encountered in the depth intervals from 187.9 to 192.4, 229.3 to 231.5, and 381.2 to 387.5 meters bls. Faults were identified by the presence of

increased oxidation mineralization, occurrences of fault gouge in drill cuttings, and anomalies in the geophysical logs.

WELL CONSTRUCTION

Construction at DHRES-13 began with installation of 14-inch diameter blank steel surface casing. The surface casing was installed to 12.2 meters bls and cemented in place. An intermediate casing was installed from land surface to a depth of 457.0 meters bls. The intermediate casing consists of 7-5/8-inch outside diameter blank, threaded and coupled steel casing. During casing installation, four vibrating-wire pressure transducers manufactured by Geokon of Lebanon, New Hampshire, were attached to the outside of the casing string to measure pore pressures in the pCdiab, pCt, and pCmls. Details regarding the piezometers installed in the upper portion of DHRES-13 are given in **Table 4** and installed depths are shown on **Figure 3**.

TABLE 4. DETAILS FOR GROUTED PRESSURE TRANSDUCER INSTALLATION FOR HYDROLOGIC TEST WELL DHRES-13

	Identifier*	Serial Number	Installed Depth (meters bls)	Hydrogeologic Unit	Pressure Rating (Mega-Pascals)
1	DHRES-13_846	10-37198	202.8	pCdiab	5
2	DHRES-13_788	10-37199	260.8	pCt	5
3	DHRES-13_730	10-37197	319.3	pCt	5
4	DHRES-13_649	10-29608	400.3	pCmls	7.5

*Identifier consists of well name and piezometer elevation in meters above mean sea level

After the casing and instrumentation were installed in the borehole, pressure grout was installed in the annular space by Halliburton of Farmington, New Mexico. The pressure grout mix consisted of the following ratio by weight: 2.5 parts water: 1 part cement: 0.3 parts bentonite. The lower 38 meters of annular seal material consisted of neat cement to prevent loss of the pressure grout from the bottom of the upper interval during drilling of the lower borehole. The grout and cement were allowed to cure for 72 hours before drilling of the lower borehole commenced. The pressure grouting job documents were provided by Halliburton and are included in **Appendix C**.

The production casing for DHRES-13 consists of 4-1/2-inch outside diameter blank and slotted, threaded and coupled steel casing. Two perforated intervals were installed in the depth intervals from 539.0 to 699.7, and 748.9 to 1,076.0 meters bls. Perforations are 0.125-inch wide by 2.5-inch long machine-cut slots, two slots per round, four rounds per foot (8 slots per foot). The bottom 20-foot joint of casing was torch cut, tapered and welded closed. The production casing was suspended inside the 7-5/8-inch casing at a depth of 422.3 meters bls using a mechanical casing hanger manufactured by TIW Corporation of Houston, Texas. Annular

materials were not installed in the production interval of the well. **Photograph 2** shows the mechanical casing hanger and the 4-1/2-inch casing installed at DHRES-13. A schematic diagram of well construction is shown on **Figure 3**.

Photograph 2. Installation of 4-1/2-inch casing with TIW® mechanical casing hanger

The surface completion for DHRES-13 consists of a locking box vault on a concrete pad. Transducer cables run from DHRES-13 to the telemetry installation in an underground conduit. The telemetry system consists of a CR-850 datalogger manufactured by Campbell Scientific of Logan, Utah, that allows remote connection through a cell modem. Data are available on the M&A Hydrogeometrics website at https://hydrogeometrics.com/vdv/Index.php.

Horizontal and vertical well coordinates for the top of 7-5/8-inch casing and center of the wellhead at DHRES-13 were surveyed by Civiltec Engineering, Inc. of Phoenix, Arizona, on June 2, 2011. Survey data and computed land surface elevation are provided in **Table 5**. Abandoned borehole DHRES-12 is approximately 3 meters west of DHRES-13 but was not surveyed.

TABLE 5. SUMMARY OF SURVEY RESULTS FOR HYDROLOGIC TEST WELL DHRES-13	
Easting	492125.623
Northing	3682682.831
Elevation Top of 7-5/8-inch conductor casing	1049.307
Elevation Land Surface	1048.86

Datum: UTM Zone 12 North (NAD27)-NGVD29 (meters)

HYDRAULIC HEAD DATA

Pore pressures measured at the DHRES-13 grouted piezometer array have been converted to total hydraulic head in meters above mean sea level and are presented on the hydrograph on **Figure 4**. Pore pressures at all the grouted piezometers appear to have equilibrated with pore pressures in the adjacent formations within approximately 3 to 4 weeks following installation. Hydraulic head data from November 17, 2011, are shown on **Figure 3**. Further discussion of pore pressure data obtained at DHRES-13 will be provided in a future report.

Groundwater level at DHRES-13 was 203.28 meters bls on November 17, 2011 (**Figure 3**).

PUMP INSTALLATION AND INSTRUMENTATION

A dedicated pump assembly was installed in hydrologic test well DHRES-13 by Duncan Pump, of Phoenix, Arizona on June 10, 2011. Well DHRES-13 was equipped with a stainless steel Grundfos Model 10S50-48 pump with a 5-horsepower, 460-volt, three-phase Grundfos Model MS4000 electric motor (Product No. 79354509). The pump was installed on 1-1/4-inch API steel column pipe with galvanized steel couplings at a depth of 305 meters bls. The well was equipped with two sounder access tubes; one 1-1/2-inch diameter and one 1-inch diameter which extend from the wellhead to the top of the pump. The access tubes are capped on the bottom, and factory slotted in the lower 3 meters. The pump, motor, and column pipe are suspended from a steel and rubber sanitary well seal installed at the wellhead. A Geokon Model 4500S pressure transducer (S/N 1109787; 1 MPa) and Geokon LC-1 datalogger are currently installed at DHRES-13.

HYDRAULIC TESTING

Initial characterization of the deep groundwater system at DHRES-13 was accomplished by conducting a 9-hour airlift test in the cased well on February 12, 2011. A 24-hour constant-rate test was conducted on June 27 and 28, 2011, using dedicated pumping equipment. Drawdown and recovery data were analyzed using the Cooper-Jacob (1946) drawdown method and the Theis (1935) recovery method implemented in the computer-based analytical aquifer test software AQTESOLV® for Windows, version 4.50.004 (Glenn M. Duffield, HydroSOLVE, Inc., 2008). Operational details and results of testing are included below.

DHRES-13 Cased Well Airlift Test

Following casing installation at well DHRES-13, a 9-hour airlift test was conducted to develop the well and to investigate hydraulic parameters and water quality in the deep groundwater system at this location. Screened intervals are from 539.0 to 699.7, and 748.9 to 1,076.0 meters bls (accessing pCdsu, pCdsl, pCdiab, pCp, and pCpi). Discharge volumes and airlift rates were calculated by periodic measurement of storage tank levels. The discharge head configuration did not provide access for measurement of groundwater levels during airlift pumping; however, groundwater level was measured prior to the test and during the recovery period. During recovery, water level was measured through the open airline (dual-wall drill pipe) using an electric water level sounder.

Depth to pre-pumping water level was 65.3 meters bls. Airlifting started at 09:16 and stopped at 18:16, on February 12, 2011. The discharge rate ranged from 0.7 to 1.9 L/s; average rate was 1.2 L/s. The specific conductance was 3,021 µS/cm near the start of pumping, increased to 5,129 µS/cm after 54 minutes of pumping, and then decreased to 937.5 µS/cm by the end of the test. At the end of the recovery period there was still a large residual drawdown of approximately 143 meters. This likely indicates that the pre-pumping water level was artificially high, perhaps because water level had not yet equilibrated after drilling and construction activities. A graph of the recovery data and analysis is shown on **Figure 5**. Straight-line analysis using the Theis recovery method yields an estimated transmissivity of 0.6 m^2/d. Operational details and test results are summarized in **Table 6**.

TABLE 6. SUMMARY OF RESULTS FROM AIRLIFT TEST CONDUCTED AT HYDROLOGIC TEST WELL DHRES-13				
Perforated Intervals (meters bls)	**Test Duration (hours)**	**Pre-pumping Water Level (meters, bls)**	**Average Discharge Rate (L/s)**	**Transmissivity (m^2/d)**
539.0 – 699.7 748.9 – 1,076.0	9 hours	65.3	1.2	0.6

DHRES-13 Constant-rate Test

A 24-hour constant-rate pumping test was conducted at well DHRES-13 to further develop the well and to investigate aquifer parameters. Discharge assembly included a Blancett digital flowmeter, a pressure gage, gate valves to adjust flow rate, and a hose bib for obtaining water samples. Water pumped from DHRES-13 was contained in a Baker tank and later disposed at the West Plant site.

During constant-rate testing, water levels were measured and recorded using the dedicated pressure transducer and data logger. Water levels were also measured periodically using an electric sounder. During testing, pumping rate, line pressure, sand content of the discharge water, and water quality parameters were measured. After pumping stopped, water level recovery was measured for a period equal to the pumping period.

Depth to pre-pumping water level was 202.59 meters bls. Pumping started at 20:07 on June 27, and stopped at 20:07 on June 28, 2011. Average pumping rate was 0.7 L/s. Maximum drawdown at the well was approximately 42.6 meters. A graph of the data and analysis is shown on **Figure 6**. Straight-line analysis of drawdown data using the Cooper-Jacob (1946) drawdown method yields an estimated transmissivity of 0.8 m^2/d; analysis of recovery data using the Theis (1935) recovery method yields an estimated transmissivity of 0.6 m^2/d. Average hydraulic conductivity calculated using transmissivity of 0.6 m^2/d and saturated interval of 488 meters (combined perforated interval) is 1 x 10^{-6} cm/s. Operational details and aquifer parameters determined from analysis of data obtained during the pumping tests are summarized in **Table 7**.

TABLE 7. SUMMARY OF CONSTANT-RATE TEST CONDUCTED AT HYDROLOGIC TEST WELL DHRES-13	
Description of Hydrologic Testing Zone (meters bls):	**Cased well** (total depth 1082.0 meters) perforated intervals 539.0 – 699.7 and 748.9 – 1,076.0 meters bls
Test Type:	Constant-rate pumping test
Geologic Units in Testing Zone:	pCdsu, pCdsl, pCp, pCdiab, pCpi
Test Duration (hours):	24
Pre-pumping Depth to Water (meters bls):	202.59
Average Discharge Rate (L/s):	0.7
Maximum Drawdown (meters):	42.6
Transmissivity from recovery data (m^2/d):	0.6
Saturated thickness (meters):	488 (thickness of combined perforated intervals)
Hydraulic Conductivity (cm/s):	1×10^{-6}

GROUNDWATER SAMPLING

Water quality parameters (temperature, pH, and specific conductance) were measured and recorded during testing using a Myron-L parameter meter that was calibrated prior to each test. Groundwater samples were collected near the end of each test. Sample identifiers and water quality parameters for samples collected during testing operations are given in **Table 8**. Data from groundwater samples collected during drilling or toward the end of airlift tests are generally used as screening samples or to obtain an initial idea of water quality. Data considered to be most representative of the hydrochemical composition of formation water are those generated from samples collected at the end of pumping tests. Results of water sample analyses will be provided and discussed in a future report.

TABLE 8. WATER SAMPLES COLLECTED DURING TESTING OPERATIONS AT HYDROLOGIC TEST WELL DHRES-13						
				Field Parameters		
Sample Identifier	Sample Description	Date	Time	Temp (°C)	pH (s.u.)	Specific Conductance (µS/cm)
RESE-1003197	DHRES-13, cased airlift	12-Feb-2011	17:50	28.3	8.66	962
RESE-1003138	DHRES-13, constant-rate pumping test	28-Jun-2011	19:45	34.8	7.36	629

REFERENCES CITED

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HydroSOLVE, Inc., 2008, **AQTESOLV for Windows 95/98/NT/2000/XP/Vista:** HydroSOLVE, Inc., Reston, Virginia, version 4.50.004 – Professional.

Schlumberger Water Services, 2011, **Integrated wireline log well montage for well DHRES-13**: Processed advanced borehole geophysical data prepared for Resolution Copper Mining for data obtained on January 16, 2011 and processed on April 20, 2011.

Theis, C.V., 1935, **The relationship between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage:** American Geophysical Union, Transactions, vol. 16, pp. 519-524; reprinted in Society of Petroleum Engineers, Pressure Transient Testing Methods, SPE Reprint Series (14), pp. 27-32, Dallas, Texas.

490,000 R. 12 E. 495,000 R. 13 E. 500,000 R. 14 E.

T. 1 S. T. 2 S. T. 3 S.

3,690,000 3,685,000 3,680,000 3,675,000

Top of the World
60
HRES-06
Corral
Middle
JI Ranch
HRES-14
HRES-12
DHRES-11
Queen Creek
HRES-15
Oak Flat
HRES-03
DHRES-14
HRES-17
Gila County
Pinal County
1,400
1,600
DHRES-09
Shaft No. 3
Shaft No. 9
DHRES-10
HRES-01
Oak Flat
DHRES-04
DHRES-03
DHRES-05
DHRES-02
HRES-02
HRES-04
DHRES-01
A-06
HRES-18
DHRES-08
HRES-16
HRES-09
DHRES-07
HRES-05
Devils Canyon
Hackberry Canyon
HRES-07
MJ-11
HRES-13
Hackberry Windmill
HRES-10
DHRES-06
HRES-08
HRES-11
Town of Superior
DHRES-12
DHRES-13
177
Arnett Creek
Mineral Creek

EXPLANATION

- Watershed Boundary
- Perennial Reach

Groundwater Monitoring Sites

- Shallow Alluvial Aquifer Monitor Well
- Apache Leap Tuff Aquifer Monitor Well
- Deep Groundwater System Monitor Well
- Shaft

Elevation Range

(meters above mean sea level)

- 1,600 - 1,800
- 1,400 - 1,600
- 1,200 - 1,400
- 1,000 - 1,200
- 800 - 1,000
- 600 - 800

N

0 0.5 1 1.5 2

Miles

Resolution Copper Mining

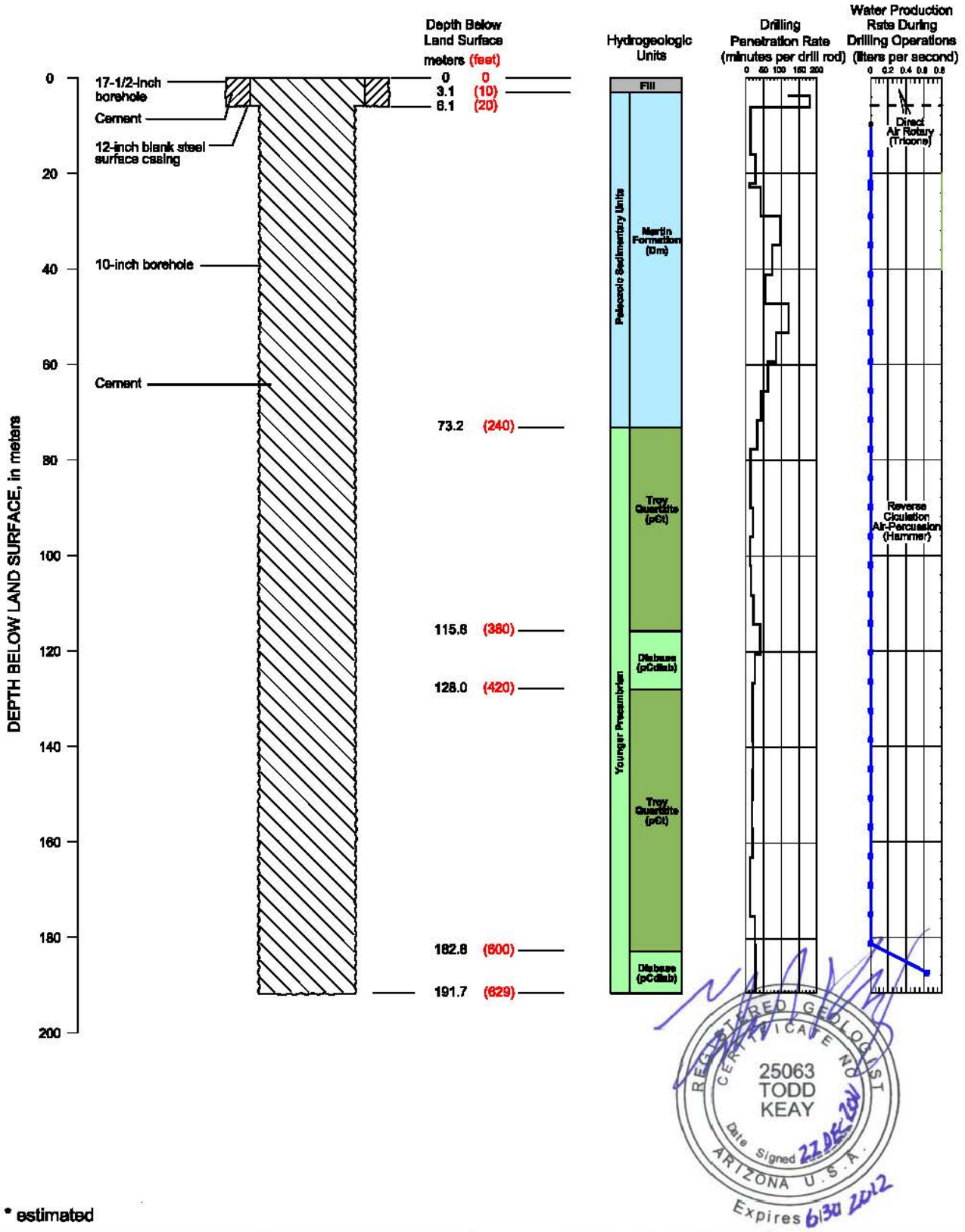
DHRES-12, DHRES-13 WELL LOCATIONS

MONTGOMERY & ASSOCIATES
Water Resource Consultants

2011

FIGURE 1

\GIS-Tuc\Projects\605\605.31\Welloc_DHRES_12_13.mxd\21Dec2011



* estimated

CADASTRAL: (D-2-12)02dba	ADWR NO: 55-912725
NORTHING: 3682683*	EASTING: 492123*
LAND SURFACE ELEVATION: 1049*	
DATUM: UTM12N, NAD 27, meters VERTICAL: NGVD 29 meters	

Resolution Copper Mining

MONTGOMERY & ASSOCIATES

DHRES-12
SCHEMATIC DIAGRAM OF WELL CONSTRUCTION (ABANDONED)

Version: Dec. 21, 2011

FIGURE 2

605\2010Well Schematics\DHRES12-wsREV2_LOGS\21Dec2011

Cement
19-inch borehole
14-inch blank steel casing
12-1/4-inch borehole
7-5/8-inch threaded & coupled blank steel casing (coupling OD is 8.5 inches)
Specialized pressure grout; grout mix ratio by weight - 2.5 water: 1 cement: 0.3 bentonite
Cross-coupling cable protectors installed at each coupling and centralizers installed approximately every 30 meters
Piezometers: vibrating-wire pressure transducer attached to outside of casing for monitoring piezometric pressure; cables extend to land surface
Mechanical casing liner hanger (TIW Corp)
Neat cement
4-1/2-inch threaded and coupled blank steel casing
4-1/2-inch threaded and coupled slotted steel casing
4-1/2-inch threaded and coupled blank steel casing
6-3/4-inch borehole
4-1/2-inch threaded and coupled slotted steel casing
4-1/2-inch blank steel casing (tapered)

DEPTH BELOW LAND SURFACE, METERS

Depth Below Land Surface meters	(feet)	
0	(0)	
3.1	(10)	
12.2	(40)	
80.0	(262)	
94.5	(310)	
112.8	(370)	
131.1	(430)	
147.6	(484)	17Nov2011
172.2	(565)	
172.8	(567)	
179.6	(589)	
187.9	(616)	
192.4	(631)	
202.8	(665)	
203.28	(666.94)	17Nov2011
229.3	(752)	
231.5	(760)	
260.8	(856)	
319.3	(1,048)	
324.6	(1,065)	
381.2	(1,251)	
387.5	(1,271)	
400.3	(1,313)	
422.3	(1,385)	
429.0	(1,407)	
433.6	(1,423)	
457.0	(1,499)	
459.9	(1,509)	
465.7	(1,528)	
518.5	(1,701)	
537.9	(1,765)	
539.0	(1,766)	
553.4	(1,816)	
568.1	(1,864)	
574.3	(1,884)	
591.0	(1,939)	
632.2	(2,074)	
680.5	(2,233)	
694.1	(2,277)	
699.7	(2,296)	
748.9	(2,457)	
777.7	(2,551)	
862.6	(2,830)	
865.6	(2,840)	
884.1	(2,901)	
965.2	(3,265)	
1,052.8	(3,454)	
1,065.3	(3,495)	
1,076.0	(3,530)	
1,082.0	(3,550)	
1,088.4	(3,571)	

Hydrogeologic Units
Fill
Paleozoic Sedimentary Units
Martin Formation (Dm)
Younger Precambrian
Troy Quartzite (pCt)
NO SAMPLE
Diabase (pCdiab)
Troy Quartzite (pCt)
FAULT ZONE
Diabase (pCdiab)
FAULT ZONE
Troy Quartzite (pCt)
Basalt (pCbas)
FAULT ZONE
Mescal Limestone (pCmls)
pCdsu
Diabase (pCdiab)
Upper Dripping Spring Quartzite (pCdsu)
Younger Precambrian
Diabase (pCdiab)
Upper Dripping Spring Quartzite (pCdsu)
Diabase (pCdiab)
pCdsu
Diabase (pCdiab)
Upper Dripping Spring Quartzite (pCdsu)
Lower Dripping Spring Quartzite (pCdsl)
Pioneer Shale (pCp)
Diabase (pCdiab)
Pioneer Shale (pCp)
Diabase (pCdiab)
Pioneer Shale (pCp)
Older Precambrian
Pinal Schist (pCpl)
Younger Precambrian
Diabase (pCdiab)
Pinal Schist (pCpl)
Diabase (pCdiab)

Drilling Penetration Rate (minutes per drill rod) 0 200 400 600
Fracture Summary Log
Drilling Method
Direct Mud Rotary (Tricone)
Flooded Reverse Circulation (Tricone)
Direct Mud Rotary (Tricone)
Borehole Imaging Available
Formation Micro-Imager
Acoustic Televiewer
Caliper (inches) 0 5 10 15 20
Temperature (degrees C) 20 30 40 50
Fluid Resistivity (ohm-meters) -10 -5 0 5 10
Natural Gamma (API units) 0 100 200 300
Spontaneous Potential (millivolts) -800 -400 0 400 800
Single Point Resistance (ohms) 0 50 100 150 200
16-inch and 64-inch Normal Resistivity (ohm-meters) 0 500 1000 1500
RX2 Sonic Velocity 100 µSec 1,000

CADASTRAL: (D-2-12) 02dba | ADWR NO: 55-912770
NORTHING: 3682682.831 | EASTING: 492125.623
LAND SURFACE ELEVATION: 1048.86
DATUM: UTM12N, NAD 27, meters
VERTICAL: NGVD 29 METERS

EXPLANATION

DHRES-13_846
DHRES-13_788
DHRES-13_730
DHRES-13_649
Total hydraulic head expressed as depth to water, corresponding to pressure transducer measurements at each discrete elevation

Non-Pumping Water Level

No Data
No Fracturing Evident
Minor Fracturing
Moderate Fracturing
Major Fracturing

REGISTERED GEOLOGIST
CERTIFICATE NO.
25063
TODD
KEAY
Date Signed 22 DEC 2011
ARIZONA U.S.A.
Expires 6/30 2012

Resolution Copper Mining
MONTGOMERY & ASSOCIATES
Water Resource Consultants

DHRES-13
SCHEMATIC DIAGRAM OF WELL CONSTRUCTION

Version: Dec 21, 2011

FIGURE 3

605\wellschematics2010\DHRES13_wa\21Dec2011

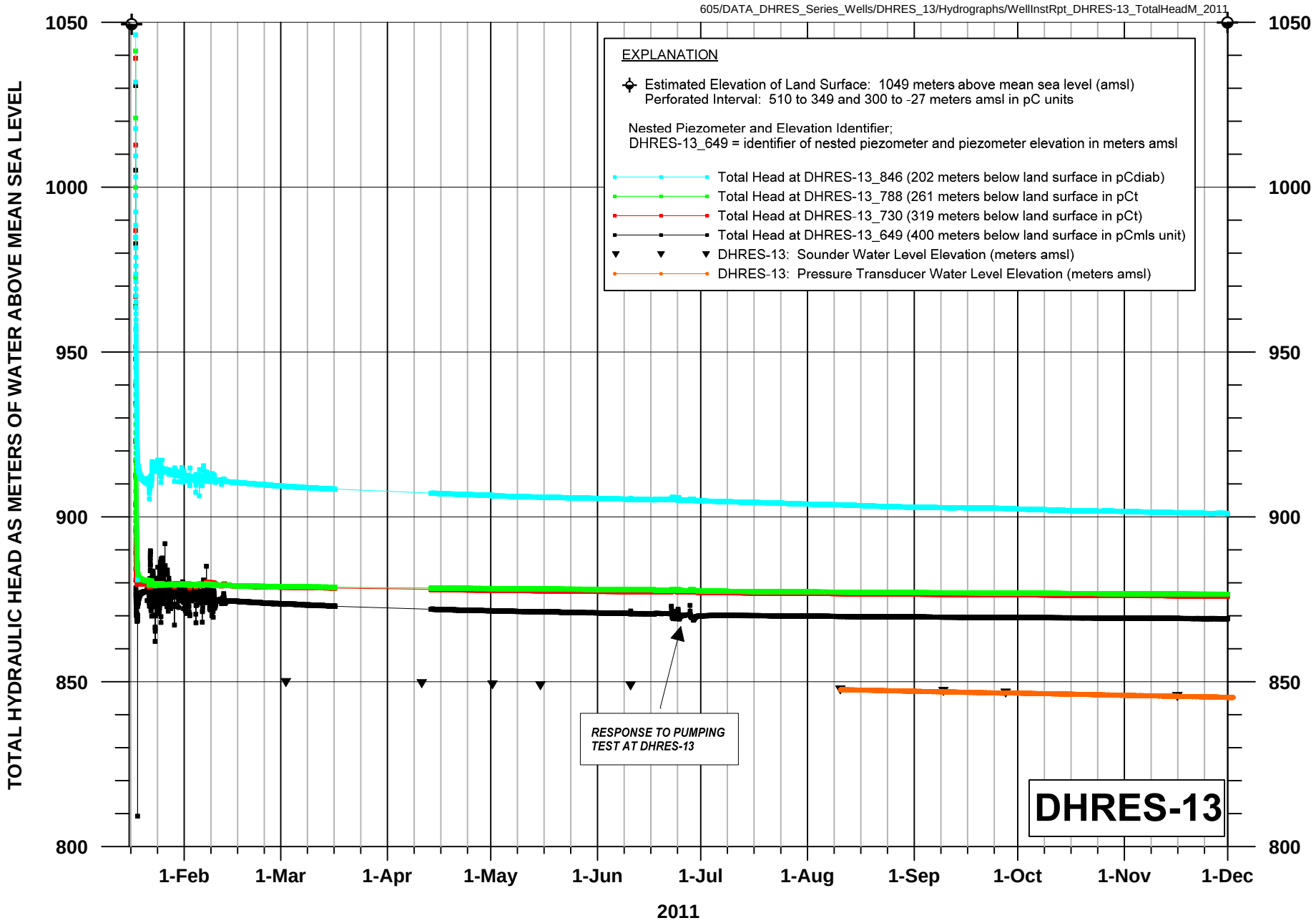


FIGURE 4. HYDROGRAPH OF TOTAL HYDRAULIC HEAD FOR GROUTED VIBRATING-WIRE PIEZOMETERS AND WATER LEVEL ELEVATION AT DEEP HYDROLOGIC TEST WELL DHRES-13, RESOLUTION PROJECT

MONTGOMERY & ASSOCIATES

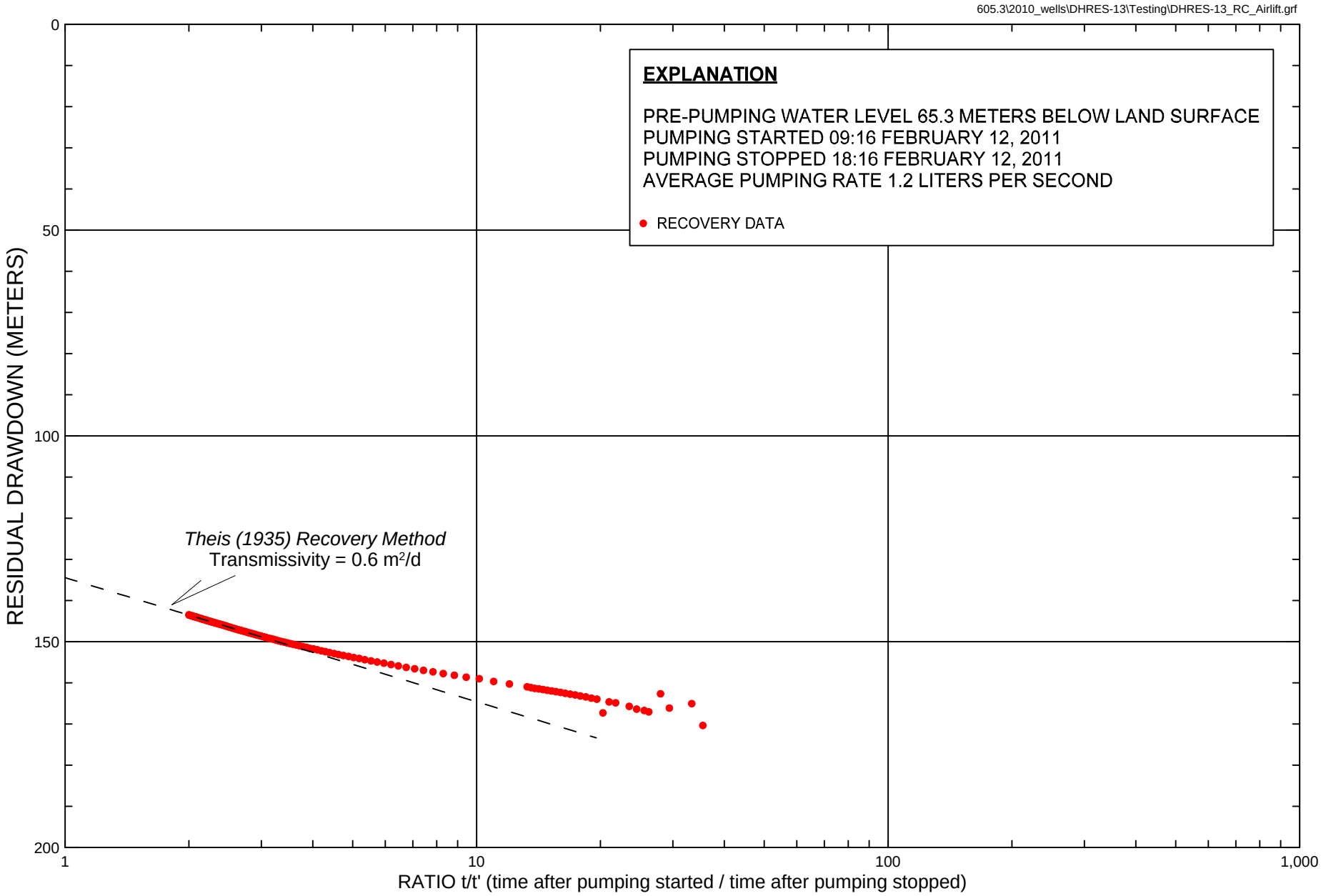


FIGURE 5. RECOVERY GRAPH FOR CASED WELL AIRLIFT TEST AT WELL DHRES-13, RESOLUTION PROJECT

MONTGOMERY & ASSOCIATES

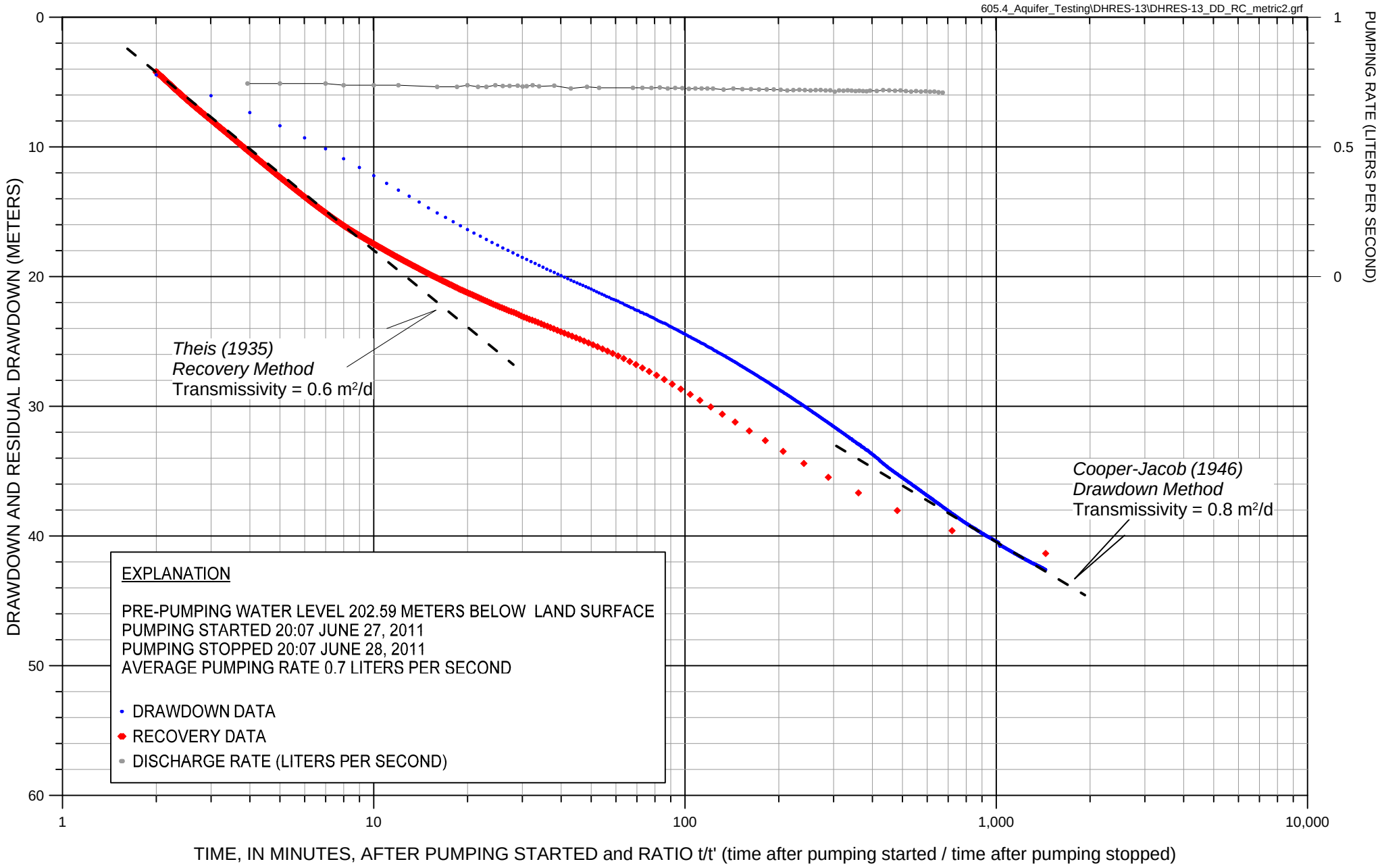


FIGURE 6. DRAWDOWN AND RECOVERY GRAPH FOR PUMPED WELL DHRES-13 DURING 24-HOUR CONSTANT-RATE PUMPING TEST, RESOLUTION PROJECT

MONTGOMERY & ASSOCIATES

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-12
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
FILL				
0 - 10	0.0 - 3.0	Fill; brown [7.5YR4/4]; weak lithified; 50% weathered brown Apache Leap Tuff, 40% weathered dark brown limey siltstone, 10% gray limestone; reaction to acid: strong	common manganese oxide coating, common iron oxide (hematite and limonite)	DIRECT AIR ROTARY; Munsell Color Version: Munsell 2000 rev; angular chips up to 0.4 cm; 17.5" air rotary
MARTIN FORMATION (Dm)				
10 - 20	3.0 - 6.1	Calcareous siltstone; dark brown [7.5YR3/3]; well lithified; dark brown calcareous siltstone; reaction to acid: strong	common manganese oxide coating, common iron oxide (hematite and limonite)	angular chips up to 1.0 cm; 17.5" air rotary
20 - 30	6.1 - 9.1	Calcareous siltstone; dark brown [7.5YR3/3]; well lithified; dark brown calcareous siltstone, trace tan limestone; reaction to acid: strong	common manganese oxide coating, trace iron oxide (hematite and limonite), trace white calcite vein	DUAL-WALL REVERSE CIRCULATION AIR HAMMER; angular chips up to 2.0 cm; 10" air hammer
30 - 40	9.1 - 12.2	Calcareous siltstone; dark brown [7.5YR3/3]; well lithified; dark brown calcareous siltstone, trace tan limestone; reaction to acid: strong	common manganese oxide coating, trace iron oxide (hematite and limonite), trace white calcite vein, trace euhedral calcite crystals on fracture surfaces	angular chips up to 1.8 cm
40 - 50	12.2 - 15.2	Calcareous siltstone; very dark brown [10YR2/2]; well lithified; dark brown and black calcareous siltstone; reaction to acid: moderate to strong	common manganese oxide coating, trace iron oxide (hematite), common iron oxide (limonite), trace white calcite vein	angular chips up to 2.1 cm
50 - 60	15.2 - 18.3	Calcareous siltstone; dark brown [7.5YR3/3]; well lithified; 98% dark brown calcareous siltstone, trace tan limestone; reaction to acid: strong	common manganese oxide coating, trace iron oxide (hematite and limonite), trace white calcite vein, 5% dark brown clay balls	angular chips up to 1.5 cm
60 - 70	18.3 - 21.3	Calcareous siltstone; dark brown [7.5YR3/3]; well lithified; dark brown calcareous siltstone, trace tan limestone; reaction to acid: strong	common manganese oxide coating, very trace iron oxide (hematite and limonite), trace white calcite vein, trace dark brown clay balls	angular chips up to 0.9 cm
70 - 80	21.3 - 24.4	Calcareous siltstone; dark brown [7.5YR3/3]; well lithified; 99% dark brown calcareous siltstone, trace tan limestone; reaction to acid: strong	common manganese oxide coating, 1% white calcite vein, trace euhedral calcite crystals on fracture surfaces	angular chips up to 1.8 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-12
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
MARTIN FORMATION (Dm)				
80 - 90	24.4 - 27.4	Calcareous siltstone; dark brown [7.5YR3/3]; well lithified; 98% dark brown calcareous siltstone, trace dark brown limestone; reaction to acid: strong	some manganese oxide coating, 2% white calcite vein, trace euhedral calcite crystals on fracture surfaces	angular chips up to 1.7 cm
90 - 100	27.4 - 30.5	Calcareous siltstone and limestone; dark brown [7.5YR3/3]; well lithified; 80% dark brown calcareous siltstone, 15% gray limestone, trace black mudstone; reaction to acid: strong	some manganese oxide coating, 5% white calcite vein, trace euhedral calcite crystals on fracture surfaces, very trace iron oxide (hematite and limonite)	angular chips up to 2.2 cm
100 - 110	30.5 - 33.5	Calcareous siltstone and limestone; dark gray [5YR4/1]; well lithified; 55% dark gray limestone, 45% brown calcareous siltstone, trace pink limestone; reaction to acid: strong	trace white calcite vein, very trace iron oxide (hematite and limonite)	angular chips up to 1.4 cm
110 - 120	33.5 - 36.6	Limestone and siltstone; reddish yellow [7.5YR6/6] and dark gray [5YR4/1]; moderate to well lithified; 60% tannish-orange slightly calcareous siltstone, 39% dark gray limestone; reaction to acid: moderate to strong	trace manganese oxide coating on siltstone, 1% white calcite vein, trace iron oxide (hematite and limonite)	angular chips up to 1.4 cm
120 - 130	36.6 - 39.6	Siltstone; reddish yellow [7.5YR6/6]; moderate lithified; light tannish-orange siltstone, trace dark gray limestone; reaction to acid: none to very weak	trace iron oxide (hematite and limonite), trace manganese oxide on siltstone	subangular chips up to 1.3 cm
130 - 140	39.6 - 42.7	Siltstone; red [2.5YR4/6]; well lithified; 85% red siltstone, 15% tannish-orange calcareous siltstone; reaction to acid: none to very weak	trace iron oxide (hematite and limonite), trace manganese oxide on siltstone	subangular chips up to 1.6 cm
140 - 150	42.7 - 45.7	Siltstone; reddish yellow [7.5YR6/6]; well lithified; 90% yellowish-orange slightly calcareous siltstone, 10% red siltstone; reaction to acid: none to very weak	trace iron oxide (hematite and limonite), trace manganese oxide on siltstone	subangular chips up to 2.3 cm
150 - 160	45.7 - 48.8	Siltstone; reddish yellow [7.5YR6/6]; well lithified; 90% orange slightly calcareous siltstone, 10% yellowish-orange slightly calcareous siltstone; reaction to acid: none to very weak	trace iron oxide (hematite and limonite), trace manganese oxide on siltstone	subangular chips up to 2.0 cm
160 - 170	48.8 - 51.8	Siltstone; reddish yellow [7.5YR6/6]; well lithified; 90% orange slightly calcareous siltstone, 10% yellowish-orange slightly calcareous siltstone; reaction to acid: none to very weak	trace iron oxide (hematite and limonite), trace manganese oxide on siltstone, trace calcite vein	subangular chips up to 1.0 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-12
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
MARTIN FORMATION (Dm)				
170 - 180	51.8 - 54.9	Siltstone and calcareous siltstone; reddish yellow [7.5YR6/6] and dark reddish gray [2.5YR3/1]; well lithified; 65% orange slightly calcareous siltstone, 35% brown calcareous siltstone; reaction to acid: moderate to strong	trace iron oxide (hematite and limonite), trace manganese oxide on siltstone, trace calcite vein	subangular chips up to 1.8 cm
180 - 190	54.9 - 57.9	Calcareous siltstone; dark reddish gray [2.5YR3/1]; well lithified; 99% dark brown calcareous siltstone, 1% orange slightly calcareous siltstone; reaction to acid: very strong	trace iron oxide (hematite and limonite), trace manganese oxide on siltstone, trace calcite vein	subangular chips up to 1.3 cm
190 - 200	57.9 - 61.0	Calcareous siltstone; dark reddish gray [2.5YR3/1]; well lithified; 95% dark brown calcareous siltstone, 5% tannish-orange slightly calcareous siltstone; reaction to acid: very strong	trace iron oxide (hematite and limonite), trace manganese oxide on siltstone, trace calcite vein	subangular chips up to 1.9 cm
200 - 210	61.0 - 64.0	Calcareous siltstone; dark reddish gray [2.5YR3/1]; well lithified; 95% dark brown calcareous siltstone, 5% tannish-orange slightly calcareous siltstone; reaction to acid: very strong	trace iron oxide (hematite and limonite), trace manganese oxide on siltstone, trace calcite vein	subangular chips up to 1.3 cm
210 - 220	64.0 - 67.1	Calcareous siltstone and siltstone; red [2.5YR4/6]; well lithified; 50% reddish-orange slightly calcareous siltstone, 50% dark brown calcareous siltstone; reaction to acid: strong	some iron oxide (hematite and limonite), trace manganese oxide on siltstone, trace calcite vein	subangular chips up to 1.0 cm
220 - 230	67.1 - 70.1	Calcareous siltstone and siltstone; strong brown [7.5YR3/8]; well lithified; 60% tannish-yellow calcareous siltstone, 40% dark brown calcareous siltstone; reaction to acid: moderate	some iron oxide (hematite and limonite), trace manganese oxide on siltstone, trace calcite vein	subangular chips up to 1.1 cm
230 - 240	70.1 - 73.2	Siltstone; yellowish red [5YR5/8]; well lithified; 95% red, yellowish-orange calcareous siltstone, 5% dark brown calcareous siltstone; reaction to acid: moderate	some iron oxide (hematite and limonite), trace manganese oxide on siltstone	subangular chips up to 1.4 cm
240 - 250	73.2 - 76.2	Siltstone and quartzite; yellowish red [5YR5/8]; well lithified; 95% reddish-orange calcareous siltstone, 5% tannish-white, coarse-grained, slightly arkosic quartzite; reaction to acid: moderate	trace iron oxide (hematite and limonite), trace manganese oxide coating	subangular chips up to 1.3 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-12
Resolution Copper Mining
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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
250 - 260	76.2 - 79.2	Arkosic, course-grained quartzite; pinkish gray [5YR7/2]; well lithified; 75% white, pink, and tan coarse-grained , slightly arkosic quartzite, 25% reddish-orange calcareous siltstone; reaction to acid: none to very weak	trace iron oxide (hematite and limonite), trace manganese oxide coating	angular chips up to 1.4 cm
260 - 270	79.2 - 82.3	Arkosic, course-grained quartzite; pinkish gray [5YR7/2]; well lithified; 98% white, pink, and tan coarse-grained , slightly arkosic quartzite, 2% reddish-orange calcareous siltstone; reaction to acid: none to very weak	trace iron oxide (hematite and limonite)	angular chips up to 1.7 cm
270 - 280	82.3 - 85.3	Course-grained quartzite; pinkish gray [5YR7/2]; well lithified; 98% white, pink, and tan coarse-grained quartzite, 2% reddish-orange calcareous siltstone; reaction to acid: none to very weak	trace iron oxide (hematite and limonite)	angular chips up to 1.7 cm
280 - 290	85.3 - 88.4	Course-grained quartzite; pinkish gray [5YR7/2]; well lithified; White, pink, and tan coarse-grained quartzite; reaction to acid: none	common iron oxide (hematite and limonite) on grain boundaries, trace manganese oxide on fracture surfaces	angular chips up to 2.1 cm
290 - 300	88.4 - 91.4	Course-grained quartzite; pinkish gray [5YR7/2]; well lithified; White, pink, and tan coarse-grained quartzite; reaction to acid: very weak	common iron oxide (hematite and limonite) on grain boundaries, trace manganese oxide on fracture surfaces	angular chips up to 2.2 cm
300 - 310	91.4 - 94.5	Course-grained quartzite; pinkish gray [5YR7/2]; well lithified; White, pink, and tan coarse-grained quartzite; reaction to acid: very weak	common iron oxide (hematite and limonite) on grain boundaries, hematite speckling throughout quartzite, trace manganese oxide on fracture surfaces	angular chips up to 1.8 cm
310 - 320	94.5 - 97.5	Course-grained quartzite; pinkish gray [5YR7/2]; well lithified; White, pink, and tan coarse-grained quartzite; reaction to acid: very weak	common iron oxide (hematite and limonite) on grain boundaries, hematite speckling throughout quartzite, trace manganese oxide on fracture surfaces	angular chips up to 2.5 cm
320 - 330	97.5 - 100.6	Course-grained quartzite; pinkish gray [5YR7/2]; well lithified; White, pink, and tan coarse-grained quartzite; reaction to acid: very weak	common iron oxide (hematite and limonite) on grain boundaries, hematite speckling throughout quartzite, trace manganese oxide on fracture surfaces	angular chips up to 3.1 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
330 - 340	100.6 - 103.6	Course-grained quartzite; pinkish gray [5YR7/2]; well lithified; 85% white, pink, and tan coarse-grained quartzite, 15% yellow and orange coarse-grained quartzite; reaction to acid: weak	common iron oxide (hematite) on grain boundaries, abundant iron oxide (limonite) on grain boundaries, trace manganese oxide on fractures	angular chips up to 3.7 cm
340 - 350	103.6 - 106.7	Course-grained quartzite; strong brown [7.5YR4/6]; well lithified; 50% white, pink, and tan coarse-grained quartzite, 50% yellow and orange coarse-grained quartzite; reaction to acid: weak	common iron oxide (hematite) on grain boundaries, abundant iron oxide (limonite) on grain boundaries, common manganese oxide on fractures	angular chips up to 2.4 cm
350 - 360	106.7 - 109.7	Course-grained quartzite; strong brown [7.5YR4/6]; well lithified; 80% white, pink, and tan coarse-grained quartzite, 20% orange coarse-grained quartzite; reaction to acid: weak	common iron oxide (hematite) on grain boundaries, abundant iron oxide (limonite) on grain boundaries, common manganese oxide on fractures	angular chips up to 1.8 cm
360 - 370	109.7 - 112.8	Course-grained quartzite; black [N2.5] and weak red [10R4/4]; well lithified; 85% black and red, coarse-grained quartzite, 15% yellowish-orange, coarse-grained quartzite; reaction to acid: weak	common iron oxide (hematite) on grain boundaries, some iron oxide (limonite) on grain boundaries, abundant manganese oxide on fractures, trace calcite vein	subangular chips up to 1.5 cm
370 - 380	112.8 - 115.8	Course-grained quartzite; black [N2.5] and weak red [10R4/4]; well lithified; 95% black and red, coarse-grained quartzite, 5% yellowish-orange, coarse-grained quartzite; reaction to acid: weak	common iron oxide (hematite) on grain boundaries, some iron oxide (limonite) on grain boundaries, abundant manganese oxide on fractures, trace calcite vein	subangular chips up to 1.3 cm
PRECAMBRIAN DIABASE (pCdiab)				
380 - 390	115.8 - 118.9	Oxidized diabase; black [N2.5] and weak red [10R4/4]; well lithified; 80% black and red diabase with 70% pyroxene, 30% plagioclase and common magnetite; 5% red and black, coarse-grained quartzite, 5% yellowish-orange, coarse-grained quartzite; reaction to acid: very weak	common iron oxide (hematite) on grain boundaries, some iron oxide (limonite) on grain boundaries, some manganese oxide on fractures, trace calcite vein	subangular chips up to 2.0 cm
390 - 400	118.9 - 121.9	Oxidized diabase; black [N2.5] and strong brown [7.5YR5/6]; well lithified; 80% black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; 20% pinkish-brown, coarse-grained quartzite; reaction to acid: very weak	common iron oxide (hematite and limonite) on grain boundaries, trace calcite vein	subangular chips up to 2.3 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
400 - 410	121.9 - 125.0	Oxidized diabase; black [N2.5] and strong brown [7.5YR5/6]; well lithified; 80% black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; 20% pinkish-brown, coarse-grained quartzite; reaction to acid: very weak	abundant iron oxide (hematite and limonite) on grain boundaries, trace calcite vein	subangular chips up to 1.6 cm
410 - 420	125.0 - 128.0	Oxidized diabase; black [N2.5] and strong brown [7.5YR5/6]; well lithified; 90% black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; 10% red, tan and white, coarse-grained quartzite; reaction to acid: very weak	abundant iron oxide (hematite and limonite) on grain boundaries, trace calcite vein	subangular chips up to 1.5 cm
420 - 430	128.0 - 131.1	Oxidized diabase / course-grained quartzite; black [N2.5] and yellowish brown [10YR5/4]; well lithified; 60% black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; 5% red, tan and white, coarse-grained quartzite, 35% yellow, medium to fined-grained quartzite; reaction to acid: none to very weak	abundant iron oxide (hematite and limonite) on grain boundaries, very trace calcite vein	subangular chips up to 1.9 cm
TROY QUARTZITE (pCt)				
430 - 440	131.1 - 134.1	Course-grained quartzite; reddish yellow [7.5YR6/8] and weak red [10R5/4]; well lithified; 90% tan, yellow, and pink, coarse-grained quartzite, 8% yellow, fine-grained quartzite, 2% black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: none	abundant iron oxide (hematite and limonite) on grain boundaries, very trace calcite vein, trace milky quartz vein	subangular chips up to 1.1 cm
440 - 450	134.1 - 137.2	Course-grained quartzite; weak red [10R5/4] and reddish yellow [7.5YR6/8]; well lithified; 60% pink, coarse-grained quartzite, 35% white and tan, coarse-grained quartzite, 5% yellow, fine-grained quartzite, trace black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: none	abundant iron oxide (hematite and limonite) on grain boundaries, trace milky quartz vein	subangular chips up to 1.0 cm
450 - 460	137.2 - 140.2	Course-grained quartzite; weak red [10R5/4] and reddish yellow [7.5YR6/8]; well lithified; 80% pink, coarse-grained quartzite, 20% white and tan, coarse-grained quartzite, trace black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: none	common iron oxide (hematite and limonite) on grain boundaries, trace milky quartz vein	subangular chips up to 1.3 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
460 - 470	140.2 - 143.3	Course-grained quartzite; light gray [10R7/1] and reddish yellow [7.5YR6/8]; well lithified; 90% white and tan, coarse-grained quartzite, 8% pink, coarse-grained quartzite, 1% black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite, trace light green, coarse-grained quartzite; reaction to acid: none	common iron oxide (hematite and limonite) on grain boundaries, 1% milky quartz vein	subangular chips up to 0.9 cm
470 - 480	143.3 - 146.3	Course-grained quartzite; light gray [10R7/1] and reddish yellow [7.5YR6/8]; well lithified; 90% white and tan, coarse-grained quartzite, 8% pink, coarse-grained quartzite, 1% black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite, trace light green, coarse-grained quartzite; reaction to acid: none	common iron oxide (hematite and limonite) on grain boundaries, 1% milky quartz vein	subangular chips up to 1.2 cm
480 - 490	146.3 - 149.4	Course-grained quartzite; light gray [10R7/1] and reddish yellow [7.5YR6/6]; well lithified; 90% light gray, coarse-grained quartzite, 10% yellow, coarse-grained quartzite, trace pink, coarse-grained quartzite, trace black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: none to very weak	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), trace milky quartz vein	subangular chips up to 0.8 cm
490 - 500	149.4 - 152.4	Course-grained quartzite; light gray [10R7/1] and reddish yellow [7.5YR6/6]; well lithified; yellow, pink, and tan, coarse-grained quartzite, trace pink, coarse-grained quartzite, trace black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite, trace light green, coarse-grained quartzite; reaction to acid: none to very weak	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), trace milky quartz vein	subangular chips up to 0.8 cm
500 - 510	152.4 - 155.4	Course-grained quartzite; light gray [10R7/1] and reddish yellow [7.5YR6/6]; well lithified; yellow, pink, and tan, coarse-grained quartzite, trace pink, coarse-grained quartzite, trace black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite, trace light green, coarse-grained quartzite; reaction to acid: none to very weak	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), trace milky quartz vein	subangular chips up to 1.4 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
510 - 520	155.4 - 158.5	Quartz arenite; reddish gray [10R6/1] and reddish yellow [7.5YR6/6]; well lithified; 90% white, coarse-grained quartzite with common hematite speckling throughout, 9% yellow, pink, and tan, coarse-grained quartzite, 1% black and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: none to very weak	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), trace milky quartz vein	subangular chips up to 1.8 cm
520 - 530	158.5 - 161.5	Quartz arenite; brownish yellow [10YR6/6] and reddish gray [10R6/1]; well lithified; 50% white, coarse-grained quartzite with common hematite speckling throughout, 45% yellow and gray, coarse-grained quartzite, 5% black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: none	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), trace milky quartz vein	subangular chips up to 1.5 cm
530 - 540	161.5 - 164.6	Quartz arenite; brownish yellow [10YR6/6] and dark yellowish brown [10YR3/4]; well lithified; 80% yellow and gray, coarse-grained quartzite, 10% brown calcareous siltstone, 5% black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: moderate to strong	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), trace milky quartz vein	subangular chips up to 1.7 cm
540 - 550	164.6 - 167.6	Quartz arenite; brownish yellow [10YR6/6] and dark yellowish brown [10YR3/4]; well lithified; 90% yellow, tan and gray, coarse-grained quartzite, 5% brown calcareous siltstone, 5% black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: moderate to strong	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), trace milky quartz vein	subangular chips up to 1.2 cm
550 - 560	167.6 - 170.7	Quartz arenite; weak red [10R5/4] and brownish yellow [10YR6/6]; well lithified; 90% white, coarse-grained quartzite with common hematite speckling throughout, 10% yellow and gray, coarse-grained quartzite, trace black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: none to very weak	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), trace milky quartz vein	subangular chips up to 1.4 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
560 - 570	170.7 - 173.7	Quartz arenite; weak red [10R5/4] and brownish yellow [10YR6/6]; well lithified; 80% white, coarse-grained quartzite with common hematite speckling throughout, 20% yellow, tan and gray, coarse-grained quartzite, trace black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: none to very weak	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), trace milky quartz vein	subangular chips up to 1.6 cm
570 - 580	173.7 - 176.8	Quartz arenite; dusky red [2.5YR3/2] and light reddish brown [2.5YR6/4]; well lithified; 50% dark purple and green, fine-grained quartzite, 40% yellow, tan and gray, coarse-grained quartzite, 10% white, coarse-grained quartzite with common hematite speckling throughout, trace black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: very weak	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), very trace milky quartz vein	subangular chips up to 3.1 cm
580 - 590	176.8 - 179.8	Quartz arenite; dusky red [2.5YR3/2] and light reddish brown [2.5YR6/4]; well lithified; 70% red-purple and green, fine-grained quartzite, 30% pink, tan and gray, coarse-grained quartzite, trace black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: very weak	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), very trace milky quartz vein	subangular chips up to 2.1 cm
590 - 600	179.8 - 182.9	Quartz arenite; light gray [10R7/1]; well lithified; 93% white, coarse-grained quartzite with common hematite speckling throughout, 2% yellow, tan and gray, coarse-grained quartzite, 5% black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: very weak	common iron oxide (limonite) on grain boundaries, some iron oxide (hematite), very trace milky quartz vein	subangular chips up to 1.8 cm
600 - 610	182.9 - 185.9	Quartz arenite / Oxidized diabase; dark reddish brown [2.5YR3/3]; well lithified; 95% white, coarse-grained quartzite with common hematite speckling throughout, 1% pink, coarse-grained quartzite, 3% black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: very weak	common iron oxide (limonite and hematite), 1% milky quartz vein	subangular chips up to 1.4 cm

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PRECAMBRIAN DIABASE (pCdiab)				
610 - 620	185.9 - 189.0	Oxidized diabase; dark reddish brown [2.5YR3/3] and black [N2.5]; well lithified; 50% white, coarse-grained quartzite with common hematite speckling throughout, 10% yellow, coarse-grained quartzite, trace red, fine-grained quartzite, 40% black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite; reaction to acid: weak	common iron oxide (limonite and hematite), trace milky quartz vein, trace calcite vein	subangular chips up to 2.1 cm
620 - 629	189.0 - 191.7	Oxidized diabase; black [N2.5]; well lithified; 80% black, white, yellow and red diabase with 60% pyroxene, 40% plagioclase and common magnetite, 5% white, coarse-grained quartzite with common hematite speckling throughout, 15% yellow and brown, coarse-grained quartzite, trace red, fine-grained quartzite; reaction to acid: weak	common iron oxide (limonite and hematite), trace calcite vein	subangular chips up to 3.1 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
FILL				
0 - 10	0.0 - 3.0	Fill; brown [7.5YR4/4]; moderate to well lithified; 90% weathered dark brown limey siltstone; 5% weathered brown Apache Leap Tuff; 5% tannish-brown limestone; reaction to acid: moderate to strong	trace manganese oxide coating on chips, some iron oxide (hematite and limonite), trace calcite vein	DIRECT AIR ROTARY; Munsell Color Version: Munsell 2000 rev; angular chips up to 1.3 cm
MARTIN FORMATION (Dm)				
10 - 20	3.0 - 6.1	Calcareous siltstone; dark brown [7.5YR3/3]; well lithified; 95% dark brown calcareous siltstone; 5% tannish-brown limestone; reaction to acid: moderate to strong	trace manganese oxide coating on chips, some iron oxide (hematite and limonite), trace calcite vein	angular chips up to 1.4 cm
20 - 30	6.1 - 9.1	Calcareous siltstone and limestone; dark brown [7.5YR3/3]; well lithified; 50% dark brown calcareous siltstone; 50% tan limestone; reaction to acid: moderate to strong	trace manganese oxide coating on chips, some iron oxide (hematite and limonite), trace calcite vein	angular chips up to 1.7 cm
30 - 40	9.1 - 12.2	Calcareous siltstone; dark brown [7.5YR3/3]; well lithified; dark brown calcareous siltstone; trace yellow mudstone; reaction to acid: moderate to strong	trace manganese oxide coating on chips, some iron oxide (hematite and limonite), trace calcite vein	angular chips up to 1.6 cm
40 - 50	12.2 - 15.2	Calcareous silty sandstone; brown [7.5YR4/2]; well lithified; 90% brown calcareous silty sandstone; 10% gray and tannish-brown limestone; trace white limestone; reaction to acid: moderate to strong	trace manganese oxide, some iron oxide (hematite and limonite), common calcite up to 0.6 cm and calcite veinlet	CONVENTIONAL MUD ROTARY; angular chips up to 1.2 cm; trace cement; unwashed sample appears to be rocks and soil, instead of rocks and mud
50 - 60	15.2 - 18.3	Calcareous siltstone and sandstone; brown [10YR5/3]; well lithified; 50% dark brown calcareous siltstone; 50% dark gray shiny fine-grained, silty sandstone with some larger quartz crystals; reaction to acid: weak	common iron oxide (hematite and limonite), very trace calcite veinlet	angular chips up to 0.8 cm; strong acid reaction on washed sample; LCM affects color; 96% LCM cotton substance
60 - 70	18.3 - 21.3	Calcareous silty sandstone; very dark grayish brown [10YR3/2]; well lithified; dark brown and brownish-black calcareous silty sandstone; trace dark gray shiny fine-grained sandstone; reaction to acid: moderate	some iron oxide (hematite and limonite), some calcite and calcite veins, trace manganese oxide	angular chips up to 2.9 cm; common LCM
70 - 80	21.3 - 24.4	Calcareous silty sandstone and siltstone; brown [10YR4/3]; well lithified; 75% dark brown and brownish-black calcareous silty sandstone; 20% orange-brown calcareous siltstone; 5% dark gray shiny fine-grained sandstone; reaction to acid: strong	some iron oxide (hematite and limonite), some calcite and calcite veins, trace manganese oxide, trace quartz	angular chips up to 1.2 cm; some LCM

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MARTIN FORMATION (Dm)				
80 - 90	24.4 - 27.4	Calcareous silty sandstone; dark grayish brown [10YR4/2]; well lithified; 88% dark brown and brownish-black calcareous silty sandstone; 10% orange-brown calcareous siltstone; 2% dark gray shiny fine-grained sandstone; reaction to acid: strong	trace iron oxide (hematite), some calcite, very trace quartz	angular chips up to 2.0 cm; some LCM
90 - 100	27.4 - 30.5	Calcareous silty sandstone; brown [10YR5/3]; well lithified; 93% dark brown and brownish-black calcareous silty sandstone; 4% light gray limestone; 3% dark gray shiny fine-grained sandstone; trace orange-brown calcareous siltstone; reaction to acid: strong	trace iron oxide (hematite and limonite), trace calcite veinlet, trace manganese oxide, very trace quartz	angular chips up to 1.9 cm
100 - 110	30.5 - 33.5	Sandstone and limestone; brown [10YR5/3]; well lithified; 70% tan sandstone; 30% gray limestone; reaction to acid: very strong	very trace iron oxide (hematite), common calcite veinlets in tan sandstone up to 1 mm in thickness, trace manganese oxide	angular chips up to 1.8 cm
110 - 120	33.5 - 36.6	Calcareous silty sandstone and siltstone; dark grayish brown [10YR4/2]; well lithified; 75% dark brown and brownish-black calcareous silty sandstone; 25% orange-brown calcareous siltstone; trace gray limestone; trace dark gray shiny fine-grained sandstone; reaction to acid: very strong	trace iron oxide (hematite and limonite), trace calcite, trace manganese oxide	angular chips up to 1.5 cm
120 - 130	36.6 - 39.6	Siltstone; light olive brown [2.5Y5/4]; well lithified; 95% orange-brown siltstone; 5% gray limestone and dark brown calcareous silty sandstone; trace dark gray shiny fine-grained sandstone; reaction to acid: moderate	trace iron oxide (hematite), very trace calcite veinlet, trace manganese oxide	angular chips up to 1.6 cm
130 - 140	39.6 - 42.7	Siltstone; reddish brown [5YR5/4]; well lithified; orange-brown and orange-red siltstone with very trace laminations, very trace gray limestone; reaction to acid: weak to moderate	trace iron oxide (hematite), trace manganese oxide	angular chips up to 1.4 cm
140 - 150	42.7 - 45.7	Siltstone; reddish brown [5YR5/4]; well lithified; orange-brown and orange-red siltstone; very trace dark brown calcareous silty sandstone; very trace dark gray sandstone; reaction to acid: weak to moderate	trace iron oxide (hematite and common limonite), very trace calcite veinlet, trace manganese oxide	angular chips up to 1.6 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
MARTIN FORMATION (Dm)				
150 - 160	45.7 - 48.8	Siltstone; light olive brown [2.5Y5/4]; well lithified; orange-brown and some orange-red siltstone; very trace clay; reaction to acid: weak to moderate	trace iron oxide (hematite and limonite), common manganese oxide	angular chips up to 0.9 cm
160 - 170	48.8 - 51.8	Siltstone; strong brown [7.5YR5/6]; well lithified; orange-brown and some orange-red siltstone; reaction to acid: weak	trace calcite veinlet, trace manganese oxide	angular chips up to 1.8 cm
170 - 180	51.8 - 54.9	Siltstone; strong brown [7.5YR5/6]; well lithified; orange-brown and some orange-red siltstone; reaction to acid: very weak	very trace iron oxide (limonite), very trace calcite veinlet, trace manganese oxide	angular chips up to 2.1 cm
180 - 190	54.9 - 57.9	Siltstone; strong brown [7.5YR5/6]; well lithified; orange-brown and some orange-red siltstone; very trace limestone; very trace dark brown siltstone; reaction to acid: moderate to strong	very trace iron oxide (hematite and limonite), very trace calcite, very trace quartz veinlet, trace manganese oxide	angular chips up to 1.4 cm
190 - 200	57.9 - 61.0	Calcareous silty sandstone and siltstone; strong brown [7.5YR5/6]; well lithified; 70% dark brown calcareous silty sandstone; 30% orange-brown siltstone with very trace laminations; reaction to acid: strong	trace iron oxide (limonite), very trace calcite veinlet, trace manganese oxide, very trace quartz veinlet	angular chips up to 1.2 cm
200 - 210	61.0 - 64.0	Calcareous silty sandstone; light yellowish brown [10YR6/4]; well lithified; 98% dark brown calcareous silty sandstone; 2% orange-brown siltstone; reaction to acid: strong	very trace iron oxide (limonite), trace calcite, trace manganese oxide, very trace quartz	angular chips up to 2.0 cm
210 - 220	64.0 - 67.1	Calcareous silty sandstone; light yellowish brown [10YR6/4]; well lithified; 98% dark brown calcareous silty sandstone; 2% orange-brown siltstone; reaction to acid: strong	very trace iron oxide (limonite), trace calcite on fracture surfaces	angular chips up to 2.3 cm
220 - 230	67.1 - 70.1	Calcareous sandstone; light yellowish brown [10YR6/4]; well lithified; 95% dark brown calcareous sandstone; 5% orange-brown siltstone; reaction to acid: strong	very trace iron oxide (hematite and limonite)	angular chips up to 2.0 cm; some LCM
230 - 240	70.1 - 73.2	Calcareous siltstone; light yellowish brown [10YR6/4]; well lithified; 75% orange calcareous siltstone; 25% dark brown calcareous siltstone; reaction to acid: strong	very trace white calcite vein, very trace iron oxide (hematite and limonite), trace manganese oxide on fractures	angular chips up to 1.3 cm; 40% LCM

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Resolution Copper Mining
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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
MARTIN FORMATION (Dm)				
240 - 250	73.2 - 76.2	Calcareous siltstone; light yellowish brown [10YR6/4]; well lithified; 90% orange calcareous siltstone; 10% dark brown calcareous sandstone; reaction to acid: moderate	very trace white calcite vein, trace iron oxide (hematite and limonite), trace manganese oxide on fractures	angular chips up to 1.2 cm; 50% LCM
250 - 260	76.2 - 79.2	Calcareous siltstone; light yellowish brown [10YR6/4]; well lithified; orange calcareous siltstone; trace dark brown calcareous sandstone; very trace gray limestone; reaction to acid: moderate	trace iron oxide (hematite and limonite), trace manganese oxide on fractures	angular chips up to 1.0 cm; 50% LCM
260 - 270	79.2 - 82.3	Calcareous siltstone; light yellowish brown [10YR6/4]; well lithified; orange calcareous siltstone; trace dark brown calcareous sandstone; very trace gray limestone; reaction to acid: moderate	trace iron oxide (hematite and limonite), trace manganese oxide on fractures	angular chips up to 0.8 cm; 60% LCM
270 - 280	82.3 - 85.3	Calcareous siltstone and quartzite; light yellowish brown [10YR6/4]; well lithified; 70% orange calcareous siltstone; 30% white, tan and pink medium to coarse-grained quartzite; trace dark brown calcareous sandstone; reaction to acid: very weak to moderate	common iron oxide (hematite and limonite) on grain boundaries and fractures	angular chips up to 1.2 cm; 60% LCM
TROY QUARTZITE (pCt)				
280 - 290	85.3 - 88.4	Quartzite and calcareous siltstone; weak red [10R5/4] and reddish yellow [7.5YR6/8]; well lithified; 80% white, pink, and tan medium to coarse-grained quartzite; 20% orange calcareous siltstone; trace brown calcareous sandstone; reaction to acid: very weak to moderate	common iron oxide (hematite and limonite) on grain boundaries and fractures	angular chips up to 1.0 cm; 60% LCM
290 - 300	88.4 - 91.4	Quartzite; weak red [10R5/4] and reddish yellow [7.5YR6/8]; well lithified; 95% white, tan and pink medium to coarse-grained quartzite; 5% orange calcareous siltstone; trace dark brown calcareous sandstone; reaction to acid: very weak to moderate	common iron oxide (hematite and limonite) on grain boundaries and fractures, very trace manganese oxide on fracture surfaces	angular chips up to 1.4 cm; 60% LCM
300 - 310	91.4 - 94.5	Quartzite; weak red [10R5/4] and reddish yellow [7.5YR6/8]; well lithified; white, tan and pink medium to coarse-grained quartzite; trace orange calcareous siltstone; trace dark brown calcareous sandstone; reaction to acid: very weak to moderate	common iron oxide (hematite and limonite) on grain boundaries and fractures, very trace manganese oxide on fracture surfaces	angular chips up to 1.1 cm; 60% LCM
LOST CIRCULATION ZONE				
310 - 320	94.5 - 97.5	NO SAMPLE - Lost Circulation Zone		

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
LOST CIRCULATION ZONE				
320 - 330	97.5 - 100.6	NO SAMPLE - Lost Circulation Zone		
330 - 340	100.6 - 103.6	NO SAMPLE - Lost Circulation Zone		
340 - 350	103.6 - 106.7	NO SAMPLE - Lost Circulation Zone		
350 - 360	106.7 - 109.7	100% LCM		
360 - 370	109.7 - 112.8	100% LCM		
PRECAMBRIAN DIABASE (pCdiab)				
370 - 380	112.8 - 115.8	Oxidized diabase and quartzite; black [N2.5] and yellowish brown [10YR5/4]; well lithified; 60% heavily oxidized, black and red diabase; 30% pink and yellow, medium-grained quartzite; 10% black and red, coarse-grained quartzite; reaction to acid: none	abundant iron oxide (hematite and limonite) on grain boundaries and fractures, common manganese oxide staining	angular chips up to 0.8 cm; 95% LCM
380 - 390	115.8 - 118.9	Oxidized diabase and quartzite; black [N2.5] and yellowish brown [10YR5/4]; well lithified; 50% heavily oxidized, black and red diabase; 40% red, black, and tan coarse-grained quartzite; 10% medium-grained yellow quartzite; reaction to acid: weak to moderate	abundant iron oxide (hematite and limonite) on grain boundaries and fractures, common manganese oxide staining, trace white calcite vein	angular chips up to 1.0 cm; 99% LCM
390 - 400	118.9 - 121.9	Oxidized diabase and quartzite; black [N2.5] and yellowish brown [10YR5/4]; well lithified; 50% heavily oxidized, black and red diabase; 40% red, black, and tan coarse-grained quartzite; 10% medium-grained yellow quartzite; reaction to acid: weak to moderate	abundant iron oxide (hematite and limonite) on grain boundaries and fractures, common manganese oxide staining, trace white calcite vein	angular chips up to 1.2 cm; 99% LCM
400 - 410	121.9 - 125.0	Oxidized diabase and quartzite; black [N2.5] and yellowish brown [10YR5/4]; well lithified; 70% heavily oxidized, black and red diabase; 20% red, black, and tan coarse-grained quartzite; 10% medium-grained yellow quartzite; reaction to acid: very weak to weak	abundant iron oxide (hematite and limonite) on grain boundaries and fractures, common manganese oxide staining, trace white calcite vein	angular chips up to 0.9 cm; 99% LCM

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
410 - 420	125.0 - 128.0	Oxidized diabase and quartzite; black [N2.5] and yellowish brown [10YR5/4]; well lithified; 80% heavily oxidized, black and red diabase; 10% white, pink, and tan medium-grained quartzite; 10% yellow, fine-grained quartzite; reaction to acid: very weak to weak	common iron oxide (hematite and limonite) on grain boundaries and fractures, common manganese oxide staining, trace white calcite vein	angular chips up to 0.9 cm; 70% LCM
420 - 430	128.0 - 131.1	Oxidized diabase and quartzite; black [N2.5] and yellowish brown [10YR5/4]; well lithified; 80% heavily oxidized, black and red diabase with very trace magnetite; trace white, pink, and tan medium-grained quartzite; 20% yellow, fine-grained quartzite; reaction to acid: very weak to weak	common iron oxide (hematite and limonite) on grain boundaries and fractures, trace manganese oxide staining, trace white calcite vein	angular chips up to 1.0 cm; 70% LCM
TROY QUARTZITE (pCt)				
430 - 440	131.1 - 134.1	Quartzite; yellowish brown [10YR5/4]; well lithified; 95% yellowish-tan, fine-grained quartzite; 5% heavily oxidized, black and red diabase; trace white and red, medium-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 1.2 cm; 70% LCM
440 - 450	134.1 - 137.2	Quartzite; light reddish brown [2.5YR7/3]; well lithified; 80% white and red, medium-grained quartzite; 20% yellowish-tan, fine to medium-grained quartzite; trace heavily oxidized, black and red diabase; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 0.8 cm; 70% LCM
450 - 460	137.2 - 140.2	Quartzite; light reddish brown [2.5YR7/3]; well lithified; 90% white and red, medium-grained quartzite; 10% yellowish-tan, fine to medium-grained quartzite; trace heavily oxidized, black and red diabase; trace light green, medium-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 1.0 cm; 70% LCM
460 - 470	140.2 - 143.3	Quartzite; light reddish brown [2.5YR7/3]; well lithified; 90% white and red, medium-grained quartzite; 10% yellowish-tan, fine to medium-grained quartzite; trace heavily oxidized, black and red diabase; trace light green, medium-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 1.3 cm; 70% LCM

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
470 - 480	143.3 - 146.3	Quartzite; light reddish brown [2.5YR7/3]; well lithified; 90% white and red, medium-grained quartzite; 9% yellowish-tan, fine to medium-grained quartzite; trace heavily oxidized, black and red diabase; 1% light green, medium-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 1.0 cm; 70% LCM
480 - 490	146.3 - 149.4	Quartzite; light reddish brown [2.5YR7/3]; well lithified; 90% white and red, medium-grained quartzite; 9% yellowish-tan, fine to medium-grained quartzite; trace heavily oxidized, black and red diabase; 1% light green, medium-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 1.1 cm; 70% LCM
490 - 500	149.4 - 152.4	Quartzite; light reddish brown [2.5YR7/3]; well lithified; 90% white and red, medium-grained quartzite; 9% yellowish-tan, fine to medium-grained quartzite; trace heavily oxidized, black and red diabase; 1% light green, medium-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 1.0 cm; 80% LCM
500 - 510	152.4 - 155.4	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white and red, medium-grained quartzite; trace heavily oxidized, black and red diabase; trace light green, medium-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 0.9 cm; 70% LCM
510 - 520	155.4 - 158.5	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white and red, medium-grained quartzite; trace heavily oxidized, black and red diabase; trace light green, medium-grained quartzite; trace dark brown siltstone; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 1.1 cm; 70% LCM
520 - 530	158.5 - 161.5	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white and red, medium-grained quartzite; trace heavily oxidized, black and red diabase; trace light green, medium-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures	angular chips up to 1.4 cm; 70% LCM
530 - 540	161.5 - 164.6	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white, pink, and red, medium-grained quartzite; trace heavily oxidized, black and red diabase; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures, very trace manganese oxide staining on fracture surfaces	angular chips up to 1.2 cm; 40% LCM

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
540 - 550	164.6 - 167.6	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white, pink, and red, medium-grained quartzite; trace heavily oxidized, black and red diabase; trace dark brown calcareous siltstone; trace dirty tan quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures, very trace manganese oxide staining on fracture surfaces	angular chips up to 1.3 cm; 50% LCM
550 - 560	167.6 - 170.7	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white, pink, and red, medium-grained quartzite; trace heavily oxidized, black and red diabase; trace dark brown calcareous siltstone; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fractures, very trace manganese oxide staining on fracture surfaces	angular chips up to 1.0 cm; 25% LCM
560 - 570	170.7 - 173.7	Quartzite; light gray [10R7/1]; well lithified; white and orange, medium-grained quartzite; trace dark brown siltstone; reaction to acid: none to very weak	iron oxide (common hematite and some limonite) staining on grain boundaries and fracture surfaces	angular chips up to 0.9 cm; 25% LCM
570 - 580	173.7 - 176.8	Quartzite; light gray [10R7/1]; well lithified; white and orange, medium-grained quartzite; trace dark brown siltstone; reaction to acid: none to very weak	iron oxide (common hematite and some limonite) staining on grain boundaries and fracture surfaces	angular chips up to 0.8 cm; 25% LCM
580 - 590	176.8 - 179.8	Quartzite; light gray [10R7/1]; well lithified; 95% white and orange, medium-grained quartzite; 5% heavily oxidized, black, white, yellow and red diabase with trace magnetite; trace dark brown siltstone; reaction to acid: none to very weak	iron oxide (common hematite and some limonite) staining on grain boundaries and fracture surfaces of quartzite, abundant iron oxide (hematite and limonite) staining on diabase	angular chips up to 1.2 cm; 20% LCM
590 - 600	179.8 - 182.9	Quartzite; dusky red [10R3/3]; well lithified; 60% white, purple, and orange, medium-grained quartzite; 28% purple, fine-grained quartzite with trace muscovite; 10% reddish-orange, fine-grained quartzite; 2% yellow, fine-grained quartzite; reaction to acid: none to very weak	iron oxide (common hematite and some limonite) staining on grain boundaries and fracture surfaces of quartzite, abundant iron oxide (hematite and limonite) staining on diabase	angular chips up to 1.1 cm; 10% LCM
600 - 610	182.9 - 185.9	Quartzite; weak red [10R5/2]; well lithified; white and orange, medium-grained quartzite; trace dark purple, medium-grained quartzite; trace reddish-orange, fine-grained quartzite; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces of quartzite, abundant iron oxide (hematite and limonite) staining on diabase, trace manganese oxide staining on fracture surfaces, trace epidote	angular chips up to 1.6 cm; 40% LCM

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
610 - 620	185.9 - 189.0	Quartzite; dark reddish gray [10YR4/1]; well lithified; white and orange, medium-grained quartzite; trace yellow, fine-grained quartzite; trace heavily oxidized, black and red basalt; reaction to acid: none	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces	angular chips up to 1.7 cm; 50% LCM
620 - 630	189.0 - 192.0	Quartzite and diabase; dark reddish gray [10YR3/1] and black [N2.5]; well lithified; 60% white and orange, medium-grained quartzite; 35% heavily oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; 5% purple, fine-grained quartzite; trace yellowish-orange, fine-grained quartzite; reaction to acid: none	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein, some manganese oxide staining on fracture surfaces	angular chips up to 2.2 cm; 20% LCM
PRECAMBRIAN DIABASE (pCdiab)				
630 - 640	192.0 - 195.1	Diabase; black [N2.5]; well lithified; 95% heavily oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; 5% white and orange, medium-grained quartzite; trace purple, fine-grained quartzite; reaction to acid: none	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein, some manganese oxide staining on fracture surfaces	angular chips up to 2.0 cm; 15% LCM
640 - 650	195.1 - 198.1	Diabase; black [N2.5]; well lithified; 95% heavily oxidized, black, white, red, and yellow diabase (crystals 1-2 mm); 5% white and orange, medium-grained quartzite; trace purple, fine-grained quartzite; reaction to acid: none	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein, some manganese oxide staining on fracture surfaces	angular chips up to 2.3 cm; 10% LCM
650 - 660	198.1 - 201.2	Diabase; black [N2.5]; well lithified; 99% oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; trace white and orange, medium-grained quartzite; trace yellowish-orange, fine-grained quartzite; reaction to acid: none	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, 1% white calcite vein, some manganese oxide staining on fracture surfaces	angular chips up to 2.2 cm; 10% LCM
660 - 670	201.2 - 204.2	Diabase; black [N2.5]; well lithified; 99% oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; trace white and orange, medium-grained quartzite; trace yellowish-orange, fine-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein	angular chips up to 1.9 cm; 5% LCM

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
670 - 680	204.2 - 207.3	Diabase; black [N2.5]; well lithified; 99% oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; trace white and orange, medium-grained quartzite; trace yellowish-orange, fine-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein	angular chips up to 2.0 cm; 5% LCM
680 - 690	207.3 - 210.3	Diabase; black [N2.5]; well lithified; 99% oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; trace white and orange, medium-grained quartzite; trace yellowish-orange, fine-grained quartzite; reaction to acid: none to very weak	1% white calcite vein, common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces	angular chips up to 2.5 cm; <5% LCM
690 - 700	210.3 - 213.4	Diabase; black [N2.5]; well lithified; 99% oxidized, black, white, red, and yellow diabase with 60% pyroxene and 40% plagioclase (1-2 mm) and trace magnetite, trace white and orange, medium-grained quartzite; trace yellowish-orange, fine-grained quartzite; reaction to acid: none to very weak	1% white calcite vein, common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces	angular chips up to 2.7 cm; <5% LCM
700 - 710	213.4 - 216.4	Diabase; black [N2.5]; well lithified; 99% oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; trace white and orange, medium-grained quartzite; trace yellowish-orange, fine-grained quartzite; trace red, fine-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, 2% white calcite vein	angular chips up to 2.2 cm; 1% LCM
710 - 720	216.4 - 219.5	Diabase; black [N2.5]; well lithified; 99% oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; trace white and orange, medium-grained quartzite; trace yellowish-orange, fine-grained quartzite; trace red, fine-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, 2% white calcite vein	angular chips up to 2.7 cm; <1% LCM
720 - 730	219.5 - 222.5	Diabase; black [N2.5]; well lithified; 99% oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; trace white and orange, medium-grained quartzite; trace yellowish-orange, fine-grained quartzite; trace red, fine-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein	angular chips up to 2.3 cm; <1% LCM

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
730 - 740	222.5 - 225.6	Diabase; black [N2.5]; well lithified; 99% oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; trace white and orange, medium-grained quartzite; trace yellowish-orange, fine-grained quartzite; trace red, fine-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein	angular chips up to 2.1 cm; <1% LCM
740 - 750	225.6 - 228.6	Diabase; black [N2.5]; well lithified; oxidized, black, white, red, and yellow diabase (crystals 1-2 mm), trace magnetite; trace light brownish-red siltstone; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein	angular chips up to 1.6 cm
750 - 760	228.6 - 231.6	Diabase; black [N2.5]; well lithified; oxidized, black, white, red, and yellow diabase (crystals <1 mm), trace magnetite; trace light brownish-red siltstone; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein	angular chips up to 1.7 cm
760 - 770	231.6 - 234.7	Diabase; black [N2.5]; well lithified; oxidized, black, white, red, and yellow diabase (crystals <1 mm), trace magnetite; trace light brownish-red siltstone; trace whitish-pink, medium-grained quartzite; reaction to acid: none to very weak	common iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces, trace white calcite vein	angular chips up to 1.2 cm
TROY QUARTZITE (pCt)				
770 - 780	234.7 - 237.7	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white, orange, and red, medium-grained quartzite; trace diabase; reaction to acid: none	some iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces	angular chips up to 1.0 cm
780 - 790	237.7 - 240.8	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white, orange, and red, medium-grained quartzite; trace diabase; reaction to acid: none	some iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces	angular chips up to 1.0 cm
790 - 800	240.8 - 243.8	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white, orange, and red, medium-grained quartzite; trace diabase; reaction to acid: none	some iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces	angular chips up to 0.9 cm
800 - 810	243.8 - 246.9	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white and red, medium-grained quartzite; trace diabase; reaction to acid: none	some iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces	AIR-ASSISTED FLOODED REVERSE CIRCULATION; angular chips up to 1.2 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
810 - 820	246.9 - 249.9	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white and red, medium-grained quartzite; trace diabase; trace yellow, fine-grained quartzite; reaction to acid: none	some iron oxide (hematite and limonite) staining on grain boundaries and fracture surfaces	angular chips up to 2.0 cm
820 - 830	249.9 - 253.0	Quartzite; light reddish brown [2.5YR7/3]; well lithified; white and dark red, medium-grained quartzite; trace medium-grained yellow quartzite; trace diabase; reaction to acid: none	iron oxide (abundant hematite and trace limonite) staining on grain boundaries and fracture surfaces	angular chips up to 3.1 cm
830 - 840	253.0 - 256.0	Quartzite; dusky red [10R3/3]; well lithified; 70% dark red, medium-grained quartzite; 30% white, orange, and yellow, medium-grained quartzite; reaction to acid: none	iron oxide (abundant hematite and trace limonite) staining on grain boundaries and fracture surfaces	angular chips up to 2.0 cm
840 - 850	256.0 - 259.1	Quartzite; dusky red [10R3/3]; well lithified; 60% white, orange, and yellow, medium-grained quartzite; 30% pinkish-red, medium-grained quartzite; 10% pinkish-orange, fine-grained quartzite; very trace diabase; reaction to acid: none	iron oxide (abundant hematite and trace limonite) staining on grain boundaries and fracture surfaces	angular chips up to 1.6 cm
850 - 860	259.1 - 262.1	Quartzite; dusky red [10R3/3]; well lithified; 98% pinkish-red, medium-grained quartzite; 2% white, orange, and yellow, medium-grained quartzite; very trace fine-grained, light green quartzite; very trace diabase; reaction to acid: none	iron oxide (abundant hematite and trace limonite) staining on grain boundaries and fracture surfaces, very trace manganese oxide	angular chips up to 3.2 cm
860 - 870	262.1 - 265.2	Quartzite; dusky red [10R3/3]; well lithified; 99% medium-grained reddish-pink quartzite; 1% medium-grained white quartzite; trace orange, fine-grained-pink quartzite; reaction to acid: none	iron oxide (abundant hematite and trace limonite) staining on grain boundaries and fracture surfaces, some manganese oxide, very trace white quartz vein	angular chips up to 1.9 cm
870 - 880	265.2 - 268.2	Quartzite; dark reddish gray [10R4/1]; well lithified; poorly sorted, grayish-purple, medium to coarse-grained quartzite; very trace diabase; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces	angular chips up to 2.4 cm
880 - 890	268.2 - 271.3	Quartzite; dark reddish gray [10R4/1]; well lithified; poorly sorted, grayish-purple, medium to coarse-grained quartzite; very trace red, medium-grained quartzite; very trace diabase; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces	angular chips up to 2.6 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
890 - 900	271.3 - 274.3	Quartzite; dark reddish gray [10R4/1]; well lithified; grayish-purple, fine to medium-grained, arkosic quartzite; 50% grayish-purple, poorly sorted, medium to coarse-grained quartzite; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces	angular chips up to 2.6 cm
900 - 910	274.3 - 277.4	Quartzite; dark reddish gray [10R4/1]; well lithified; 90% poorly sorted, grayish-purple, medium to coarse-grained quartzite; 10% yellowish-pink, medium-grained quartzite; very trace diabase; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces	angular chips up to 1.9 cm
910 - 920	277.4 - 280.4	Quartzite; dark reddish gray [10R4/1]; well lithified; 95% poorly sorted, grayish-purple, medium to coarse-grained quartzite; 5% whitish-pink, medium-grained quartzite; very trace diabase; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, trace tan clay balls, trace white quartz vein	angular chips up to 2.1 cm
920 - 930	280.4 - 283.5	Quartzite; dark reddish gray [10R4/1]; well lithified; dark grayish-purple and red, poorly sorted, medium to coarse-grained quartzite; trace tan medium-grained quartzite; very trace diabase; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, trace tan clay balls, trace white quartz vein	angular chips up to 1.7 cm
930 - 940	283.5 - 286.5	Quartzite; dark reddish gray [10R4/1] and black [N2.5]; well lithified; grayish-purple, poorly sorted, medium to coarse-grained quartzite; trace yellow, fine-grained quartzite; trace orange chert; trace purple, fine-grained quartzite; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, common manganese oxide, trace white quartz vein	angular chips up to 1.5 cm
940 - 950	286.5 - 289.6	Quartzite; dark reddish gray [10R4/1] and black [N2.5]; well lithified; 99% grayish-purple, poorly sorted, medium to coarse-grained quartzite; trace yellow, fine-grained quartzite; trace orange chert; trace reddish-tan siltstone; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, common manganese oxide, 1% white quartz vein	angular chips up to 2.1 cm
950 - 960	289.6 - 292.6	Quartzite; dusky red [10R3/2] and black [N2.5]; well lithified; 98% brown and purple, medium to coarse-grained quartzite; trace yellow, fine-grained quartzite; trace orange chert; trace reddish-tan siltstone; very trace diabase; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, common manganese oxide, 2% white quartz vein	angular chips up to 1.7 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
TROY QUARTZITE (pCt)				
960 - 970	292.6 - 295.7	Quartzite; dusky red [10R3/2] and black [N2.5]; well lithified; 93% blackish-purple, medium-grained quartzite; trace yellow, fine-grained quartzite; trace orange chert; trace reddish-tan siltstone; 5% white and red quartzite; very trace diabase; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, common manganese oxide, 2% white quartz vein	angular chips up to 1.6 cm
970 - 980	295.7 - 298.7	Quartzite; dusky red [10R3/3] and black [N2.5]; well lithified; 95% blackish-purple, medium-grained quartzite; trace yellow, fine-grained quartzite; trace orange chert; trace reddish-tan siltstone; 5% white and red quartzite; trace light green, fine-grained quartzite; trace dark red clay balls; trace diabase; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, common manganese oxide, trace white quartz vein	angular chips up to 1.6 cm
980 - 990	298.7 - 301.8	Quartzite; dusky red [10R3/3]; well lithified; 94% brown, white, and purple, medium-grained quartzite with trace anhedral orange-pink feldspar; trace yellow, fine-grained quartzite; trace orange chert; 5% white and red quartzite; trace light green, fine-grained quartzite; 5% fines of reddish-pink silty clay; very trace tan siltsotne; very trace diabase; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, common manganese oxide, 1% white quartz vein	angular chips up to 1.3 cm
990 - 1,000	301.8 - 304.8	Quartzite; dusky red [10R3/3]; well lithified; 94% brown, white, and purple, medium-grained quartzite with trace anhedral orange-pink feldspar; trace yellow, fine-grained quartzite; trace orange chert; 5% white and red quartzite; trace light green, fine-grained quartzite; trace diabase; 5% fines of reddish-pink silty clay; very trace light green, fine-grained quartzite; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, common manganese oxide, 1% white quartz vein	angular chips up to 1.6 cm
1,000 - 1,010	304.8 - 307.8	Quartzite; dusky red [10R3/3]; well lithified; 94% brown, white, and purple, medium-grained quartzite with trace anhedral orange-pink feldspar; trace yellow, fine-grained quartzite; trace orange chert; 5% white and red quartzite; trace light green, fine-grained quartzite; 5% fines of reddish-pink silty clay; reaction to acid: none	iron oxide (common hematite and trace limonite) staining on grain boundaries and fracture surfaces, common manganese oxide, 1% white quartz vein	angular chips up to 1.3 cm

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TROY QUARTZITE (pCt)				
1,010 - 1,020	307.8 - 310.9	Quartzite; dusky red [10R3/3]; well lithified; 75% brown, white, and purple, medium-grained quartzite with trace anhedral orange-pink feldspar; trace yellow, fine-grained quartzite; trace orange chert; 5% white and red quartzite; trace light green, fine-grained quartzite; 10% whitish-pink, medium-grained quartzite; trace fines of reddish-pink silty clay; reaction to acid: none	common iron oxide (hematite) coating chips, trace iron oxide (limonite) staining on grain boundaries, common manganese oxide, ~1% white quartz vein	angular chips up to 1.0 cm
1,020 - 1,030	310.9 - 313.9	Quartzite; dusky red [10R3/3]; well lithified; 75% brown, white, and purple, medium-grained quartzite with trace anhedral orange-pink feldspar; trace yellow, fine-grained quartzite; trace orange chert; 5% white and red quartzite; trace light green, fine-grained quartzite; 10% whitish-pink, medium-grained quartzite; trace fines of reddish-pink silty clay; reaction to acid: none	common iron oxide (hematite) coating chips, trace iron oxide (limonite) staining on grain boundaries, common manganese oxide, ~1% white quartz vein	angular chips up to 1.1 cm
1,030 - 1,040	313.9 - 317.0	Quartzite; dark reddish gray [10R3/1]; well lithified; purplish-gray, fine to medium-grained quartzite; reaction to acid: none	some iron oxide (hematite) on grain boundaries	angular chips up to 2.2 cm; 15% LCM
1,040 - 1,050	317.0 - 320.0	Quartzite; dark reddish gray [10R3/1]; well lithified; purplish-gray, fine to medium-grained quartzite; reaction to acid: none	some iron oxide (hematite) on grain boundaries	angular chips up to 2.1 cm; 25% LCM
1,050 - 1,060	320.0 - 323.1	Quartzite; dark reddish gray [10R3/1]; well lithified; 80% purplish-gray, fine to medium-grained quartzite; 15% dark brownish-black basalt; 5% reddish-orange jasper; reaction to acid: none	some iron oxide (hematite) on grain boundaries	angular chips up to 1.8 cm; 25% LCM
1,060 - 1,070	323.1 - 326.1	Quartzite; dark reddish gray [10R3/1]; well lithified; 80% purplish-gray, fine to medium-grained quartzite; 15% dark brownish-black basalt; 5% reddish-orange jasper; reaction to acid: none	some iron oxide (hematite) on grain boundaries	angular chips up to 1.7 cm; 25% LCM
PRECAMBRIAN BASALT (pCbas)				
1,070 - 1,080	326.1 - 329.2	basalt; very dusky red [10R2.5/2]; well lithified; dark brownish-purple basalt; very trace diabase; reaction to acid: none	some iron oxide (hematite)	angular chips up to 1.0 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN BASALT (pCbas)				
1,080 - 1,090	329.2 - 332.2	basalt; very dusky red [10R2.5/2]; well lithified; dark brownish-purple basalt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 1.2 cm
1,090 - 1,100	332.2 - 335.3	basalt; very dusky red [10R2.5/2]; well lithified; dark brownish-purple basalt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 1.2 cm
1,100 - 1,110	335.3 - 338.3	basalt; very dusky red [10R2.5/2]; well lithified; dark purplish-black basalt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 1.8 cm
1,110 - 1,120	338.3 - 341.4	basalt; very dusky red [10R2.5/2]; well lithified; dark purplish-black basalt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 1.6 cm
1,120 - 1,130	341.4 - 344.4	basalt; very dusky red [10R2.5/2]; well lithified; 95% dark purplish-black basalt, 5% orange clay balls; trace red basalt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 1.6 cm
1,130 - 1,140	344.4 - 347.5	basalt; very dusky red [10R2.5/2]; well lithified; dark purplish-black basalt, trace orange clay balls; trace red basalt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 1.7 cm
1,140 - 1,150	347.5 - 350.5	basalt; very dusky red [10R2.5/2]; well lithified; black, purple, and red basalt; reaction to acid: none	very trace epidote, some iron oxide (hematite)	angular chips up to 1.4 cm
1,150 - 1,160	350.5 - 353.6	basalt; very dusky red [10R2.5/2]; well lithified; black, purple, and red basalt; reaction to acid: none	trace epidote, some iron oxide (hematite)	angular chips up to 2.1 cm
1,160 - 1,170	353.6 - 356.6	basalt; very dusky red [10R2.5/2]; well lithified; black, purple, and red basalt; very trace whitish-tan, medium-grained quartzite; reaction to acid: none	very trace epidote, some iron oxide (hematite)	angular chips up to 1.6 cm
1,170 - 1,180	356.6 - 359.7	basalt; very dusky red [10R2.5/2]; well lithified; black, purple, and red basalt; very trace dark brown, medium-grained quartzite; reaction to acid: none	some iron oxide (hematite)	angular chips up to 2.1 cm
1,180 - 1,185	359.7 - 361.2	basalt; very dusky red [10R2.5/2]; well lithified; blackish-purple basalt; reaction to acid: none	very trace epidote, some iron oxide (hematite)	angular chips up to 1.7 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN BASALT (pCbas)				
1,190 - 1,200	362.7 - 365.8	basalt; very dusky red [10R2.5/2]; well lithified; blackish-purple basalt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 1.7 cm
1,200 - 1,210	365.8 - 368.8	basalt; very dusky red [10R2.5/2]; well lithified; 80% blackish-purple basalt; 5% bright orange-red, fine-grained quartzite; 15% orange silt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 2.8 cm
1,210 - 1,220	368.8 - 371.9	basalt; very dusky red [10R2.5/2]; well lithified; 90% blackish-purple basalt; trace bright orange-red, fine-grained quartzite; 10% brownish-orange silt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 2.4 cm
1,220 - 1,230	371.9 - 374.9	basalt; very dusky red [10R2.5/2]; well lithified; 90% black, purple, and red basalt; 10% brown silt; reaction to acid: none	some iron oxide (hematite), trace calcite vein	angular chips up to 1.7 cm
1,230 - 1,240	374.9 - 378.0	basalt; very dusky red [10R2.5/2]; well lithified; 90% black, purple, and red basalt; 10% brown silt; reaction to acid: none	some iron oxide (hematite), trace calcite vein	angular chips up to 2.4 cm
1,240 - 1,250	378.0 - 381.0	basalt; very dusky red [10R2.5/2]; well lithified; 90% black, purple, and red basalt (3 mm quartz filled vugs on some chips); 10% brown silt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 4.1 cm
1,250 - 1,260	381.0 - 384.0	basalt; very dusky red [10R2.5/2]; well lithified; 90% black, purple, and red basalt; 10% brown silt; reaction to acid: none	some iron oxide (hematite)	angular chips up to 1.2 cm
1,260 - 1,270	384.0 - 387.1	basalt; very dusky red [10R2.5/2]; well lithified; 90% black, purple, and red basalt; 5% dark red silty quartzite; 5% brownish-orange silt; reaction to acid: none	common iron oxide (hematite)	angular chips up to 1.4 cm
MESCAL LIMESTONE (pCmls)				
1,270 - 1,280	387.1 - 390.1	Limestone; red [10R4/6] and light gray [5Y7/2]; well lithified; cut chips are 68% reddish-pink limestone; 13% yellowish-tan limestone; 9% gray limestone; trace dark brownish-purple silty quartzite; 10% orange-brown silt; reaction to acid: moderate to very strong	some iron oxide (hematite) on limestone, trace white quartz vein	angular chips up to 1.2 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
MESCAL LIMESTONE (pCmls)				
1,280 - 1,290	390.1 - 393.2	Limestone; red [10R4/6] and light gray [5Y7/2]; well lithified; 81% reddish-pink limestone; 5% yellowish-tan limestone; 4% gray limestone; trace dark brownish-purple silty quartzite; 10% orange-brown silt; reaction to acid: moderate to very strong	some iron oxide (hematite) on limestone, trace white quartz vein	angular chips up to 1.4 cm
1,290 - 1,300	393.2 - 396.2	Limestone; red [10R4/6] and light gray [5Y7/2]; well lithified; 81% reddish-pink limestone; 5% yellowish-tan limestone; 4% gray limestone; trace dark brownish-purple silty quartzite; 10% orange-brown silt; reaction to acid: moderate to very strong	some iron oxide (hematite) on limestone	angular chips up to 1.6 cm
1,300 - 1,310	396.2 - 399.3	Limestone; red [10R4/6] and light gray [5Y7/2]; well lithified; 89% reddish-pink and tan limestone; 10% orange-brown silt; reaction to acid: moderate to strong	1% white calcite vein, some iron oxide (hematite) on limestone	angular chips up to 2.1 cm
1,310 - 1,320	399.3 - 402.3	Limestone; weak red [10R5/3]; well lithified; pink, red, and brown limestone; trace gray limestone; trace greenish-black diabase; reaction to acid: moderate to strong	very trace calcite vein	angular chips up to 1.1 cm; trace brown silt
1,320 - 1,330	402.3 - 405.4	Limestone; weak red [10R5/3]; well lithified; pink, red, and brown limestone; trace gray limestone; trace greenish-black diabase; reaction to acid: moderate to strong		angular chips up to 1.4 cm; trace brown silt
1,330 - 1,340	405.4 - 408.4	Limestone; weak red [10R5/3]; well lithified; 90% pink, brown, and red limestone; trace gray limestone; 10% black basalt; reaction to acid: moderate to strong		angular chips up to 2.0 cm; trace brown silt
1,340 - 1,350	408.4 - 411.5	Limestone; weak red [10R5/3]; well lithified; 98% pink, tan, and red limestone; 2% black basalt with very trace magnetite; reaction to acid: moderate to strong	trace iron oxide (hematite)	angular chips up to 2.4 cm; 2% brown silt
1,350 - 1,360	411.5 - 414.5	Limestone; weak red [10R5/3] and black [N2.5]; well lithified; 50% pink and tan limestone; 25% black basalt with very trace magnetite; 25% orange-brown limestone; reaction to acid: moderate	trace iron oxide (hematite), trace calcite vein	angular chips up to 1.5 cm; 2% brown silt

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MESCAL LIMESTONE (pCmls)				
1,360 - 1,370	414.5 - 417.6	Limestone; strong brown [7.5YR5/6] and black [N2.5]; well lithified; 90% orange-brown silty limestone; 2% pinkish-tan limestone; 8% black limestone; reaction to acid: moderate to strong	trace iron oxide (hematite), trace calcite vein	angular chips up to 1.6 cm; 2% brown silt
1,370 - 1,380	417.6 - 420.6	Limestone; weak red [10R5/3] and black [N2.5]; well lithified; 90% pinkish-tan limestone; 7% black basalt; 3% orange-brown silty limestone; reaction to acid: moderate to strong	trace iron oxide (hematite), trace calcite vein	angular chips up to 2.0 cm; 2% brown silt
1,380 - 1,390	420.6 - 423.7	Limestone; weak red [10R5/3] and black [N2.5]; well lithified; 70% pinkish-tan limestone; 20% orange-brown limestone; 5% gray limestone; 4% black basalt; reaction to acid: moderate to strong	some iron oxide (hematite) on fracture surfaces and hematite veins, trace calcite vein, 1% orange clay balls	angular chips up to 2.6 cm; 5% brown silt
1,390 - 1,400	423.7 - 426.7	Limestone and diabase; strong brown [7.5YR5/6] and very dark gray [N3]; well lithified; 50% dark green chalky limestone; 30% dark green diabase; 19% orange-brown silty limestone; reaction to acid: weak to moderate	some iron oxide (hematite) on fracture surfaces and hematite veins, trace calcite vein, 1% white fault gouge	angular chips up to 1.6 cm; 5% brown-green silt
UPPER DRIPPING SPRING QUARTZITE (pCdsu)				
1,400 - 1,410	426.7 - 429.8	Quartzite and diabase; very dark gray [N3]; well lithified; 70% brownish-tan, fine-grained quartzite; 30% dark green diabase; reaction to acid: weak	trace calcite vein	angular chips up to 2.7 cm; 5% brown silt
1,410 - 1,420	429.8 - 432.8	Quartzite; very dark gray [N3]; well lithified; 99% brownish-tan medium to fine-grained quartzite; 1% dark green diabase; reaction to acid: weak		angular chips up to 1.4 cm; 1% brown silt
PRECAMBRIAN DIABASE (pCdiab)				
1,420 - 1,430	432.8 - 435.9	Diabase; very dark gray [N3]; well lithified; very dark green diabase; trace brownish-tan medium to fine-grained quartzite; very trace orange-brown silty limestone; reaction to acid: none to weak	trace calcite vein	angular chips up to 1.5 cm; trace brown silt
1,430 - 1,440	435.9 - 438.9	Diabase; very dark gray [N3]; well lithified; very dark green diabase; trace brownish-tan medium to fine-grained quartzite; reaction to acid: none to weak	trace calcite vein	angular chips up to 1.0 cm; 1% brown silt

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PRECAMBRIAN DIABASE (pCdiab)				
1,440 - 1,450	438.9 - 442.0	Diabase; very dark gray [N3]; well lithified; very dark green diabase; trace brownish-tan medium to fine-grained quartzite; reaction to acid: none to weak	trace calcite vein	angular chips up to 1.3 cm; 1% brown silt
1,450 - 1,460	442.0 - 445.0	Diabase; very dark gray [N3]; well lithified; very dark green diabase (crystals <1 mm); reaction to acid: none to weak	trace calcite vein, some iron oxide (hematite)	angular chips up to 1.3 cm; 1% brown silt
1,460 - 1,470	445.0 - 448.1	Diabase; very dark gray [N3]; well lithified; very dark green diabase (crystals <1 mm) with trace magnetite; reaction to acid: none to weak	some iron oxide (hematite and limonite) on fracture surfaces, trace calcite vein	angular chips up to 1.0 cm; 2% brown silt
1,470 - 1,480	448.1 - 451.1	Diabase; very dark gray [N3]; well lithified; very dark green diabase (crystals <1 mm) with trace magnetite; reaction to acid: none to weak	some iron oxide (hematite and limonite) on fracture surfaces	angular chips up to 1.7 cm; trace brown silt
1,480 - 1,490	451.1 - 454.2	Diabase; very dark gray [N3]; well lithified; 99% very dark green diabase (crystals <1 mm) with trace magnetite; reaction to acid: none to weak	1% calcite vein, trace iron oxide (hematite and limonite) on fracture surfaces	angular chips up to 1.0 cm; trace brown silt
1,490 - 1,500	454.2 - 457.2	Diabase; very dark gray [N3]; well lithified; very dark green diabase (crystals <1 mm) with trace magnetite; reaction to acid: none to weak	trace iron oxide (hematite and limonite) on fracture surfaces	angular chips up to 0.8 cm; trace brown silt
1,500 - 1,510	457.2 - 460.2	Diabase; very dark gray [N3]; well lithified; 98% very dark green diabase (crystals <1 mm) with trace magnetite; reaction to acid: none to weak	2% calcite vein, trace iron oxide (hematite and limonite) on fracture surfaces	AIR-ASSISTED FLOODED REVERSE CIRCULATION; angular chips up to 1.1 cm; trace brown silt
1,510 - 1,520	460.2 - 463.3	Diabase; black [N2.5]; well lithified; 99% very dark greenish-black diabase with <1 mm plagioclase laths with trace magnetite; reaction to acid: none to moderate	1% white calcite chips, very trace iron oxide (limonite)	angular chips up to 1.3 cm
UPPER DRIPPING SPRING QUARTZITE (pCdsu)				
1,520 - 1,530	463.3 - 466.3	Quartzite; very dark gray [7.5YR3/1]; well lithified; 80% grayish-brown and brown, fine-grained, well sorted quartzite; 20% very dark greenish-black diabase with plagioclase laths <1 mm with very trace magnetite; reaction to acid: none to weak	common iron oxide staining (hematite and limonite), trace calcite veinlet and chips	angular chips up to 0.9 cm

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UPPER DRIPPING SPRING QUARTZITE (pCdsu)				
1,530 - 1,540	466.3 - 469.4	Quartzite; dark reddish brown [5YR3/3]; well lithified; grayish-brown and brown, fine-grained, well sorted, arkosic quartzite; very trace dark greenish-black diabase; reaction to acid: none to weak	common iron oxide staining (hematite and limonite)	angular chips up to 1.5 cm
1,540 - 1,550	469.4 - 472.4	Quartzite; dark reddish brown [5YR3/2]; well lithified; brown, fine-grained, well sorted, arkosic quartzite; grayish-brown very fine-grained quartzite; reaction to acid: none to moderate	common iron oxide staining (hematite and limonite)	angular chips up to 2.0 cm
1,550 - 1,560	472.4 - 475.5	Quartzite; dark gray [7.5YR4/1]; well lithified; 75% brownish-gray and brown, fine-grained, arkosic quartzite and quartzite; 25% light gray, very fine-grained quartzite; reaction to acid: none to very weak	common iron oxide staining (hematite and limonite)	angular chips up to 1.1 cm
1,560 - 1,570	475.5 - 478.5	Quartzite; dark grayish brown [10YR4/2]; well lithified; 90% brownish-gray and brown, fine-grained, arkosic quartzite and quartzite; 10% light gray, very fine-grained quartzite; very trace greenish-black diabase; reaction to acid: none to very weak	common iron oxide staining (hematite and limonite), very trace calcite veinlet, some black hematite	angular chips up to 1.3 cm
1,570 - 1,580	478.5 - 481.6	Quartzite; brown [7.5YR5/2]; well lithified; brownish-gray and brown, fine-grained, arkosic quartzite and quartzite; very trace light gray, very fine-grained quartzite; reaction to acid: very weak	common iron oxide staining (hematite and limonite), trace green chlorite, some black hematite	angular chips up to 1.1 cm
1,580 - 1,590	481.6 - 484.6	Quartzite; brown [7.5YR4/3]; well lithified; brownish-gray and brown, fine-grained, well sorted, arkosic quartzite and some quartzite; reaction to acid: none to very weak	common iron oxide staining (hematite and limonite), trace metallic black hematite, trace dark green mineral (chlorite?)	angular chips up to 0.7 cm
1,590 - 1,600	484.6 - 487.7	Quartzite; brown [7.5YR4/2]; well lithified; brownish-gray and brown, fine-grained, well sorted, arkosic quartzite and some quartzite; reaction to acid: weak to moderate	common iron oxide staining (hematite and limonite), trace metallic black hematite, trace dark green mineral (chlorite?)	angular chips up to 1.1 cm
1,600 - 1,610	487.7 - 490.7	Quartzite; dark grayish brown [10YR4/2]; well lithified; brownish-gray and brown, fine-grained, well sorted, arkosic quartzite and some quartzite; very trace light gray, very fine-grained quartzite; reaction to acid: none to very weak	common iron oxide staining (hematite and limonite), trace metallic black hematite	angular chips up to 1.3 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-13
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
UPPER DRIPPING SPRING QUARTZITE (pCdsu)				
1,610 - 1,620	490.7 - 493.8	Quartzite; dark yellowish brown [10YR4/4]; well lithified; 98% brownish-gray and orange-brown, fine-grained, arkosic quartzite and some quartzite; 2% light gray, very fine-grained quartzite; reaction to acid: none to very weak	common iron oxide staining (hematite and limonite), trace metallic black hematite	angular chips up to 1.0 cm
1,620 - 1,630	493.8 - 496.8	Quartzite; dark yellowish brown [10YR4/4]; well lithified; 99% brownish-gray and orange-brown, fine-grained, arkosic quartzite and some quartzite; 1% light gray, very fine-grained quartzite; reaction to acid: none to very weak	common iron oxide staining (hematite and limonite), trace metallic black hematite	angular chips up to 1.5 cm
1,630 - 1,640	496.8 - 499.9	Quartzite; brown [7.5YR4/2]; well lithified; 99% brownish-gray and orange-brown, fine-grained, arkosic quartzite and some quartzite; 1% light gray, very fine-grained quartzite; reaction to acid: none to very weak	some iron oxide staining (hematite and limonite), very trace metallic black hematite	angular chips up to 0.7 cm
1,640 - 1,650	499.9 - 502.9	Quartzite; dark gray [7.5YR4/1]; well lithified; grayish-brown and brown, fine-grained, arkosic quartzite and quartzite; reaction to acid: weak to moderate	some iron oxide staining (hematite and limonite), trace metallic black hematite	angular chips up to 1.2 cm
1,650 - 1,660	502.9 - 506.0	Quartzite; dark brown [7.5YR3/3]; well lithified; grayish-brown and orange-brown, fine-grained, arkosic quartzite and quartzite; trace light gray quartzite; reaction to acid: none to very weak	very trace calcite chips, common iron oxide staining (hematite and limonite), trace metallic black hematite, some iron oxide hematite speckling on light gray quartzite	angular chips up to 1.3 cm
1,660 - 1,670	506.0 - 509.0	Quartzite; dark gray [7.5YR4/1]; well lithified; 96% brown and orange-brown, fine-grained, arkosic quartzite and some quartzite; 4% light gray, very fine-grained quartzite; reaction to acid: none to very weak	abundant iron oxide (hematite) on fracture surfaces, staining, and speckling, common iron oxide staining (limonite), some metallic black hematite	angular chips up to 1.1 cm
1,670 - 1,680	509.0 - 512.1	Quartzite; dark reddish brown [5YR3/3]; well lithified; brown and orange-brown, fine-grained, arkosic quartzite and quartzite; trace black basalt; very trace diabase, trace black siltstone; reaction to acid: none	common iron oxide staining (hematite and limonite), trace metallic black hematite	angular chips up to 1.3 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
UPPER DRIPPING SPRING QUARTZITE (pCdsu)				
1,680 - 1,690	512.1 - 515.1	Quartzite; dark reddish brown [5YR3/3]; well lithified; brown and orange-brown, fine-grained, arkosic quartzite; trace light gray, very fine-grained quartzite; reaction to acid: none	common iron oxide staining (hematite and limonite), trace metallic black hematite	angular chips up to 1.8 cm
1,690 - 1,700	515.1 - 518.2	Quartzite; strong brown [7.5YR4/6]; well lithified; 70% light gray, very fine-grained to fine-grained quartzite; 30% brown and orange-brown quartzite; reaction to acid: none	some iron oxide staining (hematite and limonite), trace metallic black hematite	angular chips up to 1.8 cm
1,700 - 1,710	518.2 - 521.2	Quartzite; dusky red [2.5YR3/2]; well lithified; 70% orange-brown and brown, fine-grained quartzite; 30% greenish-black diabase with plagioclase laths <1 mm; very trace light gray, very fine-grained quartzite; reaction to acid: none	trace calcite chips and veinlet, one chip is 1.6 cm, most <0.5 cm, abundant iron oxide staining (hematite and limonite) on quartzite	angular chips up to 1.8 cm
PRECAMBRIAN DIABASE (pCdiab)				
1,710 - 1,720	521.2 - 524.3	Diabase; black [N2.5]; well lithified; 98% greenish-black diabase with plagioclase laths up to 2 mm, mostly <1 mm, trace magnetite; 2% brown and orange-brown, fine-grained quartzite; reaction to acid: none	very trace calcite, some iron oxide staining (hematite and limonite) on quartzite chips, very trace pyrite on diabase	angular chips up to 0.9 cm
1,720 - 1,730	524.3 - 527.3	Diabase; very dark gray [N3]; well lithified; greenish-black diabase with plagioclase laths up to 2 mm, mostly 1 mm, trace magnetite; very trace brown, fine-grained quartzite; reaction to acid: none	very trace calcite, some iron oxide staining (hematite and limonite) on quartzite chips, very trace pyrite	angular chips up to 1.5 cm
1,730 - 1,740	527.3 - 530.4	Diabase; very dark gray [N3]; well lithified; 97% black diabase with plagioclase laths up to 2 mm, trace magnetite; 3% brown, fine-grained, arkosic quartzite; reaction to acid: none to very weak	trace calcite, very trace pyrite, iron oxide staining on quartzite	angular chips up to 1.4 cm
1,740 - 1,750	530.4 - 533.4	Diabase; black [N2.5]; well lithified; 99% black diabase with plagioclase laths up to 2 mm, mostly <1 mm, trace magnetite; 1% brown and orange-brown, fine-grained, arkosic quartzite; reaction to acid: weak	trace calcite, very trace pyrite, iron oxide staining on quartzite	angular chips up to 1.5 cm
1,750 - 1,760	533.4 - 536.4	Diabase; black [N2.5]; well lithified; black diabase with plagioclase laths up to 1 mm, trace magnetite; trace brown and orange-brown, fine-grained, arkosic quartzite; reaction to acid: very weak	trace calcite, very trace pyrite, iron oxide staining on quartzite	angular chips up to 1.8 cm

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PRECAMBRIAN DIABASE (pCdiab)				
1,760 - 1,770	536.4 - 539.5	Diabase and quartzite; dark gray [N4/]; well lithified; 77% black diabase with <1 mm plagioclase laths, trace magnetite; 23% brown, fine-grained, arkosic quartzite; reaction to acid: very weak to weak	trace calcite and calcite veinlet, very trace pyrite on diabase and quartzite, iron oxide staining on quartzite	angular chips up to 1.2 cm; unwashed samples has a lot of sand and fines
UPPER DRIPPING SPRING QUARTZITE (pCdsu)				
1,770 - 1,780	539.5 - 542.5	Arkosic quartzite; greenish black [10Y2.5/1]; well lithified; 90% brownish-gray, fine-grained, arkosic quartzite; 10% black shale; reaction to acid: none to very weak	very trace pyrite on quartzite and shale, trace iron oxide staining on quartzite and basalt	angular chips up to 1.7 cm
1,780 - 1,790	542.5 - 545.6	Arkosic quartzite / Diabase; very dark gray [N3] and pinkish gray [5YR7/2]; well lithified; 60% pinkish-white, fine-grained, arkosic quartzite; 40% black diabase with plagioclase laths <1 mm, very trace magnetite; trace black shale; reaction to acid: none to weak	some iron oxide staining (hematite and limonite) on most quartzite	angular chips up to 1.2 cm
1,790 - 1,800	545.6 - 548.6	Arkosic quartzite; pinkish gray [5YR7/2] and very dark gray [N3]; well lithified; 95% grayish-white and brown, fine-grained, well sorted, arkosic quartzite; 5% black diabase with <1 mm plagioclase laths; reaction to acid: none	very trace calcite, some iron oxide staining (hematite and limonite)	angular chips up to 2.7 cm
1,800 - 1,810	548.6 - 551.7	Arkosic quartzite; dark reddish brown [5YR3/3]; well lithified; 95% grayish-white and brown, fine-grained, well sorted, arkosic quartzite; 5% black diabase with <1 mm plagioclase laths; reaction to acid: none	very trace calcite, trace iron oxide staining, very trace metallic mineral - manganese oxide?	angular chips up to 1.2 cm
1,810 - 1,820	551.7 - 554.7	Arkosic quartzite; dark reddish gray [5YR4/2]; well lithified; 87% pinkish-white, fine-grained, well sorted, arkosic quartzite and quartzite; 13% black diabase with <1 mm plagioclase laths , trace black shale; reaction to acid: none to very weak	very trace calcite, trace iron oxide staining, very trace metallic mineral - manganese oxide?	angular chips up to 1.0 cm
PRECAMBRIAN DIABASE (pCdiab)				
1,820 - 1,830	554.7 - 557.8	Diabase; very dark gray [N3]; well lithified; 99% black diabase with <1 mm plagioclase laths, trace magnetite; 1% brown and orange-brown quartzite; reaction to acid: very weak	trace calcite and very trace calcite veinlet	angular chips up to 1.3 cm

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PRECAMBRIAN DIABASE (pCdiab)				
1,830 - 1,840	557.8 - 560.8	Diabase; very dark gray [N3]; well lithified; black diabase with plagioclase laths up to 1 mm, trace magnetite; trace grayish-brown and brown, fine-grained quartzite; reaction to acid: none to very weak	very trace calcite	angular chips up to 1.1 cm
1,840 - 1,850	560.8 - 563.9	Diabase; black [N2.5]; well lithified; greenish-black diabase with plagioclase laths up to 1 mm, trace magnetite; very trace pinkish-white quartzite; reaction to acid: none to very weak	very trace calcite, trace serpentine, some plagioclase needles have green alteration on boundaries	angular chips up to 1.4 cm
1,850 - 1,860	563.9 - 566.9	Diabase; black [N2.5]; well lithified; 70% black diabase with plagioclase laths up to 1 mm, mostly <1 mm, trace magnetite; 30% pinkish-white, fine to medium-grained, arkosic quartzite; reaction to acid: weak	trace calcite, very trace serpentine, some plagioclase needles have green alteration on boundaries	angular chips up to 1.4 cm
UPPER DRIPPING SPRING QUARTZITE (pCdsu)				
1,860 - 1,870	566.9 - 570.0	Quartzite; very dark gray [N3] and pinkish gray [5YR7/2]; well lithified; 95% pinkish-white, fine to medium-grained, arkosic quartzite; 5% black diabase with <1 mm plagioclase laths, trace magnetite; very trace basalt; reaction to acid: none to very weak	very trace calcite, very trace serpentine	angular chips up to 1.8 cm
PRECAMBRIAN DIABASE (pCdiab)				
1,870 - 1,880	570.0 - 573.0	Diabase and quartzite; very dark gray [N3] and pinkish gray [5YR7/2]; well lithified; 60% black diabase with <1 mm plagioclase laths, very trace magnetite; 40% pinkish-white, fine to medium-grained, arkosic quartzite; reaction to acid: none to very weak	very trace calcite	angular chips up to 1.4 cm
1,880 - 1,890	573.0 - 576.1	Diabase; very dark gray [N3] and pinkish gray [5YR7/2]; well lithified; black diabase with <1 mm plagioclase laths, trace magnetite; very trace brown quartzite; reaction to acid: none to very weak	trace calcite	angular chips up to 1.3 cm
1,890 - 1,900	576.1 - 579.1	Diabase; black [N2.5]; well lithified; black diabase with <1 mm plagioclase laths, trace magnetite; very trace brown quartzite; reaction to acid: weak	very trace calcite, very trace serpentine, very trace green alteration on plagioclase needles	angular chips up to 1.6 cm
1,900 - 1,910	579.1 - 582.2	Diabase; black [N2.5]; well lithified; black diabase with plagioclase laths up to 3 mm, mostly <2 mm, trace magnetite; reaction to acid: none to very weak	very trace calcite, trace green alteration on plagioclase needles	angular chips up to 1.5 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
1,910 - 1,920	582.2 - 585.2	Diabase; very dark gray [N2.5]; well lithified; greenish-black diabase with plagioclase laths up to 2 mm, some magnetite; reaction to acid: none to very weak	very trace calcite, trace serpentine, some green alteration on plagioclase needles	angular chips up to 1.2 cm
1,920 - 1,930	585.2 - 588.3	Diabase; black [N2.5]; well lithified; greenish-black diabase with plagioclase laths up to 1 mm, trace magnetite; reaction to acid: none to very weak	very trace calcite, trace serpentine, some green alteration on plagioclase needles	angular chips up to 1.4 cm
1,930 - 1,940	588.3 - 591.3	Diabase; black [N2.5]; well lithified; black diabase with plagioclase laths up to 1 mm, some magnetite; reaction to acid: very weak	trace calcite	angular to subangular chips up to 1.0 cm
1,940 - 1,950	591.3 - 594.4	Diabase; black [N2.5]; well lithified; 93% black diabase with <1 mm plagioclase laths; 2% grayish-white, fine to medium-grained, arkosic quartzite, trace magnetite; reaction to acid: weak	5% white calcite	angular to subangular chips up to 1.5 cm
UPPER DRIPPING SPRING QUARTZITE (pCdsu)				
1,950 - 1,960	594.4 - 597.4	Arkosic quartzite; greenish gray [10Y5/1]; well lithified; 99% pinkish-white and grayish-white, fine to medium-grained, arkosic quartzite; 1% black diabase; reaction to acid: none to very weak		angular to subangular chips up to 1.2 cm
1,960 - 1,970	597.4 - 600.5	Arkosic quartzite; very dark gray [N3]; well lithified; 79% gray, fine to medium-grained, arkosic quartzite; 20% black shale; 1% black diabase; reaction to acid: none	trace pyrite	angular chips up to 1.0 cm
1,970 - 1,980	600.5 - 603.5	Shale; very dark gray [N3]; well lithified; 90% black shale; 10% greenish-gray, fine-grained, arkosic quartzite; trace diabase; reaction to acid: none	trace pyrite	angular chips up to 1.6 cm
1,980 - 1,990	603.5 - 606.6	Shale; very dark gray [N3]; well lithified; black shale, trace diabase; reaction to acid: none	trace pyrite veins	angular chips up to 1.8 cm
1,990 - 2,000	606.6 - 609.6	Shale; very dark gray [N3]; well lithified; black shale, trace diabase; reaction to acid: none	very trace calcite, trace pyrite veins	angular chips up to 1.4 cm
2,000 - 2,010	609.6 - 612.6	Shale; black [N2.5]; well lithified; black shale, trace diabase; reaction to acid: none	very trace calcite, trace pyrite veins	angular chips up to 2.1 cm

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
UPPER DRIPPING SPRING QUARTZITE (pCdsu)				
2,010 - 2,020	612.6 - 615.7	Shale; black [N2.5]; well lithified; black shale, trace diabase; reaction to acid: none	very trace calcite, trace pyrite veins	angular chips up to 1.8 cm
2,020 - 2,030	615.7 - 618.7	Shale; black [N2.5]; well lithified; black shale, trace black diabase; reaction to acid: none	trace bronzy cubic pyrite	angular chips up to 1.2 cm; trace dark gray silt balls
2,030 - 2,040	618.7 - 621.8	Shale; black [N2.5]; well lithified; black laminated shale; reaction to acid: none	common bronzy cubic pyrite, trace pyrite on fractures	angular chips up to 3.3 cm
2,040 - 2,050	621.8 - 624.8	Shale; very dark gray [N3]; well lithified; black laminated shale; trace black diabase, trace greenish-gray quartzite; reaction to acid: none	trace bronzy cubic pyrite	angular chips up to 1.2 cm
2,050 - 2,060	624.8 - 627.9	Quartzite; dark greenish gray [5GY4/1]; well lithified; 91% green silty quartzite; 7% black shale; 2% light gray shale; reaction to acid: none	very trace pyrite on black shale	angular chips up to 1.3 cm; trace light gray silt balls
2,060 - 2,070	627.9 - 630.9	Quartzite; greenish gray [5GY5/1]; well lithified; 91% gray silty quartzite; 5% greenish-gray shale; 3% black shale; 1% brown siltstone; trace pink quartzite; reaction to acid: none	very trace pyrite	angular chips up to 1.6 cm; very trace light gray silt balls
2,070 - 2,080	630.9 - 634.0	Quartzite; greenish gray [10Y5/1]; well lithified; 40% green silty quartzite; 35% gray and tan laminated shale; 20% black shale; 5% pink fine-grained, arkosic quartzite; reaction to acid: none	very trace pyrite	angular chips up to 1.5 cm; very trace light gray silt balls
2,080 - 2,090	634.0 - 637.0	Quartzite; dark greenish gray [10Y4/1]; well lithified; 88% greenish-gray, fine to medium-grained, arkosic quartzite; 10% black shale; 2% pink arkosic quartzite; very trace diabase; reaction to acid: none	very trace pyrite, very trace iron oxide staining	angular to subangular chips up to 1.0 cm
2,090 - 2,100	637.0 - 640.1	Arkosic quartzite; dark gray [10YR4/1]; well lithified; 69% green, fine to medium-grained, arkosic quartzite; 25% pink fine-grained, arkosic quartzite; 1% greenish-black diabase; reaction to acid: none	very trace pyrite, very trace iron oxide staining (hematite and limonite), trace chlorite	angular to subangular chips up to 2.2 cm

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
LOWER DRIPPING SPRING QUARTZITE (pCdsl)				
2,100 - 2,110	640.1 - 643.1	Arkosic quartzite; dark gray [10YR4/1]; well lithified; 91% pinkish-white, fine-grained, arkosic quartzite (white dominant chips are slightly less arkosic); 7% green, fine to medium-grained, arkosic quartzite; 2% black shale, trace diabase; reaction to acid: none	trace iron oxide staining (hematite and limonite), very trace chlorite	angular to subangular chips up to 1.6 cm
2,110 - 2,120	643.1 - 646.2	Arkosic quartzite; dark gray [10YR4/1]; well lithified; 87% pinkish-white and brownish-pink fine-grained, arkosic quartzite (brownish-pink is considerably more arkosic); 11% green, fine to medium-grained, arkosic quartzite; 3% black shale; very trace diabase; reaction to acid: none	very trace iron oxide staining (hematite)	angular to subangular chips up to 1.2 cm
2,120 - 2,130	646.2 - 649.2	Arkosic quartzite; dark gray [10YR4/1]; well lithified; 92% pinkish-white and brownish-pink fine-grained, arkosic quartzite (brownish-pink is considerably more arkosic); 5% green, fine to medium-grained, arkosic quartzite; 3% black shale; very trace diabase; reaction to acid: none	very trace pyrite, very trace iron oxide staining (hematite)	angular to subangular chips up to 1.4 cm
2,130 - 2,140	649.2 - 652.3	Arkosic quartzite; weak red [2.5YR4/2]; well lithified; 91% pinkish-white and brownish-white, fine-grained, arkosic quartzite; 7% green, fine to medium-grained, arkosic quartzite; 2% black shale; very trace diabase; reaction to acid: none	very trace pyrite, common iron oxide staining (hematite and some limonite)	angular to subangular chips up to 1.3 cm
2,140 - 2,150	652.3 - 655.3	Arkosic quartzite; reddish gray [5YR5/2]; well lithified; pinkish-white and white, fine-grained, arkosic quartzite; white chips are slightly less arkosic, trace black shale; very trace diabase; reaction to acid: none	some iron oxide staining (hematite)	angular to subangular chips up to 1.2 cm
2,150 - 2,160	655.3 - 658.4	Arkosic quartzite; reddish gray [5YR5/2]; well lithified; pinkish-white and white, fine-grained, arkosic quartzite; white chips are slightly less arkosic, trace greenish-white, fine to medium-grained, arkosic quartzite; very trace black shale; reaction to acid: none	some iron oxide staining (hematite and very trace limonite), very trace black metallic hematite, trace green serpentinization	angular to subangular chips up to 1.6 cm

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
LOWER DRIPPING SPRING QUARTZITE (pCdsl)				
2,160 - 2,170	658.4 - 661.4	Quartzite; reddish gray [5YR5/2]; well lithified; 50% pink and white, fine to medium-grained slightly arkosic quartzite; 50% white and gray, medium-grained quartz arenite; very trace black shale; reaction to acid: none	minor chlorite, trace euhedral and anhedral pyrite, some iron oxide (hematite), very trace limonite	angular to subangular chips up to 0.5 cm
2,170 - 2,180	661.4 - 664.5	Quartzite; reddish gray [5YR5/2]; well lithified; 90% white and pink, medium-grained quartz arenite; 9% pink fine to medium-grained slightly arkosic quartzite; 1% black and green diabase, very trace light blue siltstone; reaction to acid: none	minor chlorite, trace euhedral and anhedral pyrite, some iron oxide (hematite), very trace limonite	angular to subangular chips up to 1.3 cm
2,180 - 2,190	664.5 - 667.5	Quartzite; reddish gray [5YR5/2] and very dark gray [N3]; well lithified; 90% white and pink, medium-grained quartz arenite; 3% pink fine to medium-grained slightly arkosic quartzite; 7% black and green diabase, trace black shale; reaction to acid: none	minor chlorite, trace euhedral and anhedral pyrite, some iron oxide (hematite), very trace limonite	angular to subangular chips up to 0.9 cm
2,190 - 2,200	667.5 - 670.6	Quartzite; reddish gray [5YR5/2] and very dark gray [N3]; well lithified; 92% white and pink, medium-grained quartz arenite; trace pink fine to medium-grained slightly arkosic quartzite; 8% black and green diabase, trace black shale; reaction to acid: none	trace chlorite, trace euhedral and anhedral pyrite, trace iron oxide (hematite), very trace limonite	angular to subangular chips up to 1.1 cm
2,200 - 2,210	670.6 - 673.6	Quartzite; reddish gray [5YR5/2] and very dark gray [N3]; well lithified; 95% white and pink, medium-grained quartz arenite; trace pink fine to medium-grained slightly arkosic quartzite; 4% black and green diabase, 1% black shale; reaction to acid: none	trace chlorite, trace euhedral and anhedral pyrite, trace iron oxide (hematite)	angular to subangular chips up to 1.0 cm
LOWER DRIPPING SPRING QUARTZITE - Barnes Conglomerate (pCdsb)				
2,210 - 2,220	673.6 - 676.7	Barnes Conglomerate; reddish gray [5YR5/2] and very dark gray [N3]; well lithified; 95% white and pink, medium-grained quartz arenite; 3% white and green, medium-grained quartz arenite; 2% black and green diabase; reaction to acid: none	minor chlorite, very trace euhedral and anhedral pyrite, trace iron oxide (hematite), trace white and pink quartz vein	angular to subangular chips up to 0.8 cm
2,220 - 2,230	676.7 - 679.7	Barnes Conglomerate; reddish gray [5YR5/2] and very dark gray [N3]; well lithified; 75% white, gray and pink, medium-grained quartz arenite; 22% pinkish-brown, fine-grained, arkosic quartzite; very trace diabase black and green diabase; reaction to acid: none	minor chlorite, very trace euhedral and anhedral pyrite, trace iron oxide (hematite), 3% white and pink quartz vein	angular to subangular chips up to 0.8 cm

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Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
LOWER DRIPPING SPRING QUARTZITE - Barnes Conglomerate (pCdsb)				
2,230 - 2,240	679.7 - 682.8	Barnes Conglomerate; reddish gray [5YR5/2] and grayish green [5G5/2]; well lithified; 70% pink and green, medium-grained quartz arenite; 15% white and green, medium-grained quartz arenite; very trace black shale; reaction to acid: none	minor chlorite, very trace euhedral and anhedral pyrite, trace iron oxide (hematite), 15% white and pink quartz vein	angular to subangular chips up to 1.0 cm
PIONEER SHALE (pCp)				
2,240 - 2,250	682.8 - 685.8	Silty arkosic quartzite; reddish gray [5YR5/2] and grayish green [5G5/2]; well lithified; 50% green, fine-grained quartzite; 50% dark purple silty quartzite; very trace pink fine-grained quartzite; reaction to acid: none	trace chlorite	angular chips up to 0.8 cm
2,250 - 2,260	685.8 - 688.8	Silty arkosic quartzite; reddish gray [5YR5/2] and grayish green [5G5/2]; well lithified; 80% purple, green, and pink fine-grained, arkosic quartzite; 20% dark purple silty quartzite; reaction to acid: none	trace chlorite, trace pyrite, very trace iron oxide (hematite)	angular chips up to 0.7 cm
2,260 - 2,270	688.8 - 691.9	Silty arkosic quartzite; reddish gray [5YR5/2] and grayish green [5G5/2]; well lithified; gray, purple, and green, fine-grained, arkosic quartzite; reaction to acid: none	minor chlorite, trace pyrite, very trace iron oxide (hematite), 1% white quartz vein	angular chips up to 0.8 cm
2,270 - 2,280	691.9 - 694.9	Silty arkosic quartzite; reddish gray [5YR5/2] and grayish green [5G5/2]; well lithified; 90% gray, purple, and green, fine-grained, arkosic quartzite; 10% green and black diabase with trace magnetite; reaction to acid: none	abundant chlorite, trace pyrite, very trace iron oxide (hematite), trace white quartz vein	angular chips up to 0.7 cm
PRECAMBRIAN DIABASE (pCdiab)				
2,280 - 2,290	694.9 - 698.0	Diabase; very dark green [N3]; well lithified; black, green, and white diabase with some magnetite; reaction to acid: none to very weak	1% calcite vein, trace pyrite	angular chips up to 0.6 cm
2,290 - 2,300	698.0 - 701.0	Diabase; very dark green [N3]; well lithified; black, green, and white diabase with some magnetite; very trace light purple silty quartzite; reaction to acid: none to very weak	1% calcite vein, trace pyrite	angular chips up to 0.7 cm
2,300 - 2,310	701.0 - 704.1	Diabase; very dark green [N3]; well lithified; black, green, and white diabase with some magnetite; trace light purple silty quartzite; reaction to acid: none to very weak	trace pyrite, trace calcite vein, very trace iron oxide (hematite)	angular chips up to 1.3 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-13
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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
2,310 - 2,320	704.1 - 707.1	Diabase; very dark green [N3]; well lithified; black, green, and white diabase with some magnetite; trace light purple silty quartzite; reaction to acid: none to very weak	trace pyrite, trace calcite vein, very trace iron oxide (hematite)	angular chips up to 0.8 cm
2,320 - 2,330	707.1 - 710.2	Diabase; very dark green [N3]; well lithified; black, green, and white diabase with some magnetite; trace light purple silty quartzite; reaction to acid: none to very weak	trace pyrite, trace calcite vein, very trace iron oxide (hematite), very trace epidote	angular chips up to 0.7 cm
2,330 - 2,340	710.2 - 713.2	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: weak	trace pyrite, trace iron oxide (hematite) staining	angular chips up to 0.9 cm
2,340 - 2,350	713.2 - 716.3	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace pyrite, trace iron oxide (hematite) staining	angular chips up to 1.2 cm
2,350 - 2,360	716.3 - 719.3	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace pyrite, trace iron oxide (hematite) staining	angular chips up to 0.9 cm
2,360 - 2,370	719.3 - 722.4	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace pyrite, trace iron oxide (hematite) staining	angular chips up to 0.6 cm
2,370 - 2,380	722.4 - 725.4	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace pyrite, trace iron oxide (hematite) staining, some gray clay	angular chips up to 0.6 cm
2,380 - 2,390	725.4 - 728.5	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace pyrite, trace iron oxide (hematite) staining	angular chips up to 0.3 cm
2,390 - 2,400	728.5 - 731.5	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace pyrite, trace iron oxide (hematite) staining	angular chips up to 0.5 cm

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PRECAMBRIAN DIABASE (pCdiab)				
2,400 - 2,410	731.5 - 734.6	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace iron oxide (hematite) staining	angular chips up to 0.9 cm
2,410 - 2,420	734.6 - 737.6	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace pyrite, trace iron oxide (hematite) staining	angular chips up to 0.3 cm
2,420 - 2,430	737.6 - 740.7	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace iron oxide (hematite) staining	angular chips up to 1.2 cm
2,430 - 2,440	740.7 - 743.7	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and pink quartzite; reaction to acid: very weak	trace iron oxide (hematite) staining	angular chips up to 0.6 cm
2,440 - 2,450	743.7 - 746.8	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; very trace white and pink quartzite; reaction to acid: very weak	trace iron oxide (hematite) staining, trace pyrite	angular chips up to 2.5 cm
2,450 - 2,460	746.8 - 749.8	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and yellow quartzite; reaction to acid: very weak	trace iron oxide (hematite) staining, trace pyrite	angular chips up to 0.8 cm
2,460 - 2,470	749.8 - 752.9	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and yellow quartzite; reaction to acid: very weak	trace iron oxide (hematite) staining, trace pyrite	angular chips up to 0.8 cm
2,470 - 2,480	752.9 - 755.9	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace white and yellow quartzite; reaction to acid: very weak	trace iron oxide (hematite) staining	angular chips up to 0.5 cm
2,480 - 2,490	755.9 - 759.0	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; very trace white and yellow quartzite; reaction to acid: very weak	trace iron oxide (hematite and limonite) staining	angular chips up to 0.7 cm

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PRECAMBRIAN DIABASE (pCdiab)				
2,490 - 2,500	759.0 - 762.0	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; very trace white and yellow quartzite; reaction to acid: very weak	trace iron oxide (hematite and limonite) staining, trace calcite vein	angular chips up to 0.6 cm
2,500 - 2,510	762.0 - 765.0	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace gray, medium-grained quartzite; very trace black shale; reaction to acid: very weak		angular chips up to 1.0 cm
2,510 - 2,520	765.0 - 768.1	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace gray, medium-grained quartzite; very trace black shale; very trace pinkish-purple, fine-grained quartzite; reaction to acid: very weak		angular chips up to 1.2 cm
2,520 - 2,530	768.1 - 771.1	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; trace gray, medium-grained quartzite; very trace black shale; very trace pinkish-purple, fine-grained quartzite; reaction to acid: very weak		angular chips up to 0.9 cm
2,530 - 2,540	771.1 - 774.2	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; reaction to acid: very weak	trace calcite vein	angular chips up to 0.7 cm
2,540 - 2,550	774.2 - 777.2	Diabase; very dark green [N3]; well lithified; black, dark green, and white diabase with trace magnetite; very trace purple-gray silty quartzite; reaction to acid: very weak		angular chips up to 0.6 cm
PIONEER SHALE (pCp)				
2,550 - 2,560	777.2 - 780.3	Silty arkosic quartzite; reddish gray [10R5/2]; well lithified; 80% green, light purple and pink silty arkosic quartzite; 20% green, black, and white diabase with very trace magnetite; reaction to acid: very weak	very trace iron oxide (hematite and limonite) staining	angular chips up to 2.1 cm
2,560 - 2,570	780.3 - 783.3	Silty arkosic quartzite; reddish gray [10R5/2]; well lithified; 99% green and light purple silty arkosic quartzite; 1% green, black, and white diabase; reaction to acid: none	very trace euhedral pyrite, very trace iron oxide (hematite and limonite) staining	angular chips up to 1.9 cm

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PIONEER SHALE (pCp)				
2,570 - 2,580	783.3 - 786.4	Silty quartzite; dusky red [10R3/2]; well lithified; 75% dark purple silty quartzite; 25% green and light purple, fine-grained, arkosic quartzite; reaction to acid: none	very trace euhedral pyrite, very trace chlorite in shale	angular chips up to 0.9 cm
2,580 - 2,590	786.4 - 789.4	Fine-grained arkosic quartzite; dusky red [10R3/2]; well lithified; 70% green and purple, fine-grained, arkosic quartzite; 30% dark purple silty quartzite; reaction to acid: none	very trace chlorite in shale	angular chips up to 1.4 cm
2,590 - 2,600	789.4 - 792.5	Fine-grained arkosic quartzite; dusky red [10R3/2]; well lithified; 60% green and purple, fine-grained, arkosic quartzite; 40% dark purple silty quartzite; reaction to acid: none	very trace chlorite in shale	angular chips up to 0.8 cm
2,600 - 2,610	792.5 - 795.5	Fine-grained arkosic quartzite; dusky red [10R3/2]; well lithified; 60% green and purple, fine-grained, arkosic quartzite; 40% dark purple very silty quartzite; reaction to acid: none	very trace chlorite in shale	angular chips up to 0.9 cm
2,610 - 2,620	795.5 - 798.6	Silty quartzite; dusky red [10R3/2]; well lithified; 95% dark purple silty quartzite; 5% green and light purple, fine-grained, arkosic quartzite; reaction to acid: none	very trace chlorite in shale	angular chips up to 0.7 cm
2,620 - 2,630	798.6 - 801.6	Silty quartzite; dusky red [10R3/2]; well lithified; 95% dark purple silty quartzite; 5% green and light purple, fine-grained, arkosic quartzite; reaction to acid: none	very trace chlorite in shale	angular chips up to 0.6 cm
2,630 - 2,640	801.6 - 804.7	Silty quartzite; dusky red [10R3/2]; well lithified; 95% dark purple silty quartzite; 5% green and light purple, fine-grained, arkosic quartzite; very trace diabase; reaction to acid: none	very trace chlorite in shale, very trace pyrite	angular chips up to 1.0 cm
2,640 - 2,650	804.7 - 807.7	Silty quartzite; dusky red [10R3/2]; well lithified; 99% dark purple silty quartzite; 5% green, fine-grained quartzite; very trace diabase; reaction to acid: none	very trace chlorite in shale, very trace iron oxide (hematite and limonite) in fractures	angular chips up to 1.3 cm
2,650 - 2,660	807.7 - 810.8	Silty quartzite; dusky red [10R3/2]; well lithified; 80% dark purple silty quartzite; 20% green, purple and tan, fine-grained, arkosic quartzite; reaction to acid: none	very trace chlorite in shale, very trace iron oxide (hematite and limonite) in fractures	angular chips up to 0.8 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PIONEER SHALE (pCp)				
2,660 - 2,670	810.8 - 813.8	Silty quartzite; dusky red [10R3/2]; well lithified; 90% purple silty quartzite; 10% green, purple and tan, fine-grained, arkosic quartzite; very trace diabase; reaction to acid: none	very trace chlorite in shale, trace iron oxide (hematite and limonite) in fractures	angular chips up to 0.8 cm
2,670 - 2,680	813.8 - 816.9	Silty quartzite; dusky red [10R3/2] and dusky red [10R3/2]; well lithified; 85% purple silty quartzite; 10% gray and pink fine-grained, arkosic quartzite; 4% green, purple and tan, fine-grained, arkosic quartzite; reaction to acid: none	very trace chlorite in shale, trace iron oxide (hematite and limonite) in fractures	angular chips up to 0.7 cm
2,680 - 2,690	816.9 - 819.9	Fine-grained arkosic quartzite; pale red [10R6/2] and dusky red [10R3/2]; well lithified; 65% gray, green, and pink fine to medium-grained, arkosic quartzite; 25% purple silty quartzite; trace diabase; 10% green, purple and tan, fine-grained, arkosic quartzite; reaction to acid: none	very trace chlorite in shale, trace iron oxide (hematite and limonite) in fractures	angular chips up to 0.9 cm
2,690 - 2,700	819.9 - 823.0	Fine-grained arkosic quartzite; pale red [10R6/2] and dusky red [10R3/2]; well lithified; 90% pink, gray, purple, and green, medium-grained quartzite; 8% purple silty quartzite; 2% green, medium-grained quartzite; reaction to acid: none	very trace pyrite, common iron oxide (hematite and limonite) in fractures	angular chips up to 0.9 cm
2,700 - 2,710	823.0 - 826.0	Silty quartzite; pale red [10R6/2] and dusky red [10R3/2]; well lithified; 50% purple silty quartzite; 45% pink, green, gray and purple, fine-grained, arkosic quartzite; 4% green, medium-grained quartzite; 1% diabase; reaction to acid: none	some iron oxide (hematite and limonite) in fractures	angular chips up to 0.8 cm
2,710 - 2,720	826.0 - 829.1	Silty quartzite; dusky red [10R3/2]; well lithified; 95% purple silty quartzite; 3% pink, green, gray and purple, fine-grained, arkosic quartzite; trace green, medium-grained quartzite; 2% diabase; reaction to acid: none	trace iron oxide (hematite and limonite) in fractures	angular chips up to 0.8 cm
2,720 - 2,730	829.1 - 832.1	Silty quartzite; dusky red [10R3/2]; well lithified; 95% purple silty quartzite; 3% pink, green and gray, medium-grained, arkosic quartzite; 2% green, fine-grained quartzite; trace diabase; reaction to acid: none	trace iron oxide (hematite and limonite) in fractures	angular chips up to 0.7 cm

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PIONEER SHALE (pCp)				
2,730 - 2,740	832.1 - 835.2	Silty quartzite; dusky red [10R3/2]; well lithified; 98% purple silty quartzite; 2% green, fine-grained quartzite; reaction to acid: none		angular chips up to 0.8 cm
2,740 - 2,750	835.2 - 838.2	Silty quartzite; dusky red [10R3/2]; well lithified; 90% purple silty quartzite; 7% pink, green and gray, medium-grained, arkosic quartzite; 2% green, fine-grained quartzite; 1% tan, fine-grained quartzite; trace diabase; reaction to acid: none to very weak	some iron oxide (hematite and limonite) in fractures, very trace calcite vein	angular chips up to 1.1 cm
2,750 - 2,760	838.2 - 841.2	Silty quartzite; dusky red [10R3/2] and very dark gray [N3]; well lithified; 65% purple silty quartzite; 25% pink, green and gray, medium-grained, arkosic quartzite; 8% green, fine to medium-grained quartzite; 2% diabase; reaction to acid: none	some iron oxide (hematite and limonite) in fractures	angular chips up to 0.6 cm
2,760 - 2,770	841.2 - 844.3	Silty quartzite; dusky red [10R3/2]; well lithified; 97% purple silty quartzite; 1% pink, green and gray, medium-grained, arkosic quartzite; trace green, fine to medium-grained quartzite; 2% diabase; reaction to acid: none	trace iron oxide (hematite and limonite) in fractures	angular chips up to 0.9 cm
2,770 - 2,780	844.3 - 847.3	Silty quartzite; dusky red [10R3/2]; well lithified; 70% purple silty quartzite; 23% pink, green and gray, medium-grained, arkosic quartzite; 6% green, fine to medium-grained quartzite; 1% diabase; reaction to acid: none	some iron oxide (hematite and limonite) in fractures	angular chips up to 1.4 cm
2,780 - 2,790	847.3 - 850.4	Fine-grained quartzite; greenish gray [5GY5/1]; well lithified; 50% light greenish-gray, fine-grained quartzite; 35% green, medium-grained quartzite; 10% pink, green and gray, medium-grained, arkosic quartzite; 3% diabase, 2% green silty quartzite; reaction to acid: none	very trace pyrite, trace iron oxide (hematite and limonite) staining	angular chips up to 1.5 cm
2,790 - 2,800	850.4 - 853.4	Silty quartzite; dusky red [10R3/2]; well lithified; 70% purple silty quartzite; 20% pink, green and gray, medium-grained, arkosic quartzite; 8% green, fine to medium-grained quartzite; 2% diabase; reaction to acid: none	very trace pyrite, trace iron oxide (hematite and limonite) staining	angular chips up to 1.0 cm

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PIONEER SHALE (pCp)				
2,800 - 2,810	853.4 - 856.5	Silty quartzite; dusky red [10R3/2]; well lithified; 95% purple silty quartzite; 4% green, fine to medium-grained quartzite; trace diabase; reaction to acid: none	1% milky quartz vein, very trace iron oxide (hematite and limonite) staining	angular chips up to 0.9 cm
2,810 - 2,820	856.5 - 859.5	Silty quartzite; dusky red [10R3/2]; well lithified; 99% purple silty quartzite; 1% green, fine to medium-grained quartzite; trace gray, fine-grained quartzite; very trace diabase; reaction to acid: none	trace iron oxide (hematite) staining on fracture surfaces	angular chips up to 1.2 cm
2,820 - 2,830	859.5 - 862.6	Fine-grained arkosic quartzite; dusky red [10R3/2]; well lithified; 98% purple silty quartzite; 2% green silty quartzite; trace green, fine to medium-grained quartzite; reaction to acid: none	trace iron oxide (hematite) staining on fracture surfaces	angular chips up to 1.1 cm
2,830 - 2,840	862.6 - 865.6	Diabase; very dark gray [N3]; well lithified; 99% green and black fine-grained diabase, 1% green silty quartzite; very trace fine-grained tan quartzite; reaction to acid: none	very trace pyrite, very trace calcite vein	angular chips up to 2.0 cm
2,840 - 2,850	865.6 - 868.7	Fine-grained quartzite; very dark gray [N3]; well lithified; 80% green and purple, fine-grained quartzite; 15% diabase, 5% green silty quartzite; reaction to acid: none	very trace pyrite	angular chips up to 0.8 cm
2,850 - 2,860	868.7 - 871.7	Silty quartzite; dusky red [10R3/2]; well lithified; 99% purple silty quartzite; 1% green and purple, fine-grained quartzite; trace tan, very fine-grained, silty quartzite; reaction to acid: none	trace iron oxide (hematite and limonite) staining	angular chips up to 1.3 cm
2,860 - 2,870	871.7 - 874.8	Silty quartzite; dusky red [10R3/2]; well lithified; 60% purple silty quartzite; 15% green silty quartzite; 25% tan, pink, and green, medium-grained, arkosic quartzite; reaction to acid: none	trace iron oxide (hematite and limonite) staining	angular chips up to 0.8 cm
2,870 - 2,880	874.8 - 877.8	Scanlan Conlgomerate; dark reddish gray [10R3/1]; well lithified; 90% purplish-brown, fine-grained quartzite; 7% green, fine-grained quartzite; 2% green and black diabase, 1% pink, gray, and green medium-grained, arkosic quartzite; reaction to acid: none	trace iron oxide (hematite and limonite) staining	angular chips up to 1.0 cm; 2% tan silty clay

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DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PIONEER SHALE (pCp)				
2,880 - 2,890	877.8 - 880.9	Scanlan Conlgomerate; dark reddish gray [10R3/1]; well lithified; 90% purplish-brown, fine-grained quartzite; 7% green, fine-grained quartzite; 2% green and black diabase, 1% pink, gray, and green medium-grained, arkosic quartzite; reaction to acid: none	trace iron oxide (hematite and limonite) staining	angular chips up to 1.1 cm; 5% tan silty clay
2,890 - 2,900	880.9 - 883.9	Scanlan Conlgomerate; dark reddish gray [10R3/1]; well lithified; 90% purplish-brown, fine-grained quartzite; 7% green, fine-grained quartzite; 2% green and black diabase, 1% pink, gray, and green medium-grained, arkosic quartzite; reaction to acid: none	very trace pyrite, some iron oxide (hematite and limonite) staining	angular chips up to 1.1 cm; 5% tan silty clay
PINAL SCHIST (pCpi)				
2,900 - 2,910	883.9 - 887.0	Schist; greenish gray [5GY5/1]; well lithified; 75% green, blue, and silver schist; 5% green, medium-grained quartzite; reaction to acid: none	20% green, yellow, and white, milky quartz vein	subangular chips up to 1.3 cm
2,910 - 2,920	887.0 - 890.0	Schist; dark greenish gray [10Y4/1]; well lithified; 90% green, blue, and silver schist; 2% pink, gray, and green, medium-grained, arkosic quartzite; reaction to acid: none	8% pink and white, milky quartz vein, very trace iron oxide (hematite and limonite) staining	subangular chips up to 1.1 cm
2,920 - 2,930	890.0 - 893.1	Schist; dark greenish gray [10Y4/1]; well lithified; 95% green, blue, and silver schist; trace pink, gray, and green, medium-grained, arkosic quartzite; trace white clay; reaction to acid: none	5% pink, yellow, and white, milky quartz vein, very trace iron oxide (hematite and limonite) staining, very trace pyrite	subangular chips up to 1.2 cm
2,930 - 2,940	893.1 - 896.1	Schist; dark greenish gray [10Y4/1]; well lithified; 96% green, blue, and silver schist; 2% purplish-brown, fine-grained, arkosic quartzite; reaction to acid: none	2% yellow and white, milky quartz vein, very trace iron oxide (hematite and limonite) staining, very trace pyrite	subangular chips up to 1.3 cm
2,940 - 2,950	896.1 - 899.2	Schist; dark greenish gray [10Y4/1]; well lithified; 98% green, blue, and silver schist; 1% purplish-brown, fine-grained, arkosic quartzite; reaction to acid: none	1% milky quartz vein, very trace iron oxide (hematite and limonite) staining	subangular chips up to 1.0 cm
2,950 - 2,960	899.2 - 902.2	Schist; dark greenish gray [10Y4/1]; well lithified; 99% green, blue, and silver schist; trace purplish-brown, medium-grained, arkosic quartzite; reaction to acid: none	1% milky quartz vein, very trace iron oxide (hematite and limonite) staining	subangular chips up to 1.4 cm

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Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PINAL SCHIST (pCpi)				
2,960 - 2,970	902.2 - 905.3	Schist; very dark greenish gray [10BG3/1]; well lithified; 80% green, blue, and silver schist; very trace purplish-red, medium-grained, arkosic quartzite; reaction to acid: none	20% milky quartz vein	subangular chips up to 1.6 cm
2,970 - 2,980	905.3 - 908.3	Schist; very dark greenish gray [10BG3/1]; well lithified; 80% green, blue, and silver schist; very trace purplish-red, medium-grained, arkosic quartzite; reaction to acid: none	20% milky quartz vein, trace pyrite	subangular chips up to 1.5 cm
2,980 - 2,990	908.3 - 911.4	Schist; very dark greenish gray [10BG3/1]; well lithified; 60% green, blue, and silver schist; reaction to acid: none	25% milky quartz vein,15% pink potassic alteration (k-spar)	subangular chips up to 1.1 cm
2,990 - 3,000	911.4 - 914.4	Schist; very dark greenish gray [10BG3/1]; well lithified; 90% green, blue, and silver schist; reaction to acid: none	10% milky quartz vein, very trace pyrite, very trace pink potassic alteration (k-spar)	subangular chips up to 1.1 cm
3,000 - 3,010	914.4 - 917.4	Schist; very dark greenish gray [10BG3/1]; well lithified; 85% green, blue, and silver schist; reaction to acid: none	10% milky quartz vein, 5% pink potassic alteration (k-spar), very trace pyrite	subangular chips up to 0.9 cm
3,010 - 3,020	917.4 - 920.5	Schist; dark greenish gray [5GY4/1]; well lithified; 80% dark gray schist; reaction to acid: very weak	15% clear and white vein quartz, 5% potassic alteration (k-spar), trace chlorite, very trace epidote	subangular chips up to 1.5 cm
3,020 - 3,030	920.5 - 923.5	Schist; dark greenish gray [5GY4/1] and weak red [2.5YR4/2]; well lithified; 95% reddish-gray, dark gray, and greenish-gray schist; reaction to acid: very weak	5% clear and white vein quartz, abundant potassic alteration (k-spar), trace chlorite, very trace white fault gouge	subangular chips up to 1.9 cm
3,030 - 3,040	923.5 - 926.6	Schist; dark greenish gray [5GY4/1] and weak red [2.5YR4/2]; well lithified; 75% silvery gray, dark gray, red, and green schist; reaction to acid: very weak	25% clear and white vein quartz, common potassic alteration (k-spar), some chlorite, trace white fault gouge	subangular chips up to 1.6 cm
3,040 - 3,050	926.6 - 929.6	Schist; weak red [2.5YR4/2] and white [N8]; well lithified; 50% reddish-gray schist; reaction to acid: very weak	50% clear and white vein quartz, abundant potassic alteration (k-spar), minor chlorite	subangular chips up to 1.5 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-13
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PINAL SCHIST (pCpi)				
3,050 - 3,060	929.6 - 932.7	Schist; dark gray [N4], reddish brown [2.5YR4/4], and very dark gray [5BG3/1] and white [N8]; well lithified; 70% reddish-gray, silvery dark gray, and green schist; reaction to acid: very weak	30% clear and white vein quartz, common potassic alteration (k-spar), trace chlorite, very trace manganese oxide	subangular chips up to 1.5 cm
3,060 - 3,070	932.7 - 935.7	Schist; dark gray [N4], reddish brown [2.5YR4/4], and very dark gray [5BG3/1] and white [N8]; well lithified; 65% reddish-gray, silvery dark gray, and green schist; reaction to acid: very weak	35% clear and white vein quartz, abundant potassic alteration (k-spar), trace chlorite, very trace epidote	subangular chips up to 1.7 cm
3,070 - 3,080	935.7 - 938.8	Schist; dark gray [N4], reddish brown [2.5YR4/4], and very dark gray [5BG3/1] and white [N8]; well lithified; 85% reddish-gray, silvery dark gray, and green schist; reaction to acid: very weak	15% clear and white vein quartz, abundant potassic alteration (k-spar), trace chlorite	subangular chips up to 1.1 cm
3,080 - 3,090	938.8 - 941.8	Schist; reddish brown [2.5YR4/4], white [N8], and very dark gray [5BG3/1]; well lithified; 70% reddish-gray schist; reaction to acid: very weak	30% clear and white vein quartz, abundant potassic alteration (k-spar), trace chlorite, trace white fault gouge, very trace epidote, very trace tiny pyrite	subangular chips up to 1.3 cm
3,090 - 3,100	941.8 - 944.9	Schist; dark gray [N4], reddish brown [2.5YR4/4], and very dark gray [5BG3/1] and white [N8]; well lithified; 98% reddish-gray, dark gray, and greenish gray schist; reaction to acid: very weak	2% white vein quartz, abundant potassic alteration (k-spar), trace chlorite, trace white fault gouge, very trace epidote	subangular chips up to 1.0 cm
3,100 - 3,110	944.9 - 947.9	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 90% pinkish-gray and dark green schist; reaction to acid: none	10% white quartz vein, abundant potassic alteration (k-spar), trace chlorite	subangular chips up to 1.2 cm
3,110 - 3,120	947.9 - 951.0	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 95% pinkish-gray and dark green schist; reaction to acid: none	5% white quartz vein, abundant potassic alteration (k-spar), trace chlorite	subangular chips up to 0.9 cm
3,120 - 3,130	951.0 - 954.0	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 95% pinkish-gray and dark green schist; reaction to acid: none	5% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, very trace epidote	subangular chips up to 1.3 cm
3,130 - 3,140	954.0 - 957.1	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 98% dark green and pinkish-gray schist; reaction to acid: very weak	2% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, very trace epidote, trace magnetite	subangular chips up to 1.7 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-13
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PINAL SCHIST (pCpi)				
3,140 - 3,150	957.1 - 960.1	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 95% dark green and pinkish-gray schist; reaction to acid: none	5% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, very trace epidote, trace magnetite	subangular chips up to 1.2 cm
3,150 - 3,160	960.1 - 963.2	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 98% dark green, very dark gray, and pinkish-gray schist; reaction to acid: none	2% white quartz vein, common potassic alteration (k-spar), trace chlorite, very trace epidote, trace magnetite	subangular chips up to 1.1 cm
3,160 - 3,170	963.2 - 966.2	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 98% dark green, very dark gray, and pinkish-gray schist; reaction to acid: none	2% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, trace magnetite	subangular chips up to 1.4 cm
3,170 - 3,180	966.2 - 969.3	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 98% dark green, very dark gray, and pinkish-gray schist; reaction to acid: none	2% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, trace magnetite, very trace pyrite	subangular chips up to 1.5 cm
3,180 - 3,190	969.3 - 972.3	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 95% dark green, very dark gray, and pinkish-gray schist; reaction to acid: none	5% white quartz vein, abundant potassic alteration (k-spar), trace chlorite	subangular chips up to 1.3 cm
3,190 - 3,200	972.3 - 975.4	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 92% dark green, very dark gray, and pinkish-gray schist; reaction to acid: none	8% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, very trace magnetite	subangular chips up to 1.7 cm
3,200 - 3,210	975.4 - 978.4	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 90% dark green, very dark gray, and pinkish-gray schist; reaction to acid: none	10% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, very trace magnetite, trace white fault gouge	subangular chips up to 1.4 cm
3,210 - 3,220	978.4 - 981.5	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 90% dark green, very dark gray, and pinkish-gray schist; reaction to acid: none	10% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, very trace magnetite, trace white fault gouge	subangular chips up to 1.2 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-13
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PINAL SCHIST (pCpi)				
3,220 - 3,230	981.5 - 984.5	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 85% pinkish-gray, dark green, and dark gray schist; reaction to acid: none	15% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, trace magnetite, very trace epidote	subangular chips up to 1.1 cm
3,230 - 3,240	984.5 - 987.6	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 80% pinkish-gray, dark green, and dark gray schist; reaction to acid: none	20% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, trace magnetite, very trace epidote	subangular chips up to 0.9 cm
3,240 - 3,250	987.6 - 990.6	Schist; very dark greenish gray [5G/1], reddish brown [2.5YR4/4], and white [N8]; well lithified; 90% very dark green, very dark gray, and pinkish-gray schist; reaction to acid: very weak	10% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, trace magnetite	subangular chips up to 1.4 cm
3,250 - 3,260	990.6 - 993.6	Schist; very dark gray [N3], reddish brown [2.5YR4/4], and white [N8]; well lithified; 92% very dark green, very dark gray, and pinkish-gray schist; reaction to acid: none	8% white quartz vein, abundant potassic alteration (k-spar), trace chlorite, some magnetite	subangular chips up to 1.1 cm
3,260 - 3,270	993.6 - 996.7	Schist and diabase; very dark gray [N3] and reddish brown [2.5YR4/4]; well lithified; 70% dark green, dark gray, and pink schist; 25% dark green and white diabase with some magnetite; reaction to acid: none to very weak	5% white quartz vein, abundant potassic alteration (k-spar), trace chlorite	subangular chips up to 0.8 cm
PRECAMBRIAN DIABASE (pCdiab)				
3,270 - 3,280	996.7 - 999.7	Diabase; very dark gray [N3]; well lithified; 95% dark green and white diabase, 4% dark green and pinkish-gray schist; reaction to acid: very weak	1% white quartz vein, trace potassic alteration (k-spar), trace chlorite, some magnetite, trace white and tan clay balls	subangular chips up to 0.8 cm
3,280 - 3,290	999.7 - 1,002.8	Diabase; very dark gray [N3]; well lithified; dark green and white diabase with some magnetite; trace dark green and pinkish-gray schist; reaction to acid: very weak	trace white quartz vein, very trace potassic alteration (k-spar), trace chlorite, very trace calcite vein, very trace white and tan clay balls	subangular chips up to 0.7 cm
3,290 - 3,300	1,002.8 - 1,005.8	Diabase; very dark gray [N3]; well lithified; dark green and white diabase with some magnetite; very trace dark green and pinkish-gray schist; reaction to acid: very weak	trace white quartz vein, trace chlorite, very trace calcite vein, very trace white and tan clay balls	subangular chips up to 0.7 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-13
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
3,300 - 3,310	1,005.8 - 1,008.9	Diabase; very dark gray [N3]; well lithified; dark green and white diabase with some magnetite; very trace dark green and pinkish-gray schist; reaction to acid: very weak	trace white quartz vein, trace chlorite, very trace calcite vein, trace white and tan clay balls	CONVENTIONAL MUD ROTARY; subangular chips up to 0.6 cm
3,310 - 3,320	1,008.9 - 1,011.9	Diabase; grayish brown [10YR5/2]; well lithified; dark green and white diabase with up to 1 mm sized plagioclase laths, some magnetite; trace orange-brown siltstone; reaction to acid: very weak	trace white quartz, very trace calcite, trace serpentine, common green mineral alteration on plagioclase laths	subangular chips up to 0.8 cm; trace quartzite contamination with iron oxide
3,320 - 3,330	1,011.9 - 1,015.0	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with up to 1 mm sized plagioclase laths, some magnetite; trace orange-brown siltstone; very trace silvery schist; reaction to acid: none to very weak	trace white quartz, very trace calcite, very trace serpentine, trace green serpentinization on plagioclase laths, very trace chlorite, very trace slickensides	subangular chips up to 0.7 cm; trace quartzite contamination with iron oxide
3,330 - 3,340	1,015.0 - 1,018.0	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with up to 2 mm sized plagioclase laths; common magnetite, trace orange-brown siltstone; reaction to acid: none to weak	trace white quartz, very trace calcite, very trace serpentine, trace green serpentinization on plagioclase laths, very trace chlorite	subangular chips up to 0.6 cm
3,340 - 3,350	1,018.0 - 1,021.1	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with up to 2 mm sized plagioclase laths, some magnetite; trace orange-brown siltstone; trace dark gray and pink schist; reaction to acid: none to very weak	trace white quartz, trace calcite, trace serpentine, trace green serpentinization on plagioclase laths, very trace chlorite, very trace lime-green epidote	subangular chips up to 0.5 cm
3,350 - 3,360	1,021.1 - 1,024.1	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with <1 mm sized plagioclase laths, some magnetite; trace orange-brown siltstone; very trace dark gray silvery schist; very trace tan clay balls; reaction to acid: very weak	very trace white quartz, trace calcite, very trace serpentine, trace green serpentinization on plagioclase laths	subangular chips up to 0.9 cm; very trace tool marks; very trace metal wire
3,360 - 3,370	1,024.1 - 1,027.2	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with up to 1 mm sized plagioclase laths, some magnetite; trace orange-brown siltstone; very trace highly weathered diabase; reaction to acid: none to weak	very trace white quartz, trace calcite, very trace serpentine, trace green serpentinization on plagioclase laths	subangular chips up to 1.4 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-13
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
3,370 - 3,380	1,027.2 - 1,030.2	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with <1 mm sized plagioclase, some magnetite; very trace dark gray silvery schist; reaction to acid: none to weak	some calcite, very trace serpentine, very trace green serpentinization on plagioclase laths, very trace chlorite	subangular chips up to 0.7 cm
3,380 - 3,390	1,030.2 - 1,033.3	Diabase; grayish brown [2.5Y5/2]; well lithified; 99% greenish-black and white diabase with <1 mm sized plagioclase laths, common magnetite; very trace orange-brown siltstone; very trace gray silvery schist; very trace weathered diabase; reaction to acid: none to weak	1% calcite, very trace white quartz, very trace serpentine	subangular chips up to 1.1 cm
3,390 - 3,400	1,033.3 - 1,036.3	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with up to 1 mm sized plagioclase laths, some magnetite; very trace gray silvery schist; very trace weathered diabase; reaction to acid: none to very weak	very trace white quartz, very trace calcite	subangular chips up to 1.0 cm
3,400 - 3,410	1,036.3 - 1,039.4	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with up to 1 mm sized plagioclase laths, some magnetite; trace dark gray silvery schist; reaction to acid: none to weak	trace calcite vein, very trace serpentine, very trace green serpentinization on plagioclase laths	subangular chips up to 1.3 cm
3,410 - 3,420	1,039.4 - 1,042.4	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with up to 1 mm sized plagioclase laths, some magnetite; reaction to acid: none to weak	trace calcite, very trace serpentine, very trace green serpentinization on plagioclase laths, very trace chlorite	subangular chips up to 0.8 cm
3,420 - 3,430	1,042.4 - 1,045.5	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with up to 1 mm sized plagioclase laths, some magnetite; very trace orange-brown siltstone; reaction to acid: none to very weak	very trace quartz, very trace calcite, very trace serpentine, very trace green serpentinization on plagioclase laths	subangular chips up to 1.5 cm
3,430 - 3,440	1,045.5 - 1,048.5	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with up to 1 mm sized plagioclase laths, some magnetite; reaction to acid: none to very weak	very trace quartz, very trace calcite vein, very trace green serpentinization on plagioclase laths	subangular chips up to 0.8 cm

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-13
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
3,440 - 3,450	1,048.5 - 1,051.6	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black and white diabase with <1 mm sized plagioclase laths, some magnetite; very trace orange-brown siltstone; very trace dark gray foliated schist; reaction to acid: none	very trace white quartz, very trace green serpentinization on plagioclase laths, very trace potassic alteration	subangular chips up to 0.8 cm; washed sample is very dark gray [N3]
3,450 - 3,460	1,051.6 - 1,054.6	Diabase; grayish brown [2.5Y5/2]; well lithified; black diabase with <1 mm sized plagioclase laths, some magnetite; trace silvery dark gray schist; very trace greenish-white quartz vein; reaction to acid: none		subangular chips up to 0.7 cm; washed sample is very dark gray [N3]; very trace metal pieces
PINAL SCHIST (pCpi)				
3,460 - 3,470	1,054.6 - 1,057.7	Schist and diabase; light yellowish brown [2.5Y6/4]; well lithified; 50% black and white diabase with <1 mm sized plagioclase laths, trace magnetite; 10% silvery dark gray foliated schist; very trace pink quartz; reaction to acid: none	40% greenish-white vein quartz, trace green serpentinization on plagioclase laths, very trace white quartz	subangular chips up to 0.7 cm; washed sample is very dark gray [N3] and greenish-gray [10GY6/1]
3,470 - 3,480	1,057.7 - 1,060.7	diabase and quartz; grayish brown [2.5Y5/2]; well lithified; 40% black diabase with <1 mm sized plagioclase laths; 20% silvery dark gray schist with very trace foliated schist; very trace maroon siltstone; reaction to acid: none	40% greenish-white vein quartz, very trace iron oxide (hematite) on fracture surfaces, very trace serpentine, very trace epidote	subangular chips up to 0.9 cm; washed sample is very dark gray [N3] and greenish-gray [10GY6/1]
PRECAMBRIAN DIABASE (pCdiab)				
3,480 - 3,490	1,060.7 - 1,063.8	diabase; grayish brown [2.5Y5/2]; well lithified; 83% greenish-black diabase with <1 mm sized plagioclase laths, trace magnetite; 10% silvery dark gray schist; reaction to acid: none	7% greenish-white vein quartz, trace green serpentinization on plagioclase laths, very trace white quartz, very trace epidote, very trace iron oxide (hematite)	subangular chips up to 0.8 cm; washed sample is very dark gray [N3]
PINAL SCHIST (pCpi)				
3,490 - 3,500	1,063.8 - 1,066.8	Quartz; grayish brown [2.5Y5/2]; well lithified; 9% dark gray schist; 1% black diabase, very trace pinkish-white quartz; reaction to acid: very weak	90% greenish-white vein quartz, very trace calcite, very trace pyrite	subangular chips up to 0.8 cm; washed sample is very dark gray [N3] and greenish-gray [10GY6/1]
PRECAMBRIAN DIABASE (pCdiab)				
3,500 - 3,510	1,066.8 - 1,069.8	Diabase; dark greenish gray [10Y4/1]; well lithified; black diabase with <1 mm sized plagioclase laths; reaction to acid: very weak	very trace iron oxide (hematite), very trace calcite, very trace pyrite, very trace greenish-white vein quartz	subangular chips up to 0.3 cm; washed sample is very dark gray [N3]
3,510 - 3,520	1,069.8 - 1,072.9	Diabase; dark greenish gray [10Y4/1]; well lithified; greenish-black diabase with <1 mm sized plagioclase laths, some magnetite; reaction to acid: none to very weak	very trace calcite, very trace green serpentinization on plagioclase laths	subangular chips up to 0.8 cm; washed sample is very dark gray [N3]

LITHOLOGIC DESCRIPTION OF DRILL CUTTINGS FROM HYDROGEOLOGIC TEST WELL DHRES-13
Resolution Copper Mining
Pinal County, Arizona

DEPTH INTERVAL (feet)	DEPTH INTERVAL (meters)	GENERAL DESCRIPTION	SECONDARY FEATURES	COMMENTS
PRECAMBRIAN DIABASE (pCdiab)				
3,520 - 3,530	1,072.9 - 1,075.9	Diabase; dark greenish gray [10Y4/1]; well lithified; greenish-black diabase with <1 mm sized plagioclase laths, some magnetite; very trace pinkish-white quartz; reaction to acid: none to very weak	trace green serpentinization on plagioclase laths, very trace calcite, very trace white quartz, very trace bronzy cubic pyrite	subangular chips up to 0.7 cm; washed sample is very dark gray [N3]
3,530 - 3,540	1,075.9 - 1,079.0	Diabase; dark greenish gray [10Y4/1]; well lithified; greenish-black diabase with <1 mm sized plagioclase laths, some magnetite; reaction to acid: none to weak	trace green serpentinization on plagioclase laths, very trace calcite, very trace bronzy cubic pyrite	subangular chips up to 1.7 cm; washed sample is very dark gray [N3]
3,540 - 3,550	1,079.0 - 1,082.0	Diabase; dark greenish gray [10Y4/1]; well lithified; greenish-black diabase with <1 mm sized plagioclase laths, trace magnetite; reaction to acid: weak	trace calcite, very trace green serpentinization on plagioclase laths, very trace epidote	subangular chips up to 0.9 cm; washed sample is very dark gray [N3]
3,550 - 3,560	1,082.0 - 1,085.1	Diabase; grayish brown [2.5Y5/2]; well lithified; greenish-black diabase with <1 mm sized plagioclase laths, trace magnetite; reaction to acid: weak	trace calcite, trace green serpentinization on plagioclase laths, very trace iron oxide (hematite)	subangular chips up to 0.7 cm; washed sample is very dark gray [N3]
3,560 - 3,571	1,085.1 - 1,088.4	Diabase; dark greenish gray [10Y4/1]; well lithified; greenish-black diabase with <1 mm sized plagioclase laths, trace magnetite; very trace orange-brown siltstone; very trace pink quartzite; reaction to acid: very weak	trace calcite, very trace green serpentinization on plagioclase laths	subangular chips up to 0.7 cm; washed sample is very dark gray [N3]

APPENDIX B-1. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-12

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
1-Dec	DHRES-12	E. Jung	0.00	0.00	0.00	0.00	Mobilization to DHRES-12 continues. Drill rig was safely mobilized to site at 0945hrs. Currently mobilizing accessory equipment. Anticipate complete site set-up by Friday afternoon.	Demobilization	N/A	N/A
2-Dec	DHRES-12	E. Jung	0.00	0.00	0.00	0.00	Mobilization of accessory equipment continues. Anticipate complete site set-up and final inspections by tomorrow afternoon.	Mobilization	N/A	N/A
3-Dec	DHRES-12	D. Stalling	0.00	0.00	0.00	0.00	Completed site set up. Drill site passed final inspection with RCM and Peeks Performance. Drill crew is setting up to drill surface casing. Anticipate drilling to commence late this evening.	17.5" Tri-Cone Starter bit	N/A	N/A
4-Dec	DHRES-12	D. Stalling	6.10	20.00	6.10	20.00	Drilled to 6.1m then cemented 12in surface casing at 0230hrs. Crew setup rig to drill RC utilizing air with a 9-7/8" hammer. Cement has been allowed to cure a minimum of 8hrs. Drilling to commence early this afternoon.	9-7/8" Hammer R/C	N/A	Paleozoic Limestone
5-Dec	DHRES-12	E. Jung	83.82	275.00	77.72	255.00	Drilling, making great progress. Penetration rate changed from ~1hr per rod, to currently 20min per rod in quartzite. Took surveys at 35m Inc 0.5°, and 59.43m Inc 0.25°.	10" Hammer R/C	N/A	Paleozoic Limestone to 75.6m. Quartzite (tan/white/pink quartz arenite): 75.6m - current. Distinct units to be named after further review.
6-Dec	DHRES-12	E. Jung	175.26	575.00	91.44	300.00	Drilling, making good progress with 20 min rods. Tripped for bit at 0130hrs. Took surveys at 89.9m, 120.4m, and 150.9m, all 0.0°.	10" Hammer R/C	N/A	Quartzite contact with the Diabase is at 115.8m. Diabase from 115.8-129.5m. Quartzite contact at 129.5m to current depth.

APPENDIX B-1. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-12

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
7-Dec	DHRES-12	E. Jung	191.72	629.00	16.46	54.00	Drilled and reamed in tight conditions from 175.25m - 187.44m. Took survey at 175.25m Inc 0.5°. Experienced cave in and hole became tight at 191.7m. Circulated/cleaned the hole, then advanced again to 191.7m where the drill string became stuck. Freed drill string, tripped out and removed roller reamers. Tripped in and hit bridge at 135m. Reamed through several bridges to 141.12m, where a high amount of subrounded, pebbly cave in was circulated out of hole. Penetrated to 190.5m. Tripped out of hole on standby while alternate plans for the hole are being discussed.	10" Hammer R/C	Hit water at 187.44m, producing ~10gpm.	Quartzite (pЄt)
8-Dec	DHRES-12	E. Jung	191.72	629.00	0.00	0.00	The decision was made to abandon the current drill hole due to extraordinarily poor formation conditions. A second drill hole attempt will be made ~3m away from current hole. Tripped in BQ rods - hit bridge at 132.58m and could not get past the bridge- then pumped 1830 gallons of cement into hole. Began re-organizing site while waiting for shipment of additional cement. Shipment arrived ~1200hrs. Currently setting up to mix and pump additional cement into hole.	10" Open hole	N/A	Quartzite (pЄt)
9-Dec	DHRES-12	E. Jung	0.00	0.00	0.00	0.00	Mixed and pumped cement to surface and abandoned hole at 1930hrs. Moved drill rig 3m forward and began reorganizing site to drill DHRES-13. Currently setting up site.	Mobilization	N/A	N/A

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
10-Dec	DHRES-13	D. Stalling	7.62	25.00	7.62	25.00	Site set up completed. Crew started drilling at 2400hrs. Anticipate casing to be set and cemented later tonight.	17.5" Tri-Cone Starter bit	N/A	Paleozoic Limestone
11-Dec	DHRES-13	D. Stalling	12.80	42.00	5.18	17.00	Cemented sfc at midnight, tripped in 12-1/4" tri cone at 1030hrs to commence drilling. Drilled to 12.8m and immediately lost circulation. Driller reported ~1.2m void to 14.9m. Crew is using hole plug to attempt to regain circulation.	12-1/4" Tri-Cone Conventional Mud	Lost circulation and 4000gal of fluid shortly after drilling commenced. No returns.	Paleozoic Limestone
12-Dec	DHRES-13	E. Jung	18.29	60.00	5.49	18.00	Drilled to 16.76m with ~30% returns. Pulled back and on standby until water supply could be coordinated. Added hole plug and regained 100% returns. Resumed drilling at 1100hrs to 18.29m. Lost circulation to 30% while drilling. Tripped out of hole and added hole plug. Slow circulated and added hole plug while slowly tripping in until bottom of hole reached at 1600hrs. Resumed drilling with 90+ percent returns. Currently drilling.	12-1/4" Tri-Cone Conventional Mud	Lost ~100gal per min when drilling commenced (30% returns). Added hole plug until circulation regained.	Paleozoic Limestone: 90% brown calcareous siltstone; 10% gray and tan-brown limestone; trace white limestone. 12.19-15.24m: common calcite and calcite veining up to 0.6cm.
13-Dec	DHRES-13	A. Jergenson	63.70	209.00	45.42	149.00	Drilled down to 30m and tripped out collars; added roller reamers. Tripped back into hole and reamed from 18-30m. Drilled down to 63m with 100% returns. Surveys taken at 30 and 60m with inclinations of 0.5 and 0°. Currently drilling and making good progress.	12-1/4" Tri-Cone Conventional Mud	Receiving 100% returns.	Paleozoic Limestone: at 40m formation is yellow and red calcite-rich siltstone.
14-Dec	DHRES-13	E. Jung	94.18	309.00	30.48	100.00	Circulation dropped to 30% returns at 65.52m. Stopped drilling at 76.67m and added hole plug to the annulus with no success. Tripped out collars and added hole plug to drill hole. Tripped in while slow circulating and working hole plug into formation. Drilled to 94.18m with ~30% returns and loosing ~100gpm. Took survey at 91.43m Inc 0.25°. Had discussion with Baroid mud engineer - currently coordinating delivery and use of additional LCM's to control mud loss.	12-1/4" Tri-Cone Conventional Mud	Started losing ~100gpm at 65.52m with 30% returns. Currently working on solutions to mud loss.	Paleozoic Limestone. Recent cuttings are under review.

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
15-Dec	DHRES-13	E. Jung	166.12	545.00	71.93	236.00	Added Baroseal, N-seal, and Drilling Paper to control loss. Circulation improved to ~50% returns. Drilling with a penetration rate of 1hr rods. Took surveys at 121.91m Inc 0.0°, and 152.4m Inc 0.25°. Experienced minor break-down on rig at 1200hrs. Currently conducting repairs.	12-1/4" Tri-Cone Conventional Mud	Loosing ~2,600gal per hour with more than 50% fluid returns.	Paleozoic Limestone to 83.8m. Quartzite from 83.8m to 94.48m. No returns from 94.48m to 112.77m. Quartzite/Diabase mix from 112.77m to 131m. Quartzite from 131m to current.
16-Dec	DHRES-13	D. Stalling	204.22	670.00	38.10	125.00	Drilling with good progress; bore hole is stabilizing. With good returns decision has been made to continue drilling conventional instead of tripping out and switching over to flooded reverse. Currently 51hrs on bit. Took survey at 182.9m Inc 0°.	12-1/4" Tri-Cone Conventional Mud	Reporting near full returns and minor fluid losses of 150-170gal/hr.	Quartzite contact with Diabase at 190.5m, common oxidation.
17-Dec	DHRES-13	J.Kent	243.69	799.50	39.47	129.50	Drilling, making good progress. Took survey at 213m Inc 0°. Experienced increased fluid loss at 0845hrs from the lost circulation zone at ~12.8m. Decision has been made to switch over to flooded reverse to minimize fluid loss. Currently switching over to drill flooded reverse.	12-1/4" Tri-Cone Conventional Mud	Increased fluid loss occurred at 0845hrs, decision was made to switch over to flooded reverse.	Diabase contact with Quartzite at 237m. Quartzite continues to 243.69m.
18-Dec	DHRES-13	D. Stalling	243.69	799.50	0.00	0.00	Crews finished mobilizing equipment and setting up to drill flooded reverse by 0400hrs. Anticipate drilling to commence by 1400hrs, currently tripping in.	12 1/4" Tri-Cone Flooded Reverse	N/A	Diabase contact with Quartzite at 237m. Quartzite continues to 243.69m.
19-Dec	DHRES-13	E. Jung	299.62	983.00	55.93	183.50	Began drilling flooded reverse at 1700hrs, with a penetration rate of 2hrs per rod. Took survey at 274.3m Inc 0.0°. Currently drilling with no fluid loss.	12 1/4" Tri-Cone Flooded Reverse	Mud conditions are stable. Fluid level in hole is being maintained below 12.8m. No fluid loss reported.	Quartzite: Medium grained, with common iron oxide.
20-Dec	DHRES-13	E. Jung	360.58	1183.00	60.96	200.00	Drilling, making great progress. Penetration rate is ~1.5hrs per rod. Took surveys at 304.8m Inc 0.75°, and 335.26m Inc 1.25°. Plan for geophysical logging to occur at 1230hrs tomorrow. Currently drilling.	12 1/4" Tri-Cone Flooded Reverse	Mud conditions are stable. Minimal fluid loss.	Quartzite to 323m. Pioneer Shale from 323m to current: Purple-brown quartzite/siltstone, with common iron oxide.

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
21-Dec	DHRES-13	E. Jung	399.90	1312.00	39.32	129.00	Drilled to 399.9m and began tripping out for geophysical logging at 0430hrs. Took survey at 365.74m Inc 2.25°. Geophysical logging team arrived at 1230hrs and began logging hole. When logging is complete, crew will lay down the mast, weld a temporary cover on the borehole, and complete site preparation for holiday break. Currently conducting geophysical logging.	12 1/4" Tri-Cone Flooded Reverse	N/A	Pioneer Shale (pЄp)
22-Dec	DHRES-13	J.Kent	399.90	1312.00	0.00	0.00	Completed final site inspection with BLY foreman. Secured site and locked all gates. Drill rigs will be down until January 10th.	12 1/4" Tri-Cone Flooded Reverse	N/A	Pioneer Shale (pЄp) contact with limestone at ~387m. Chips are currently under review.
10-Jan	DHRES-13	J.Kent	399.90	1312.00	0.00	0.00	Crew completed site set up and monthly inspections. Set up and started to trip in BHA when a hydraulic line went out. Currently working on hydraulic line, anticipate tripping back into the hole later this evening.	12 1/4" Tri-Cone Flooded Reverse	N/A	Limestone
11-Jan	DHRES-13	A. Jergenson	399.90	1312.00	0.00	0.00	Crew's completed repairs to the hydraulic lines, and resumed tripping into the hole. Hit bridge at 120m and could not get past it. Decision was made to switch over and drill conventional with the dual wall rods to try and break through the bridge. Had to switch out bad compressor in the morning which delayed operations for 3hrs. Resumed operations and broke through the bridge at 120m. Currently tripping into the hole, anticipate reaching bottom this evening.	12 1/4" Tri-Cone Conventional (drilling conventional with dual wall rods)	N/A	Limestone
12-Jan	DHRES-13	J.Kent	399.90	1312.00	0.00	0.00	Crew encountered another bridge at 164m, and plugged up the string while trying to get through. Tripped back 50m and cleared the drill sting. Resumed back down the hole and advanced 9m before getting plugged up again. Crew currently tripping out of the hole to inspect the drill string and bit.	12 1/4" Tri-Cone Conventional (drilling conventional with dual wall rods)	N/A	Limestone

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
13-Jan	DHRES-13	J.Kent	399.90	1312.00	0.00	0.00	Completed tripping out of the hole, and the bit was plugged up with clay and rocks. Switched over to a conventional style tri cone bit, and tripped back into the hole to work through the bridge at 173m. Worked through bad zone and made it down by 0400hrs. Tripped out of the hole and switched to a flooded reverse tri cone bit and commenced tripping back in to drill. Anticipate drilling this evening 1700hrs.	12 1/4" Tri-Cone Flooded Reverse	N/A	Limestone
14-Jan	DHRES-13	J.Kent	402.95	1322.00	3.05	10.00	Completed tripping into the hole and commenced drilling at 1100hrs. Encountered several bridges while tripping into the hole, required to circulate on every rod to break through.	12 1/4" Tri-Cone Flooded Reverse	Mud is in good condition, and fluid loss is minimal.	Limestone
15-Jan	DHRES-13	J.Kent	459.94	1509.00	57.00	187.00	Completed drilling to TD at 1015hrs. Took survey at 459m Inc 3°. Currently circulating on the hole in preparation for geophysical logging. Anticipate logging the hole this evening.	12 1/4" Tri-Cone Flooded Reverse	Mud is in good condition. While circulating on the hole the crew will increase the viscosity to stabilize hole conditions.	Possible fault contact with quartzite evident by limestone/diabase mix from 423.7m to 426.7m, quartzite from 426.7m to 432.8m, Diabase from 432.8m to TD. Chips are under further review.
16-Jan	DHRES-13	E. Jung	459.94	1509.00	0.00	0.00	Geophysical logging was conducted between 2300hrs and 0715hrs. All tools were run successfully. Rigged up to install 7-5/8" casing and instrumentation. Began running casing and instrumentation at 1230hrs.	7-5/8" Casing with Instrumentation.	N/A	Diabase (pЄd).
17-Jan	DHRES-13	E. Jung	459.94	1509.00	0.00	0.00	Casing and instrumentation installation completed ~1400hrs. All four piezometers are operating correctly. Crew circulated on hole for 2 hrs. Halliburton arrived on site ~1600hrs for installation of pressure grout. Currently setting up to grout.	7-5/8" Casing with Instrumentation.	N/A	Diabase (pЄd).

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
18-Jan	DHRES-13	E. Jung	459.94	1509.00	0.00	0.00	Halliburton arrived on site at ~1600hrs, conducted safety meetings with M&A and Boart crews, and set up to install pressure grout. Installed grout from 1900hrs to 2045hrs, and demobilized from site. Grout was returned to surface during installation, and tagged at 2m below surface at 1130hrs. Crew is setting up to drill 6-3/4" flooded reverse, while on 72hr standby for grout to cure.	7-5/8" Casing with Instrumentation.	N/A	Diabase (pЄd).
19-Jan	DHRES-13	A. Jergenson	459.94	1509.00	-1476.76	-4845.00	Currently waiting for the grout to cure. Crews have been working on switching over to drill 6-3/4 flooded reverse, maintaining the rig/equipment, and housekeeping. Cement should be cured by 2100hrs Thusday night.	7-5/8" Casing with Instrumentation.	N/A	Diabase (pЄd).
20-Jan	DHRES-13	E. Jung	459.94	1509.00	-1488.03	-4882.00	Crew has been conducting maintenance and repairs while grout cures. Cure time for grout ends at 2100hrs. Crew will then trip in BHA to resume drilling flooded reverse, with 6-3/4" tricone.	7-5/8" Casing with Instrumentation.	N/A	Diabase (pЄd).
21-Jan	DHRES-13	J.Kent	459.94	1509.00	0.00	0.00	Completed waiting on cement for 72hrs at 0900hrs. Set up and tripped in BHA down to 182m. Currently working on hydraulic pumps, anticipate completing mechanical issues by late this evening.	6-3/4" Tri-Cone Flooded Reverse	N/A	Diabase (pЄd).
22-Jan	DHRES-13	D. Stalling	498.04	1634.00	38.10	125.00	Finished conducting hydraulic repairs on rig at 0430hrs. Crew tripped in to 431.3m to circulate down; tagged grout at 449.3m. Survey taken at 487.7m Inc. 2.5°. Currently drilling 1hr/rod.	6-3/4" Tri-Cone Flooded Reverse	Drilling with water.	Diabase contact with Upper Dripping Spring? at 466.3m. Gray-brown fine grain arkosic quartzite.
23-Jan	DHRES-13	E. Jung	528.52	1734.00	30.48	100.00	Survey tool became stuck ~1900hrs. Tripped out to recover tool, and discovered ~18m of cuttings inside drill collars. Recovered survey tool, cleared out collars, and began tripping in. Anticipate drilling to resume ~1600hrs. Crew will add polymers to fluid to increase viscosity/lubrication - to aid in lifting cuttings to surface.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Quartzite to 519m. Diabase, 519m to current.

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
24-Jan	DHRES-13	A. Jergenson	603.50	1980.00	-1441.70	-4730.00	Drilling making great progress. Penetration rate has been averaging ~1hr/rod. Surveys taken at 518.16m, Inc. 3°; 548.64m, Inc. 3.5°; and 579.12m, Inc 3.75°. Currently, 25 hours on tri-cone.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Contact with pink and white quartzite (Upper Dripping Springs?) at 540m. Contact with Diabase at 555m. Contact with white "clean" quartzite (Lower Dripping Springs?) at 570m. Contact with Diabase at 576m, Diabase to current depth (603.50m).
25-Jan	DHRES-13	E. Jung	662.64	2174.00	-1386.84	-4550.00	Drilling, making good progress. Took surveys at 609.6m Inc 3.5°, and 640m Inc 4.75°. Conducted repairs on the air swivel and slow feed pump. Currently drilling.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Diabase to 600.46m. Dripping Springs Quartzite from 600.46m to current.
26-Jan	DHRES-13	E. Jung	705.31	2314.00	42.67	140.00	Drilling, making good progress. Conducted repairs on the rod arm. Survey tool mis-fired and is suspect. Survey will be conducted when an alternate survey tool is obtained from nearby drill rig.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Dripping Springs Quartzite to 673.61m. Barnes Conglomerate from 673.61m to 682.73m. Pioneer Shale from 673.61m to 694.94m. Diabase from 694.94m to current. All intervals contain trace pyrite, with higher yet still trace amounts in Diabase.
27-Jan	DHRES-13	E. Jung	751.03	2464.00	45.72	150.00	Drilling, making good progress. Took surveys at 705.27m Inc 5.0°, and 762m Inc 5.0°. 72hrs on bit - anticipate trip for bit change tonight.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Diabase, with very trace pyrite.
28-Jan	DHRES-13	J.Kent	802.84	2634.00	51.82	170.00	Drilling, making good progress. Took survey's at 762m Inc 4.5°, and 792m Inc 5°. Started tripping out of the hole for a new bit at 0430hrs. Currently tripping out of the hole. Anticipate drilling late tonight, early tomorrow morning.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite. Jonovich onsite pumping out fluids from the baker tank.	Diabase contact with Pioneer Shale at 777.24m. Currently in Pioneer Shale.
29-Jan	DHRES-13	D. Stalling	828.45	2718.00	25.60	84.00	Commenced drilling at 0450hrs. Penetration rate is 1-1.5 hrs/rod. Currently using drop assembly with decreased weight on bit to reduce inclination. Survey taken at 822.9m Inc. 6.5°. After last survey, driller again decreased weight on bit to attempt to reduce inclination.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Diabase contact with Pioneer Shale at 777.24m. Currently in Pioneer Shale.

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
30-Jan	DHRES-13	E. Jung	869.59	2853.00	41.15	135.00	Drilling, making good progress. Penetration rate had been averaging 1-1/2hrs per rod. Took surveys at 823m Inc 6.5°, and 853.4m Inc 7.0°. Had been drilling with 400-450psi on the bit with a resultant increase in inclination. Will now increase to 700psi to observe response.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Pioneer Shale (pЄps) to 862.58m. Diabase (pЄd) with trace pyrite, from 862.58m to 865.63m. Pioneer Shale (pЄps) from 865.63m to current.
31-Jan	DHRES-13	E. Jung	921.41	3023.00	51.82	170.00	Drilling, making good progress. After increased weight on bit to 700psi, survey at 884m read 8.0° inclination. Reduced weight to 400-450psi. Subsequent survey at 914.36m read 7.75° inclination. Penetration rate has decreased to ~3hrs per rod. Currently 40hrs on bit.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Pioneer Shale (pЄps) to 871.75m. Pioneer Shale (pЄps) with high clay content from 871.75m to 883.92m. Possible Pinal Schist (pЄpi) with 10-20% milky qtz veins, from 883.92 to current. Cuttings under review.
1-Feb	DHRES-13	D. Stalling	945.79	3103.00	945.79	3103.00	Crew is conducting repairs and maintenance to hydraulic pumps on rig. Mechanics are on site to assist in repairs. Anticipate drilling to commence later tonight.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Pinal Schist
2-Feb	DHRES-13	E. Jung	978.71	3211.00	954.33	3131.00	Drilling with a penetration rate of 1.5hrs per rod. Took survey at 944.83m Inc 8.0°. Repaired hydraulic pump on drill rig. Currently tripping out to add a lift tube, in order to aid returns.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Pinal Schist (pЄpi)
3-Feb	DHRES-13	E. Jung	1009.80	3313.00	31.09	102.00	Added lift tube and resumed drilling with a penetration rate of ~4hrs per rod. Took surveys at 975m Inc 8.0°, and 1005.8m Inc 8.0°. Currently tripping for bit change with 83.3hrs on bit.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Pinal Schist (pЄpi) to 994m. Diabase (pЄd) from 994m to current.
4-Feb	DHRES-13	A. Jergenson	1009.80	3313.00	846.12	2776.00	Completed tripping out and placed on a new bit. Tripped in the BHA and rods down to 957m, had to stop and replace thread protectors. Commenced tripping in and reamed out hole from 957-1006m. Continued to trip to bottom, but lost circulation due to the string plugging up. Currently tripping out to find and fix cause of plugged up drill string.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Pinal Schist (pЄpi) to 994m. Diabase (pЄd) from 994m to current.

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
5-Feb	DHRES-13	D. Stalling	1009.80	3313.00	823.87	2703.00	Crew tripped in but, hit a bridge at 561.4m which repeatedly pluged the bit. Driller noted little progress but had slow returns. Currently working to drill through bridge.	6-3/4" Tri-Cone Flooded Reverse	Drilling utilizing polymers with no bentonite.	Diabase (pЄd)
6-Feb	DHRES-13	E. Jung	1009.80	3313.00	0.00	0.00	Added bentonite clays to drilling fluid to attempt to improve returns and hole stabilization. Experienced continued plugging while trying to work through bridge near 561.4m. Tripped out to remove 10.6m of cuttings from BHA. Circulated to bridge with continued problems plugging up. Worked past bridge by 1200hrs. Currently at ~735m, circulating slowly to bottom.	6-3/4" Tri-Cone Flooded Reverse	Drilling using bentonite clays and polymers. Mud conditions are stable.	Diabase (pЄd)
7-Feb	DHRES-13	E. Jung	1009.80	3313.00	0.00	0.00	Hit a bridge and plugged up at 671m. Tripped out 30.48m and circulated to clear bit. Tripped in, drilled through bridge and encountered fill at 996m. Worked slowly through fill and lost circulation/plugged up. Tripped out 61m, cleared plug, and switched over to conventional drilling, using dual wall rods. Tripped in to 993m. Currently circulating, and slowly working down the last 12m to bottom of hole.	6-3/4" Tri-Cone Conventional Mud (using dual wall drill pipe)	Mud conditions are stable.	Diabase (pЄd)
8-Feb	DHRES-13	E. Jung	1046.68	3434.00	36.88	121.00	Drilled through fill and reached the bottom of hole at0230hrs. Currently drilling with a penetration rate of 2.5 - 3 hrs per rod.	6-3/4" Tri-Cone Conventional Mud (using dual wall drill pipe)	Mud conditions are stable.	Diabase (pЄd)
9-Feb	DHRES-13	E. Jung	1046.68	3434.00	0.00	0.00		6-3/4" Tri-Cone Conventional Mud (using dual wall drill pipe)	Mud conditions are stable.	
10-Feb	DHRES-13	J.Kent	1088.44	3571.00	10.97	36.00	TD hole at 1900hrs, 1088.44m. Tripped out for geophysical logging. Logging team arrived at 0700hrs. Combo tool, Sonic, and ABI have all been run successfully. Currently running E-log.	6-3/4" Open Hole	N/A	Diabase (pЄd) to TD, 1088.4m.

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
11-Feb	DHRES-13	D. Stalling	1088.44	3571.00	0.00	0.00	All geophysics were run successfully. Crews tripped in 660m of 4 1/2" casing and are currently setting up to run the casing hangar. Casing hangar will be set at 423.7m later tonight. Well development will be conducted early tomorrow morning.	6-3/4" Open Hole	N/A	Diabase (pЄd) to TD, 1088.4m
12-Feb	DHRES-13	D. Stalling	1088.44	3571.00	0.00	0.00	Casing was successfully set at 1900hrs. Crew tripped out hangar tool and tripped in rods to 333.6m to begin well development. Air lift tests began at ~0930hrs with good results. Currently conducting air lift tests.	Well Development	Air lift test from 292.6m with production averaging 17gpm. Water parameters at 0922hrs: pH: 8.28, EC: 3021 µS, T: 20.8°C, ORD: 98mV. Water parameters at 1622hrs: pH: 8.67, EC: 1000 µS, T: 29.0°C, ORD: -8mV. Air lift will continue until parameters stabilize further.	Diabase (pЄd) to TD, 1088.4m
13-Feb	DHRES-13	E. Jung	1088.44	3571.00	0.00	0.00	Air lift and recovery tests completed at 0330hrs. Tripped out of hole and began rigging down site. Anticipate drill rig mobilization to West Plant tomorrow am. Currently rigging down.	Mobilization	Water level at 0315hrs was ~210.68m bls.	Diabase (pЄd) to TD, 1088.4m
14-Feb	DHRES-13	E. Jung	1088.44	3571.00	489.81	1607.00	Mobilization of the drill rig from site to West Plant laydown yard was completed safely. Currently breaking down the site and mobilizing auxiliary equipment to #9 laydown yard.	Mobilization	N/A	N/A
15-Feb	DHRES-13	J.Kent	1088.44	3571.00	436.17	1431.00	Mobilizing auxiliary equipment to shaft #9. Currently on site there is the 21k baker tank that will be mobilized later in the week. The laydown yard has three wood crates, and the cement mixer. Drill rig is being worked on at the West Plant laydown yard.	Mobilization	N/A	Diabase
16-Feb	DHRES-13	J.Kent	1088.44	3571.00	0.00	0.00	Mobilization continues to shaft #9 laydown yard. Drill rig repairs are still being done, anticipate mobilizing the rig to shaft #9 tomorrow.	Mobilization	N/A	N/A

APPENDIX B-2. DAILY DRILLING REPORT SUMMARY FOR HYDROLOGIC TEST WELL DHRES-13

Date	Hole #	Reporter	Shift Change Depth (m)	Shift Change Depth (ft)	Progress in last 24 Hrs (m)	Progress in last 24 Hrs (ft)	Comments	Hole Type/Size	Hydro Data	Geology
17-Feb	DHRES-13	J.Kent	1088.44	3571.00	0.00	0.00	Mobilization of auxiliary equipment, and site reclamation are near completion. Anticipate mobilizing the drill rig to shaft #9 later this afternoon. Final walk through of the drill site will be completed tomorrow morning.	Mobilization	N/A	N/A

HALLIBURTON

KENNECOTT UTAH COPPER CORP

DHRES 13

Pinal County , Arizona

Cement Surface Casing

17-Jan-2011

Job Site Documents

HALLIBURTON

Cementing Job Summary

The Road to Excellence Starts with Safety

Sold To #: 303273	**Ship To #:** 2830455	**Quote #:**	**Sales Order #:** 7907210
Customer: KENNECOTT UTAH COPPER CORP		**Customer Rep:** Jung, Erik	
Well Name: DHRES	**Well #:** 13		**API/UWI #:**
Field:	**City (SAP):** SUPERIOR	**County/Parish:** Pinal	**State:** Arizona
Contractor: Major	**Rig/Platform Name/Num:**		
Job Purpose: Cement Surface Casing			
Well Type: Development Well	**Job Type:** Cement Surface Casing		
Sales Person: KIDDOO, JUSTIN	**Srvc Supervisor:** DOBBS, GARY	**MBU ID Emp #:** 122012	

Job Personnel

HES Emp Name	Exp Hrs	Emp #	HES Emp Name	Exp Hrs	Emp #	HES Emp Name	Exp Hrs	Emp #
AXT, STEPHEN Gary	6	434802	DOBBS, GARY D	6	122012	ETCITTY, JERRY	6	227876
MARTIN, EHLER Dean	6	458474						

Equipment

HES Unit #	*Distance-1 way*	HES Unit #	*Distance-1 way*	HES Unit #	*Distance-1 way*	HES Unit #	*Distance-1 way*

Job Hours

Date	*On Location Hours*	Operating Hours	Date	*On Location Hours*	Operating Hours	Date	*On Location Hours*	Operating Hours
1/17/11	6	4.5						
TOTAL					*Total is the sum of each column separately*			

Job

Formation Name					
Formation Depth (MD)	**Top**		**Bottom**		
Form Type		**BHST**			
Job depth MD	1510. ft	**Job Depth TVD**	1510. ft		
Water Depth		**Wk Ht Above Floor**			
Perforation Depth (MD)	*From*		**To**		

Job Times

	Date	Time	Time Zone
Called Out	16 - Jan - 2011	11:00	MST
On Location	17 - Jan - 2011	12:00	MST
Job Started	17 - Jan - 2011	19:03	MST
Job Completed	17 - Jan - 2011	20:40	MST
Departed Loc	17 - Jan - 2011	22:00	MST

Well Data

Description	New / Used	Max pressure psig	Size in	ID in	Weight lbm/ft	Thread	Grade	Top MD ft	Bottom MD ft	Top TVD ft	Bottom TVD ft
12 1/4" Surface Open Hole				12.25				.	1310.		
12 1/4" Surface Open Hole				12.25				1310.	1510.		
7 5/8" Surface Casing	Unknown		7.625	6.969	26.4			.	1510.		

Sales/Rental/3rd Party (HES)

Description	Qty	Qty uom	Depth	Supplier
SHOE,GID,7 5/8 8RD	1	EA		
CLR,FLT,7-5/8 8RD 24-33.7PPF,2-3/4SSII	1	EA		
PLUG,CMTG,TOP,7 5/8,HWE,6.24 MIN/7.13 MA	1	EA		
SUGAR, GRANULATED, IMPERIAL	200	LB		
KIT,HALL WELD-A	2	EA		
SHIPPING OF FLOAT EQUIPMENT	1	EA		

Tools and Accessories

Type	Size	Qty	Make	Depth	Type	Size	Qty	Make	Depth	Type	Size	Qty	Make
Guide Shoe					**Packer**					**Top Plug**			
Float Shoe					**Bridge Plug**					**Bottom Plug**			
Float Collar					**Retainer**					**SSR plug set**			
Insert Float										**Plug Container**			
Stage Tool										**Centralizers**			

Miscellaneous Materials

HALLIBURTON

Cementing Job Summary

Gelling Agt		Conc		Surfactant		Conc		Acid Type		Qty		Conc	%
Treatment Fld		Conc		Inhibitor		Conc		Sand Type		Size		Qty	

Fluid Data

Stage/Plug #: 1

Fluid #	Stage Type	Fluid Name	Qty	Qty uom	Mixing Density lbm/gal	Yield ft3/sk	Mix Fluid Gal/sk	Rate bbl/min	Total Mix Fluid Gal/sk
1	CHEMICAL WASH	CHEMICAL WASH - SBM (21914)	20.00	bbl	8.4	.0	.0	5.0	
2	Fresh Water Spacer		10.00	bbl	8.33	.0	.0	5.0	
3	Specialized Pressure Grout	CMT - PREMIUM - CLASS G, 94 LB SK (100003685)	205.0	sacks	10.8	4.42	28.19	5.0	28.19
	94 lbm	CMT - PREMIUM - CLASS G REG OR TYPE V, BULK (100003685)							
	30 %	BENTONITE, BULK (100003682)							
	28.187 Gal	FRESH WATER							
4	Tail Slurry	CMT - PREMIUM - CLASS G, 94 LB SK (100003685)	95.0	sacks	15.8	1.15	4.99	5.0	4.99
	94 lbm	CMT - PREMIUM - CLASS G REG OR TYPE V, BULK (100003685)							
	4.989 Gal	FRESH WATER							
5	Fresh Water Displacement		70.00	bbl	8.33	.0	.0	5.0	

Calculated Values		Pressures		Volumes					
Displacement	69.7	Shut In: Instant	988	Lost Returns		Cement Slurry	175	Pad	
Top Of Cement	0	5 Min		Cement Returns	30	Actual Displacement	70	Treatment	
Frac Gradient		15 Min		Spacers	30	Load and Breakdown		Total Job	

Rates							
Circulating	4	Mixing	4	Displacement	3	Avg. Job	4

Cement Left In Pipe	Amount	20 ft	Reason	Shoe Joint

Frac Ring # 1 @	ID	Frac ring # 2 @	ID	Frac Ring # 3 @	ID	Frac Ring # 4 @	ID

The Information Stated Herein Is Correct	Customer Representative Signature

HALLIBURTON

Cementing Job Log

The Road to Excellence Starts with Safety

Sold To #: 303273	**Ship To #:** 2830455	**Quote #:**	**Sales Order #:** 7907210
Customer: KENNECOTT UTAH COPPER CORP		**Customer Rep:** Jung, Erik	
Well Name: DHRES	**Well #:** 13		**API/UWI #:**
Field:	**City (SAP):** SUPERIOR	**County/Parish:** Pinal	**State:** Arizona
Legal Description:			
Lat: N 0 deg. OR N 0 deg. 0 min. 0 secs.		**Long:** E 0 deg. OR E 0 deg. 0 min. 0 secs.	
Contractor: Major	**Rig/Platform Name/Num:**		
Job Purpose: Cement Surface Casing			**Ticket Amount:**
Well Type: Development Well	**Job Type:** Cement Surface Casing		
Sales Person: KIDDOO, JUSTIN	**Srvc Supervisor:** DOBBS, GARY		**MBU ID Emp #:** 122012

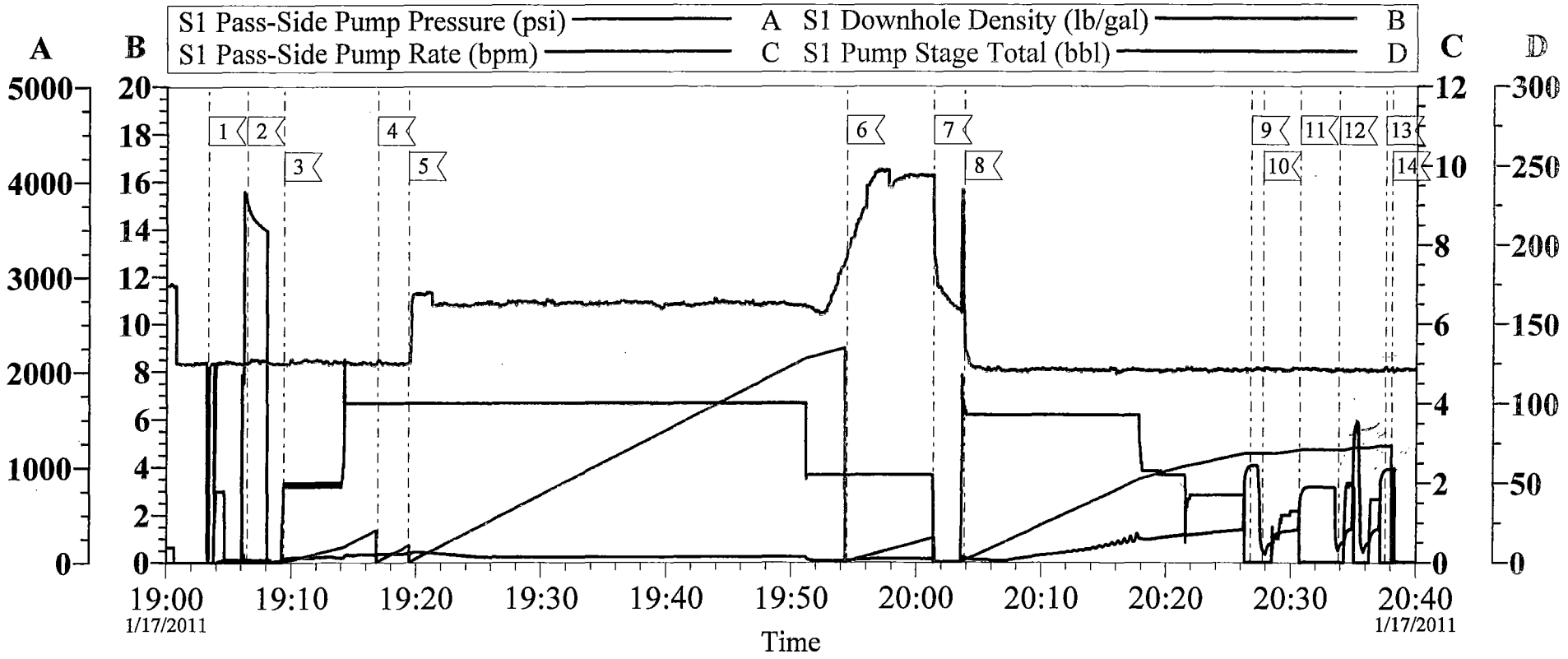
Activity Description	Date/Time	Cht #	Rate bbl/ min	Volume bbl		Pressure psig		Comments
				Stage	Total	Tubing	Casing	
Pre-Convoy Safety Meeting	01/16/2011 15:30							
Arrive at Location from Service Center	01/17/2011 12:00							
Assessment Of Location Safety Meeting	01/17/2011 12:05							
Wait on Customer or Customer Sub-Contractor Equip	01/17/2011 12:10							
Wait on Customer or Customer Sub-Contractor Equipm	01/17/2011 14:00							
Safety Meeting	01/17/2011 14:15							
Pre-Rig Up Safety Meeting	01/17/2011 17:15							
Rig-Up Equipment	01/17/2011 17:30							RIG UP PUMP TRUCK , 2 BULK TRUCKS & PICKUP
Pre-Job Safety Meeting	01/17/2011 18:40							
Start Job	01/17/2011 19:03							
Test Lines	01/17/2011 19:06					3500. 0		
Pump Spacer 1	01/17/2011 19:09		3	20			34.0	CHEM WASH
Pump Spacer 2	01/17/2011 19:16		4	10			86.0	WATER
Pump Lead Cement	01/17/2011 19:19		4	161			93.0	PUMP LEAD CEMENT MIXED @ 10.8# / 4.42 YEILD / 28.18 GPS FRESH WATER
Activity Description	**Date/Time**	**Cht #**	**Rate bbl/ min**	**Volume bbl**		**Pressure psig**		**Comments**
				Stage	**Total**	**Tubing**	**Casing**	

HALLIBURTON

Cementing Job Log

Pump Tail Cement	01/17/2011 19:54		4	15			23.0	PUMP TAIL CEMENT MIXED @ 15.8# / 1.15 YEILD / 4,99 GPS FRESH WATER
Drop Top Plug	01/17/2011 20:01							
Pump Displacement	01/17/2011 20:03		3.5	50			53.0	WATER
Bump Plug	01/17/2011 20:26		2	20	70		335.0	WATER
Check Floats	01/17/2011 20:27						1019.0	FLOATS NOT HOLDING
Bump Plug	01/17/2011 20:30		1	1			1000.0	WATER
Check Floats	01/17/2011 20:33							FLOATS NOT HOLDING
Bump Plug	01/17/2011 20:37						977.0	
Shut In Well	01/17/2011 20:38						988.0	
End Job	01/17/2011 20:40							

KENNECOTT COPPER
DHRES #13 / 7 5/8 INTER.



Local Event Log

	Intersection	SPPP			Intersection	SPPP	
1	START JOB	19:03:22	-1.000	2	TEST LINES	19:06:28	3780
3	PUMP SPACER 1	19:09:25	33.73	4	PUMP SPACER 2	19:16:58	86.02
5	PUMP LEAD CEMENT	19:19:25	93.00	6	PUMP TAIL CEMENT	19:54:29	23.00
7	DROP PLUG	20:01:23	24.42	8	PUMP DISPLACEMENT	20:03:50	51.89
9	BUMP PLUG	20:26:47	1016	10	CHECK FLOATS	20:27:46	126.0
11	BUMP PLUG	20:30:43	650.6	12	CHECK FLOATS	20:33:50	149.2
13	BUMP PLUG	20:37:35	977.0	14	SHUT IN WELL	20:38:05	988.0

Customer:	KENNECOTT COPPER	Job Date:	17-Jan-2011	Sales Order #:	7907210
Well Description:	DHRES #13	Job Type:	INTER.	ADC Used:	YES
Customer Rep:	ERIC JUNG	Service Supervisor:	DONNY DOBBS	Operator/Pump:	JERRY ETCITTY / 11223557

OptiCem v6.4.9
17-Jan-11 21:04

HALLIBURTON

Field Ticket

Field Ticket Number:	7907210	*Field Ticket Date:*	Monday, January 17, 2011

Bill To:
KENNECOTT UTAH COPPER CORP
12000 WEST 2100 SOUTH SMELTER
MAGNA, UT 84044-0329

Ship To:
KENNECOTT UTAH COPPER CORP
DHRES, 13
2830455
SUPERIOR, AZ 85273

Job Name:	Kennecott DHRES-13 Surface Casing
Order Type:	Streamline Order (ZOH)
Well Name:	DHRES 13
Company Code:	1100
Customer PO No.:	NA
Shipping Point:	Farmington, NM USA 4109E Main
Sales Office:	Rocky Mountains BD
Well Type:	Gas
Well Category:	Development

Material	Description	QTY	UOM	Base Amt	Unit Amt	Gross Amount	Discount	Net Amount
7521	CMT SURFACE CASING BOM	1	JOB	0.00	0.00	0.00	55%	0.00
2	MILEAGE FOR CEMENTING CREW,ZI	720	MI	0.00	5.76	4,147.20	55%	1,866.24
	Number of Units	1						
1	ZI-MILEAGE FROM NEAREST HES BASE,/UNIT	720	MI	0.00	9.79	7,048.80	55%	3,171.96
	Number of Units	1						
16091	ZI - PUMPING CHARGE	1	EA	0.00	4,935.00	4,935.00	55%	2,220.75
	DEPTH	1510						
	FEET/METERS (FT/M)		FT					
76400	ZI MILEAGE,CMT MTLS DEL/RET MIN	360	MI	0.00	3.35	20,502.00	55%	9,225.90
	NUMBER OF TONS	17						
74038	ZI PLUG CONTAINER RENTAL-1ST DAY	1	EA	1,322.00	0.00	1,322.00	55%	594.90
	DAYS OR FRACTION (MIN1)	1						
3965	HANDLE&DUMP SVC CHRG, CMT&ADDITIVES,ZI	397	CF	0.00	5.49	2,179.53	55%	980.79
	NUMBER OF EACH	1						
132	PORT. DAS W/CEMWIN;ACQUIRE W/HES, ZI	1	JOB	0.00	1,649.00	1,649.00	55%	742.05
	NUMBER OF DAYS	1						
10	FOOD AND LODGING, ZI	2	DAY	0.00	653.00	5,224.00	55%	2,350.80
	NUMBER OF PERSONNEL ON JOB	4						
21914	CHEMICAL WASH	840	GAL	0.00	1.81	1,520.40	55%	684.18
100003685	CLASS G / PREMIUM	205	SK	0.00	40.42	8,286.10	55%	3,728.74
100003682	BENTONITE	57	SK	0.00	54.24	3,091.68	55%	1,391.26
100003685	CLASS G / PREMIUM	95	SK	0.00	40.42	3,839.90	55%	1,727.95

HALLIBURTON

Field Ticket

Field Ticket Number:	7907210	*Field Ticket Date:*	Monday, January 17, 2011

Bill To:
KENNECOTT UTAH COPPER CORP
12000 WEST 2100 SOUTH SMELTER
MAGNA, UT 84044-0329

Ship To:
KENNECOTT UTAH COPPER CORP
DHRES, 13
2830455
SUPERIOR, AZ 85273

Job Name:	Kennecott DHRES-13 Surface Casing
Order Type:	Streamline Order (ZOH)
Well Name:	DHRES 13
Company Code:	1100
Customer PO No.:	NA
Shipping Point:	Farmington, NM USA 4109E Main
Sales Office:	Rocky Mountains BD
Well Type:	Gas
Well Category:	Development

Material	Description	QTY	UOM	Base Amt	Unit Amt	Gross Amount	Discount	Net Amount
86955	ZI FUEL SURCHG-HEAVY TRKS >1 1/2 TON	720	MI	0.00	0.51	1,101.60		1,101.60
	Number of Units	3						
86954	ZI FUEL SURCHG-CARS/PICKUPS<1 1/2TON	720	MI	0.00	0.17	122.40		122.40
	Number of Units	1						
87605	ZI FUEL SURCHG-CMT & CMT ADDITIVES	360	MI	0.00	0.17	1,040.40		1,040.40
	NUMBER OF TONS	17						
372867	Cmt PSL - DOT Vehicle Charge, CMT	4	EA	0.00	241.00	964.00		964.00
7	ENVIRONMENTAL CHARGE,/JOB,ZI	1	JOB	0.00	134.00	134.00		134.00
8	IRON SAFETY INSPECTION SURCHARGE /JOB ZI	1	JOB	0.00	83.00	83.00		83.00
100004726	SHOE,GID,7 5/8 8RD	1	EA	0.00	601.00	601.00	55%	270.45
100004802	CLR,FLT,7-5/8 8RD 24-33.7PPF,2-3/4SSII	1	EA	0.00	1,327.00	1,327.00	55%	597.15
101236216	PLUG,CMTG,TOP,7 5/8,HWE,6.24 MIN/7.13 MA	1	EA	0.00	343.00	343.00	55%	154.35
100008028	SUGAR, GRANULATED, IMPERIAL	200	LB	0.00	6.44	1,288.00	55%	579.60
100005045	KIT,HALL WELD-A	2	EA	0.00	74.30	148.60	55%	66.87
45	SHIPPING OF FLOAT EQUIPMENT	1	EA	0.00	81.00	81.00		81.00
16092	ADDITIONAL HOURS (PUMPING EQUIPMENT), ZI	1	EA	0.00	1,071.00	2,142.00	55%	963.90
	HOURS	2						
				Totals	***USD***	**73,121.61**	**38,277.37**	**34,844.24**

Halliburton Rep: GARY DOBBS
Customer Agent: Erik Jung
Halliburton Approval

HALLIBURTON

Field Ticket

Field Ticket Number:	7907210	*Field Ticket Date:*	Monday, January 17, 2011

Bill To:
KENNECOTT UTAH COPPER CORP
12000 WEST 2100 SOUTH SMELTER
MAGNA, UT 84044-0329

Ship To:
KENNECOTT UTAH COPPER CORP
DHRES, 13
2830455
SUPERIOR, AZ 85273

Job Name:	Kennecott DHRES-13 Surface Casing
Order Type:	Streamline Order (ZOH)
Well Name:	DHRES 13
Company Code:	1100
Customer PO No.:	NA
Shipping Point:	Farmington, NM USA 4109E Main
Sales Office:	Rocky Mountains BD
Well Type:	Gas
Well Category:	Development

Material	Description	QTY	UOM	Base Amt	Unit Amt	Gross Amount	Discount	Net Amount

THIS OUTPUT DOES NOT INCLUDE TAXES. APPLICABLE SALES TAX WILL BE BILLED ON THE FINAL INVOICE.
CUSTOMER HEREBY ACKNOWLEDGES RECEIPT OF THE MATERIALS AND SERVICES DESCRIBED ABOVE AND ON THE ATTACHED DOCUMENTS.

X _____
Customer Signature

FIELD TICKET TOTAL: USD 34,844.24

Was our HSE performance satisfactory? **Y or N** *(Health, Safety, Environment)*
Were you satisfied with our Equipment? **Y or N**
Were you satisfied with our people? **Y or N**

Comments

Did we provide job DVA above our normal service today? **Y or N**
Hours: _____ Other: _____ Customer Initials: _____
Please provide details: