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TECHNICAL REVIEW
GALKENO WASTE WATER TREATMENT PLANT

Prepared for:

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1 Background

During 2007, Elsa Reclamation and Development Company completed an assessment of the performance of the Galkeno 300 Waste Water Treatment Plant (WWTP) and made recommendations for process improvements to both the treatment plant and the sludge management systems at the site. These improvements included:

- A new rapid mix tank to improve lime use efficiency
- A new tube settler clarifier to improve solids removal and sludge handling
- A new sludge storage basin to improve sludge management practice and assist in densification.

Overall, these changes have been positive and have allowed the system to operate in compliance with water licence conditions for much of the time since the changes were implemented in late 2007.

Since the construction of the new works, there have been several occasions where non-compliance has occurred. In order to assess the potential issues and deficiencies in the WWTP, SENES Consultants was retained by Access Consulting Group to review the design and make recommendations for improvements. Based upon this review, there are five primary issues that have arisen since the completion of the works that lead to non compliance. These are:

1. Operation on diesel generators. These systems must be shut down every 200 hours and result in the discharge of partially untreated water.

2. Peak flows during the freshet. For a period of about 1-3 weeks flows (late May – early June) increase for typical levels of <10 L/s to 20-40 L/s. These flows cannot be accommodated by the existing facilities.

3. Longer term flows above 10 L/s. During 2008, base flows have increased substantially from long term averages of about 8 L/s to 12-15 L/s. Although the plant can theoretically handle these flows (design flow was 15 L/s), it is clear that consistent levels of high flow cannot be adequately managed in the existing plant.

4. Suspended zinc losses from the sludge pond. This pond receives batch discharges from the clarifier underflow. These slug discharges on occasion appear to result in sludge loss from the pond (based upon monitoring data of the final discharge where non compliance often occurs when the clarifier and settling basin have good quality).

5. Poor hydraulic conditions in the clarifier due to differential settlement. Two items were noted: 1) The clarifier has settled on the foundation leading to elevation variances in the trough launders resulting in poor flow distribution over the launders and 2) this discharge pipe to the lagoon flows uphill causing the clarifier launders to flood making them ineffective for flow distribution.

The following report provides a summary review of our key findings and recommendations for meeting Water Licence Limits.

2 SCOPE OF WORK

The scope of work for this project was to:

- Review of background data.
- Conduct a site tour and inspection of water treatment facilities.
- Attend to various emails and teleconference to discuss findings and recommendations.
- Prepare report and finding

3 KEY INFORMATION- GALKENO WWTP

The following is a summary of the design features of the key process components for the treatment plant. Comments are provided as appropriate on the design basis and potential for improvements.

i) Flow control: There is no ability to control the rate of adit flow. This should be considered such that short term shut down of the plant for maintenance is possible. This may be achievable by placement of a small dam and shutoff valve in the adit or by pumping untreated water to storage.

ii) Lime addition. The plant has good lime storage capacity and receives lime slurry from the Elsa lime slurry plant. The current lime slurry tank provides for 1-3 days storage capacity at the plant.

iii) Flocculant addition. The current flocculant storage system is near capacity. There may be a need to either expand the storage capacity or consider the use of higher feed strengths for polymer dosing.

iv) Lime Rapid Mix Tank. The rapid mix tank has a volume of 14 m^3 which provides a nominal retention time of 15 minutes at 15.8 L/s (250 USgpm). This is more than adequate for lime reactions to be completed.

v) Clarifier. The package clarifier is equipped with a flash mix tank, flocculation tank and tube clarification tank. The basic design was completed by Corix whose testwork indicated a system with 30 minutes residence time would be suitable for settling of the Galkeno WWTP sludges. The actual rise rate for clarifier is 4.85 m/h which is considered to be at the upper end of rise rates for most clarifiers. Typical rates for conventional plants are 0.5 to 1 m/h. Monitoring data have shown the plant does not produce consistent water quality at flows above about 10 L/s.

vi) Polishing Pond- The overflow from the clarifier goes to a polishing pond with a capacity of 1780 m^3. The basin contains a series of geotextile baffles to reduce short circuiting

and improve sedimentation. The residence time is about 1.37 days at 15 L/s. This suitable for polishing the clarifier overflow. A review of historic data indicates that the pond which was used to settle precipitates before the clarifier was installed did not consistently meet water Licence Limits.

vii) Sludge Pond. The sludge pond has a capacity of 1000 m^3. The original Corix design assumed that sludge production would be in the range of 3,150 USgal/d or 11,800 L/d. In practice, the sludge production has been much, much higher. During normal flow conditions (8 L/s), typical sludge dump cycle times were once every 8 minutes for a period of 30 seconds. Under these conditions, it is estimated that about 150,000-300,000 L/day of clarifier underflow was discharged to the sludge pond. This represents as much as 45% of the flow at 8 L/s. At higher flow conditions, dump frequency is increased. At 13 L/s, typical sludge dump cycle times were once every 5 minutes for a period of 40 seconds. Under these conditions, up to 660,000 L of clarifier underflow is discharged to the sludge pond. This represents 60% of the flow at 13 L/s. As a result, the majority of the discharge at high flows may be occurring to the sludge pond. This results in poor sludge density and poor water quality in the overflow from the sludge pond. During the site visit, 44,000 USgal (165,000 L) of sludge was removed from the sludge pond in one day. A sludge pumping system has been installed to permit direct pumping of the sludge to the open pit. Once commissioned, this will greatly assist in sludge removal/management.

4 SYSTEM PERFORMANCE

The Galkeno WWTP performance is strongly related to flow. For the period of April to November 2008, daily data indicate 100% compliance when treated flows are <10 L/s except at the end of the freshet period when flows dropped below 10 L/s but elevated zinc levels remained for 2 days and this was likely attributed to overflow of solids from the sludge pond. When flows were above 10 L/s, non-compliance was common (about 30% of the time). This clearly indicates that the plant can treat about 10 L/s and essentially be in compliance with the 0.5 mg/L Water Licence limit.

5 System Deficiencies

The following is our assessment of the major issues with the Galkeno Waste Water Treatment System.

This assessment is based upon the review of performance data and an inspection of the site completed by Mr. Knapp from the 8-10 December 2008.

1) The existing system is not capable of handling peak flows above 10 L/s for any substantive period of time. Given flows have been above 10 L/s since mid 2008, it is concluded the plant is under sized. When operating at flows of <10 l/s, the plant has performed well and typically produces good quality effluent. As a result additional settling capacity is required. This would best be provided through the provision of an

additional clarifier. This would reduce overflow rates and should greatly improve upon sludge densities both in the clarifier underflow and sludge storage basin.

2) The sludge basin is currently receiving the majority of the clarifier flow (at 13 L/s this could be in the range of 60% of the total plant inflow). The overflow from the sludge pond should be diverted to the polishing pond for additional settling. The pump should be a variable speed pump that matches clarifier underflow rates with pumping rates to the polishing pond to minimize the flow variability to the polishing pond. It is understood that this was attempted in the past but major scaling issues arose.

3) Non compliance is in part the result of shut downs due to generator maintenance. Although the system is considered to be interim, it is more likely that the current system will remain operational in some fashion for a number of years before a final closure measure is implemented Therefore strong consideration should be given to the use of grid power at the earliest convenience. The generator could be used as a backup supply.

4) The existing clarifier has settled and is not performing as designed. This has resulted in unlevel trough launders, flooding of the launders and poor hydraulic flow conditions in the clarifier. These needs to be resolved.

6 MANAGEMENT OF FRESHET FLOWS FOR COMPLIANCE

During a 1 to 3 week period in the spring, the freshet results in significant flow increases at the Galkeno 300 adit discharge. These flows can increase to 20-40 L/s. Under the current conditions, flows above 15 L/s are discharged untreated leading to period of non-compliance that can last more than a week. SENES was requested to assess the potential options available to address water treatment during the freshet conditions. Obviously no major changes are possible as these could not be designed and implemented before the onset of the freshet.

There are three reasonable options that could be considered for the 2009 spring freshet flow of say 30-40 L/s.

Option 1- Lime the adit discharge to pH 9+/- with 10 L/s treated in the clarifier and the remaining water pumped directly to the polishing pond. Discharge the clarifier overflow directly and divert sludge pond overflow to the polishing pond. Effluent quality would be improved but is almost certain that water licence limits would be exceeded as the polishing pond performance data has shown that at flows of 20-30 L/s are too high to obtain effective suspended zinc removal.

Option 2- Lime the adit discharge to pH 9+/- with 10 L/s treated in the existing clarifier, 10 L/s treated in a new clarifier and the remaining 10-20 L/s pumped directly to the polishing pond. Discharge the clarifier overflow directly and divert sludge pond overflow to the polishing pond. Effluent quality would be improved and there is a reasonable possibility that water licence limits would be met as both the historic clarifier effluent quality and the polishing pond performance

data has shown that at flows of 10-20 L/s, licence limits can be met on occasion although not consistently.

Option 3- Build a new clarifier and treat 20 L/s in the treatment plant and lime amend and pump all flows above 20 L/s to a storage location (mine workings). Discussions with Access indicate that candidate mine working may include the Hector Adit, Simes #35 vien, Simes #4 and Simes#5 pits, Hector Pit and Calumet 1-15 Pit. The company should be encouraged to review pit capacities and piping and pumping options. If a suitable storage location can be found, there is a strong potential to meet licence limits.

For all options, non-compliance would still occur if by-passing of the treatment plant was allowed during maintenance (plant or generator). Therefore a system must be included to permit short term management of the adit discharge. This may be possible by construction of a small retention dam in the adit or by pumping to storage during plant shut down.

7 OTHER CONSIDERATIONS

It should be noted that the licence limit is set at 0.5 mg/L of zinc for any sample. This limit is difficult to achieve and is beyond the technology based limits as set forth in the Metal Mining Effluent Regulations. These regulations are technology based and are based upon the performance of Canada's best operating waste water treatment plants. Based upon the MMER data, the technology based limits are 0.5 mg/L monthly average with peak levels of 1 mg/l in any sample. For any option as described above, if total zinc levels are restricted to 0.5 mg/L, major system upgrades will likely be required to virtually assure compliance with the zinc limit. The most likely alternative for Galkeno 300 would be the addition of pressure filters to remove trace levels of suspended zinc in the final effluent before discharge. It is understood that Access and ERDC proposed MMER regulations in their original water license application but it was rejected.

8 SUMMARY AND RECOMMENDATIONS

The improvements to the Galkeno WWTP in 2007 have resulted in greatly improved performance of the system. The plant has performed well and is effectively in compliance with licence limits when flows remain at or below 10 L/s. As such, we believe that the current system with modifications to handle flows above 10 L/s should be retained.

Three options could be considered for treatment improvements to address non-compliance during high flow conditions. It is our opinion that only *Option 3* has a reasonable expectation of being compliant. *Option 3* would be the addition of a second clarifier such that the plant could treat 20 L/s with flows above 20 L/s sent to storage. A second sludge storage pond may also be considered but decision on this could be deferred until the performance of the new system with 2 clarifiers is assessed.

There are a number of related actions that also need to be considered if 100% compliance is to be virtually assured:

1) Consideration should be given to switching to grid power with diesel backup. By-passing untreated water is unacceptable during generator maintenance. Given the extended time that this plant will operate, the capital costs should be readily offset by reduced power charges.

2) Consideration should be given to the provision of short term storage for adit water to allow for maintenance without by-passing untreated water. This may be possible by construction of a small retention dam in the Galkeno 300 adit or by pumping to storage to other mine workings during plant shut down.

3) The overflow from the sludge pond should be diverted to the polishing pond for additional settling. The pump should be a variable speed pump that matches clarifier underflow rates with pumping rates to the polishing pond to minimize the flow variability to the polishing pond.

4) The existing clarifier has settled and is not performing as designed. This has resulted in unlevel trough launders, flooding of the launders and poor hydraulic flow conditions (i.e. short circuiting) in the clarifier. This needs to be resolved.

5) The pumping of sludge from the sludge pond to the pits should be initiated as soon as possible to improve sludge removal from the sludge pond.

6) Approach the Water Board to have the licence limit for total zinc modified to 0.5 mg/L monthly average with 1 mg/L maximum consistent with the MMER. If this cannot be granted then in the longer term, a filter plant will likely need to be added to assure total zinc levels remain below 0.5 mg/L.

9 CLOSURE

We trust this report meets your requirements and remain

Yours truly

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