BRODIE CONSULTING

MEMORANDUM

DATE: October 9, 2008

TO: Faro Mine

FROM: Faro TAT (Hockely, Scott, Healey, Slater, Gomm, Brodie)

SUBJECT: S-Well Groundwater Assessment & Recommendation

The Faro TAT met on Sept 22, 23 to evaluate water management issues at the Faro site. This memo presents an assessment of the groundwater situation at the S-Well area and recommendation for action.

Discussion

- Water from the shallow aquifer contains up to 400 mg/L zinc and appears to discharge to surface and distribute over wet area adjacent to the North Fork of Rose Creek. The surface discharge may be due to the wet conditions this year. There is a high probability that this water forms a diffuse surface discharge to Rose Creek. The appended figure and photographs show the extent and proximity of this wet area to Rose Creek.
- The water quality and pump test results were still being analyzed, but rough estimates were developed as follows:
    - Shallow aqufier – 15 gpm, 12 tonnes of zinc per year
    - Deep aquifer – 15-50 gpm, 20 tonnes of zinc per year.
- The rough estimates of loading from the shallow aquifer to NFRC gave reasonable agreement with the observed increases in zinc concentrations in NFRC during the past two winter low flow periods (+/- 0.1 mg/l)
- A second rough check on the total load draining via the S Well area is in reasonable agreement with the loading predicted in the site water quality model (27 tonnes/year of zinc).

The work as a whole confirms that the upper (shallow) aquifer in the S Wells area is currently contributing zinc to North Fork Rose Creek, either directly or via the surface discharge. The deep aquifer is likely to be a more significant source at some time in the future.

The TAT debated how the S-Well problem should be addressed. The following was noted:

- There is insufficient time remaining this year, and there may be permitting issues associated with most of the alternative mitigation strategies. The ground surface in the vicinity of the target capture area is too wet to construct the seepage capture trench that would be needed for the passive treatment method.
- The pump data (which was limited in scope due to discharge restrictions) leaves some question as to the sustainable discharge rate from the shallow and deep aquifers. Therefore it is not possible to design a "fully optimized" groundwater collection system. But it is possible to design a combination of sumps and use of the available wells to intercept a substantial proportion of the contamination shallow aquifer.
- If the shallow aquifer is intercepted, the next question is where to send the water. Water would need to be handled year-round. There is currently no capacity for year-round treatment. The water could be stored in either the Intermediate Pond or the Faro Pit:
    - If discharged to the Intermediate Pond, the S-Well water would make a very significant increase in the concentrations there, and add to both the volumes and loads treated each year from that source. The resulting increase in loading to the treatment plant would cause the average influent concentrations to exceed the currently assumed treatment capacity of 20 mg/L. In addition, storing this water in the Intermediate Pond would reduce the capacity available for containment of freshet runoff.
    - If discharged to the Faro Pit, the S-Well water would be diluted in the large volume, and average zinc concentrations in the pit would increase by about 1.5 mg/L per year. At that rate of increase, the currently assumed treatment capacity will be exceeded in 2-3 years.
- Discharge of S-Well water to the Faro Pit is the only practical option available at this time.

<u>The TAT recommends:</u>

- Collection of near surface aquifer water from S-Well area should be implemented as soon as practicable. In addition to the concerns about gradual increases in zinc loadings via

groundwater and the associated AMP requirements, the work this summer has shown that that there is a high likelihood of surface discharges. The water license prohibits discharge of water exceeding 0.5 mg/L zinc to Rose Creek and specifically references "all points of entry" which would include diffuse surface discharge from the S-Wells area.

- A conceptual S-Wells capture system is expected to consist of:
    - Install interim collection system this fall – sump/trench in upper aquifer, pump from 2 existing deep aquifer wells to the sump. Pump from sump to Faro Pit.
    - This would constitute a first phase of groundwater collection system that would be expanded/improved as necessary in 2009.
    - Opportunities for alternate treatment methods which would compliment the collection system should be investigated beginning in 2009.
    - Further details on the collection system components are described below.
- The water collected from the S-Well area should be directed to the Faro pit in the short term.
- Discharge of the S-Well water to the Faro Pit for more than two years will cause the currently estimated treatment capacity of the Faro mill system to be exceeded. Several options for the longer term management of the S-Well water need to be considered:
    - The basis for the current estimates of treatment capacity need to be re-examined, and options for upgrading the Faro mill system to treat the additional load should be considered.
    - The S-Well area will be a source of relatively low flow – high strength water, similar to the ETA interim collection system and to a lesser extent, the Zone II pit pumpback. In general, it is more efficient to collect and treat high strength sources directly rather than diluting them first. As the proportion of these low flow – high strength sources increases, storing and diluting them in the Faro Pit or Intermediate Pond becomes less efficient. Options for a separate treatment system for roughly 200 gpm of high strength sources should be considered.
    - The S-Well water will require year-round collection. The ETA water is in fact also a year-round source, and the current approach of collecting only the summer flow is a compromise. As the year-round proportion of the sources increases, the economics of instituting year-round treatment improve. Options for year-round treatment should be considered.

- Sludge generation will increase as the high strength sources are captured and treated. The implications for sludge production, handling and long-term management need to be considered in all of the above.

S Well Contaminated Water Collection System Components:

- A 2-3 m deep sump should be constructed to intercept the shallow aquifer and covered with an insulated shack.
- Two groundwater wells have variable rate pumps already installed. These should discharge to the sump. The well-heads and the piping from the wells to the sump will need to be insulated.
- A pump should be installed in this sump and sized to be capable of pumping 50 gpm to the Faro pit.
- Temporary (08/09 winter) power from a diesel generator situated on haul road above S-Wells. Fuel consumption is expected to be in the range of 2- 3 litres per hour. Capacity for up to 4 days (300 litres) would allow unattended operation over weekend periods through the winter.
- The collected water should flow via insulated but not heat traced pipeline to Faro Pit, see (attached figure). The pipeline must gravity drain in both directions if there is a system failure. Shallow sump collection of groundwater at about the rate expected here and discharge via an insulated (but not heat traced) pipeline a little less than 300 m long was conducted without freeze up for about 10 years at Colomac. A similar system also exists in two locations at the Giant mine, although the volumes and discharge distances are much smaller.
- Consider installing a steel section in the pipeline as it passes the generator. This would allow use of exhaust heat to warm the flow.
- A control system should be designed for subsequent integration into a sitewide system, The minimum components include:
    - Low water shut off
    - System off - warning light (= high water alert)
    - Remote alarm (to guardhouse – minimum, to pager or phone alert in Faro – strongly preferred)
    - Flow meter with totalizer

- An oxygen sensor is required at the shack as this system will be situated at the toe of an ARD rock pile, or staff should use personal gas monitors.