

APPENDIX T: Pressure Grouting Plan



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APPENDIX T

Pressure Grouting and Groundwater Inflow Control Plan

The Johnny Lee deposit is hosted by shale and argillaceous (shale-rich) dolomite of the Newland Formation. As such there are no true porous media aquifers in the host rock and water flow through the bedrock units is fracture / fault controlled. Pressure grouting will be the primary means of minimizing and controlling the amount of water flowing from water-bearing faults and fractures, into the mine workings. Pressure grouting involves injecting a cementaceous (cement, accelerator, and water with no aggregate) or water activated polymer-based resin grout material into fractured rock under pressure. The grout mixture would vary in composition depending on the hydraulic pressure encountered and the size of the fractures being sealed. Grout can be injected under pressure into the wall rock as much as 100 feet (30.4 m) depending on fracturing and type of grout used. Grouting both strengthens the rock and reduces water flow through fractures, and is a widely accepted standard practice in the mining industry for controlling mine inflow.

Pilot holes are typically drilled into the projected mine workings ahead of the advancing / active mining face and are used to test for larger water inflow rates in the vicinity of anticipated water-bearing geologic structures. Large amounts of water encountered in a pilot hole require installation of a packer to seal-off the flow of water from the hole followed by directional drilling and grouting of fractured wall rock adjacent to the projected workings prior to advancing the drift/tunnel through the zone.

In fracture flow controlled systems, mining into a water-filled fracture will typically see a significant decrease in hydrostatic head (and therefore flow rate) over periods of one to several days or less. Therefore, only sustained water flows of generally 10 to 20 gallons (38 to 76 L) per minute or larger are typically grouted off when detected in pilot holes. The assumption here is that flows will generally drop off to almost nothing in a couple of days or could be relatively easily grouted in mined out walls after mining through the fracture zone should they continue to flow. In general, individual fracture flows of greater than ~20 gallons per minute would be pressure grouted in advance of mining in most development workings. Most production mining stopes are generally not grouted (because of the cut and fill mining method). Sustained inflows into ventilation raises from distinct fractures are almost always grouted regardless of the inflow rate in order to minimize inflow into the raises.

Grouting equipment consists of a grout mixer, agitator, high-pressure grout pump, hoses, grout packer, and a drill hole collar standpipe. The mixer blends the grout with water in batches and

subsequently sends the grout to the agitator for storage. The grout pump draws from the agitator and injects the grout through the high-pressure hose and into the drill hole via the drill-hole standpipe and grout packer. The packer provides a seal against the perimeter of the drill hole while the grout pump builds up pressure in the drill hole to force complete penetration of grout into the ground cracks. Grouting can attain pressures between 1,000 to 2,500 psi (6.9 to 17.2 MPa). Surplus grout not used down the drill hole circulates back to the agitator for use in the next drill hole. When all the fractures intersected by all of the drill holes in the drilled pattern around the workings are grouted, a grout curtain is built around the drift/tunnel that forces water to flow around the workings and eliminates/minimizes water from entering the drift/tunnel.

Mining support equipment required for grouting consists of a drill jumbo, bolter, LHD loader, trucks, and auxiliary support equipment. The crew would consist of generally three miners: one to mix the grout, one to monitor the flow rate and pressure, and one at the face to insert the grout tube and seal the packer.

Tintina's pressure grouting program will be implemented so as to provide basic Black Butte Copper Project water needs, and to achieve water balance goals of minimizing consumptive use and required excess water treatment. Specifically, these goals include:

- Provide for a sustainable minimum mine groundwater inflow of 210 gpm (795 Lpm) (302,400 gallons per day) to meet consumptive use demands of the Project over the life-of-the mine,
- During the operational phase, cap the maximum daily quantity of water processed through the water treatment plant to 588 gpm (2,226 Lpm) (846,720 gallons per day) and cap the maximum flow rate through the RO system to 500 gpm (1,893 liters per minute) (720,000 gallons per day),
- Help maintain a consistent inflow rate to the water treatment plant operations in order to maintain plant efficiency and recovery;
- Grout off significant water flows (>588 gpm) encountered underground as soon as possible.

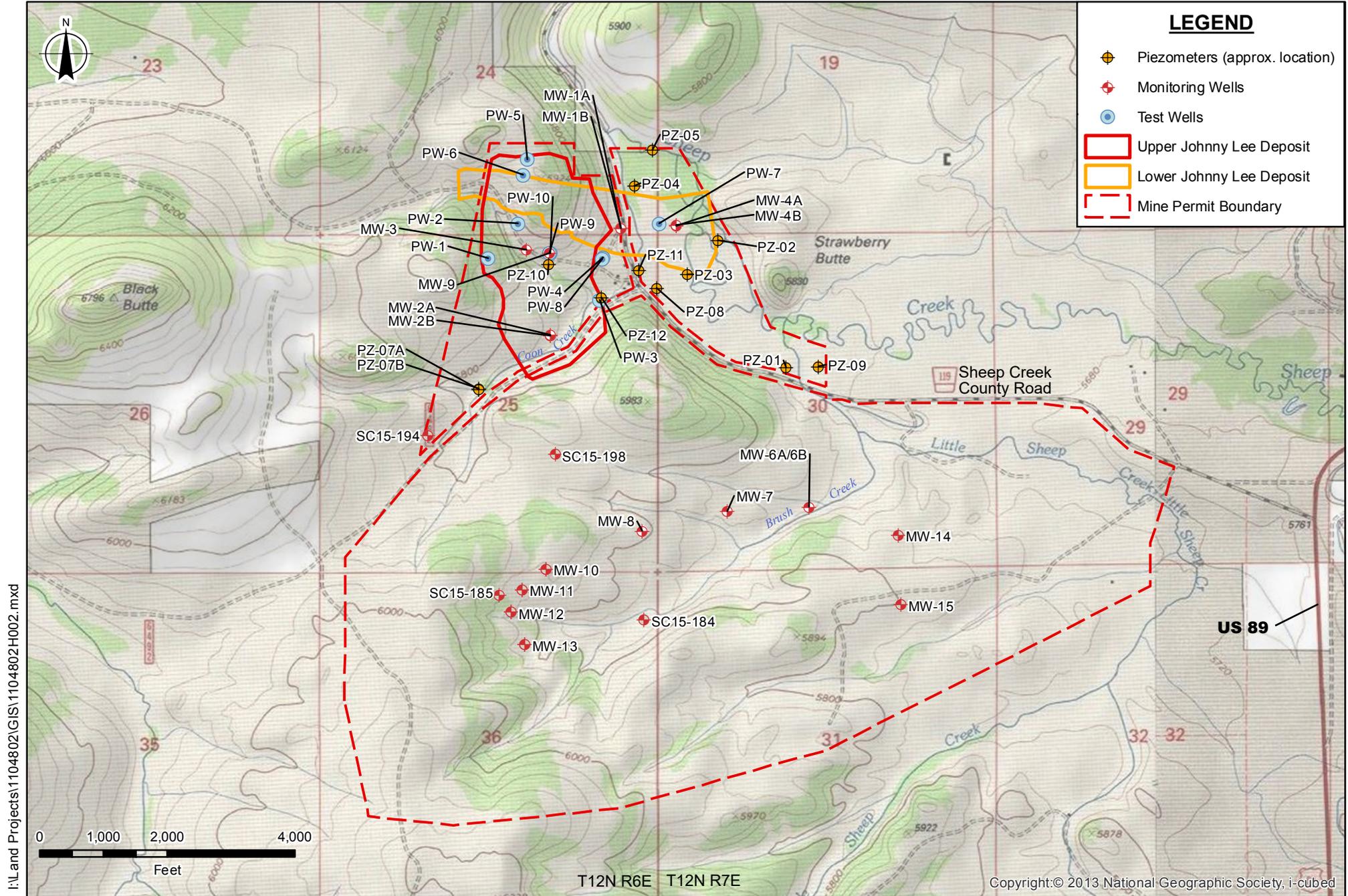
The procedure for identifying and grouting water inflows during advance of a decline or tunnel is as follows:

1. Prior to advancing a round (a distance of 15 feet (4.6 m) drill, blast and muck cycle), loose rock is scaled from exposed underground faces.
2. Ground support is installed as needed (e.g. rock bolts, steel sets, wire mesh, shotcrete, etc.).
3. A center hole, typically two or three round lengths (30-40 feet, 9.1-12.2 m), is drilled into the face.
4. If zero to <20 gpm (<76 Lpm) of water is encountered in the center hole, then drill out the remainder of the round (15 feet into face), load explosives, blast, and muck out round. Then repeat the previously described cycle again. When the water inflows <20 gpm (<76 Lpm) are mined through and fully exposed, grouting holes may be completed to seal off the water as needed.

5. If water >20 gpm (>76 Lpm) is encountered in the center hole, then plug the hole with a packer and begin the grout cycle.
6. The drill pattern to create a grout curtain around the projected workings depends upon the orientation (strike and dip) of the water-bearing structure. Generally, a ring of holes are fanned out around the projected advance of the drift/tunnel and into the structure at nominally 5 to 10 foot (1.5 to 3 m) spacing. Grout is injected after the drilling of each individual ring hole if high water inflows are encountered, and every other hole if flows are low. Holes are grouted around the ring in this fashion until there is no longer any flow from the grout ring drill holes. Once a grout curtain is built around the projection of the advancing tunnel/stope and the water-bearing structure is assumed to be sealed off, the regular blast pattern can be drilled, loaded with explosives, blasted, and mucked out. If dry, then repeat the previously described cycle again.
7. However, if water inflow is encountered after mucking, then scaling, ground support, and the grouting cycle would be repeated until the water inflow is again minimized or stopped; then the previously described mining cycle would continue.
8. Once the water-bearing structure is exposed in the mine workings, final grouting may be done as needed.

Coon Creek

The initial mine access decline will pass approximately 90 feet (27.4 m) below the Coon Creek tributary of Sheep Creek, approximately 2,312 feet (705 m) in from the portal. This is the closest proximity of the decline to the surface once beyond the portal. Shallow bedrock at test well PW-3 (located along the decline trend adjacent to Coon Creek (Figure 1) encountered minimal groundwater in its upper 75 feet (23 m), suggesting that dewatering of the deeper decline will have minimal impact on Coon Creek flow. Pumping tests of PW-3 and PW-4 showed no impacts to Coon Creek (Figure 1), nor did piezometers installed in wetlands associated with Coon Creek. Grouting of water producing fracture zones encountered at the decline level in the area underlying Coon Creek will minimize the potential for inflow into the underground workings and reduce or eliminate the potential for any reduction of surface water flow in Coon Creek resulting for the location of the underground decline.



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Date: February 2017, Source: Hydrometrics, Inc. (2017)



Figure 1
Groundwater Monitoring Sites
 Black Butte Copper Project
 Meagher County, Montana