

Memo

To:	Michelle Unger,	Client:	Teck Resources
From:	Peter Healey	Project No:	1CT005.046
Cc:	Gerry Murdoch	Date:	September 11, 2014
Subject:	Proposed Post Reclamation Geotechnical Monitoring Program		

1 Introduction

SRK Consulting (Canada) Inc has been requested by Teck Resources Limited (Teck) to prepare this post-closure Geotechnical Monitoring Program for structures and features that would form part of the closed Sa Dena Hes mine located near Watson Lake, Yukon. This memo provides a description of each of the mine components, the type of inspections, reviews and plans that would be completed and their frequency over the years following closure of the mine.

Annual inspections would be completed for a number of years, post-closure of the mine site including the remaining tailings embankment, spillways, soil covers, diversions and waste rock dumps. Details of frequency and who would carry out the inspections are provided in the sections to follow. During the inspection, the structures will be inspected to identify conditions that could potentially adversely impact the long-term performance of structures during the post closure period. Annual inspection reports will be prepared and submitted to the Yukon Water Board.

A review of Canadian Dam Association, Dam Classification category of the North Dam would be carried out as part of the next annual geotechnical inspection. The scope would also include an update to the Operations, Maintenance and Surveillance Manual (OMS) and the Environmental Preparedness Plan (EPP).

Figure 1 shows a general location map of the mine site and identifies the components that will be inspected.

2 Inspections, Reviews and Plans

2.1 Annual Inspections

Teck shall ensure that an annual inspection of the mine site be carried out by a qualified geotechnical engineer. The focus of the inspections would be the North Dam, the Sediment retaining structure (SRS) and spillway, soil covers, diversions and waste rock dumps. The findings of the inspection should be formalized in a report, which includes an evaluation of the

annually measured piezometer levels and settlement readings at the North Dam. The inspection should take place as soon as possible after the snow has melted. This would allow any necessary remedial work to be completed prior to the rainy season.

Extra ordinary inspections should be carried out after any significant storm or seismic events. The triggers for these inspections would be no less than a 50 year flood event and a seismic event equivalent to a Modified Mercalli Intensity scale of IV (Moderate) as felt in Watson Lake.

Specific details of the annual inspections for each of the mine components are provided in Section 3.

After the first 5 years following closure, the annual inspection would be carried out by a qualified professional engineer.

After 5 years annual inspection would be carried out by an appropriate representative of the owner responsible for the safety of the tailings storage facility, supplemented by inspections every 5 years by qualified professional engineer.

A report would be prepared after each inspection.

2.2 Dam Safety Review

The last DSR was carried out in 2009 by Golder Associates. The CDA Dam Classification for the North Dam reported in the 2009 review was *Significant* and consequently a review frequency of every ten years would be required. However, under post closure conditions, the North Dam could be downgraded to a *low* consequence category (as it was in the 2003 Klohn review) and as such no future DSR's would be required. A review of the consequence classification would be carried out during the next formal annual inspection and written up as a separate report.

2.3 Operations, Maintenance and Surveillance

The last OMS Manual was prepared by SRK in 2004. The manual was prepared in accordance with a requirement under Section 74 of the mine's current Water Licence #QZ99-045. The Mining Association of Canada's (MAC) publications: *Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities* (September 2002) as well as the Canadian Dam Association's (CDA) "Dam Safety Guideline" were used to develop the framework for the manual.

The manual was intended to provide procedures required to operate, monitor the performance of, and maintain the TMF and associated water management facilities to ensure that they function in accordance with their design, meet regulatory and corporate policy obligations, and link to the emergency preparedness and response plan.

An update to the 2004 OMS manual should be completed in 2015 and would focus on the maintenance and surveillance of the following components: the North Dam, the soil covers, the SRS and spillway, the waste rock dumps and the diversion channels. The plan should be updated

every ten years. However annual updates to the contact information should be made, as required.

2.4 Emergency Preparedness

The last Mine Emergency and Response Plan (MERP) was prepared by SRK as part of the 2004 OMS. The plan was directed mainly at the tailings management facility including the three dams, the spillways and the diversion ditches. Under future closure conditions, the emergency contact information in the EPP should be updated in 2015 and the MERP should be reviewed and revised in 2015 to reflect the closure conditions. The MERP should outline the response procedures and preventive measures that would be required for effective and timely management of an emergency situation.

3 Mine Components

3.1 North Dam

After final closure of the mine, the North Dam will be the only remaining embankment on site. This dam will continue to retain tailings at the northern end of the original tailings management facility. The piezometers and settlement gauges within the dam are still intact and functional.

A site plan of the North Dam is presented on Figure 2 and a typical section through the dam is shown in Figure 3. The North Dam is approximately 15 m high, with a crest elevation of 1098 m, a crest length of about 260m and a crest width of 10 m. Based on the original tailings storage curve (SRK, 1990b), the total storage for the overall impoundment would be about 1 million m³ at an assumed elevation of 1097 m. As part of the closure conditions, a 0.5m soil cover will be placed over the tailings with no ponded water.

The cover will be graded to provide positive drainage of surface runoff away from the dam.

Standpipe piezometers are located within the crest of the dam. Settlement gauges, which were installed during construction of the dam, can also be found on the crest of the dam.

The piezometric levels in the piezometers will be recorded during the annual water quality monitoring program as part of the Adaptive Management plan.

This structure would be inspected in accordance with the guidelines outlined in section 2.1 above.

3.2 Sediment Retaining Structure and Spillway

The SRS shown on Figure 4 would be constructed by leaving in place a portion of the South Dam fill along the upstream toe of the dam. A spillway would be built through the SRS to accommodate the 1,000 year runoff event. The peak inflow for this event, 5.4 m³/s, was recently updated by SRK in the 2013 update to the Detailed Decommissioning and Reclamation Plan (DDRP) (Appendix D).

The SRS would have a crest elevation of 1,087.7 m and the spillway through the dyke would have a finished invert elevation of 1,086.0 m. The upstream face would be built with a 2H:1V slope. The downstream slope would be constructed to 2.5H:1V.

The spillway and dyke would be inspected as part of the annual geotechnical inspection to ensure the stability of the dyke and the integrity of the spillway to safely discharge the design flow.

Annual maintenance would include:

- Clearing of any debris in the channel;
- Repairing of cavitation or eroded aprons; and
- Removal of any vegetation.

3.3 Drainage Channels

Three drainage channels would be constructed as part of the decommissioning of the TMF. One channel would be built from the outfall of the SRS to a convergence with the realigned Camp Creek channel. The second would be built from a point upstream of the existing Camp Creek Diversion in the original Camp Creek channel as shown on Drawing SDH-DR-09 (Appendix A). The start point of this channel would be determined in the field. The third (the North Channel) would be built along the east side of the tailings area as shown on Figure 4.

The following design criteria were used for design of the channels:

- The design inflow is based on the 1,000 year runoff event,
- The embankments would be built to minimize long term erosion, and
- Drainage channels should conform to the natural topography.

Similar inspection and maintenance checks as specified above for the SRS spillway would be carried out.

3.4 Soil Covers

In accordance with the current reclamation plan, the exposed tailings would be capped with soil to prevent wind erosion, to minimize the impact of dust, and to provide growth medium for vegetation. The cap is also required to reduce ecological and human health risks. The cap is not designed as a low infiltration barrier. The cover, however, would reduce surface ponding and promote runoff of non-contact water.

Several other areas requiring revegetation were identified throughout the property. Some of these areas would be scarified and seeded (access roads), while others would require capping to provide a growth medium for vegetation. The tailings cap would be constructed by placing material excavated from the South and Reclaim dams. The soil would be placed in a single lift to a depth of between 0.4 to 0.5 m. The cap surface would be re-contoured to a minimum grade of 2% to promote runoff and prevent ponding. The edges of the cover would be terminated flush

with the crest of the North Dam, or where downgradient terrain is encountered, it would be graded to no steeper than 2H:1V.

The cap would be revegetated by seeding and tree and shrub planting as soon as possible after placement. Local vegetation would be favoured and the density would be limited initially to allow the colonization by local volunteer species to be established from the areas surrounding the caps.

The soil capping of the areas other than the tailings would be constructed in a similar manner and contoured to blend in with the natural terrain where possible.

The covers would be inspected during the annual geotechnical inspections.

The covers will be visually inspected annually for signs of erosion, sloughing, geotechnical and hydraulic instability, and vegetation success. The inspections will determine if and where repairs are required, whether reseeding, replanting or maintenance fertilizer is required, and will monitor natural regeneration and invasion of native species.

Reclamation assessments will be conducted to identify the areas that have achieved or are progressing towards land capability objectives, and those that require additional work. The frequency of assessments for each reclamation site will depend on its age. For example, a newly reclaimed site will be assessed annually for three years, then assessed every five years until the site is mature at which time the assessment will be every ten years. Some reclaimed sites will already contain mature shrubs and trees at closure so will be assessed every ten years until they are determined to be self-sustaining.

Annual inspections and reclamation assessments will cease for sites that have reached a sustainable state.

3.5 Portals and Drainages

3.5.1 Portals

The 1408, 1250, 1380 portals at the Jewelbox and Main zone areas, and the 1200 and 1300 portals at the Burnick zone will be sealed off using coarse site waste rock to at least 5m into the portal beyond the entrance. Within the tunnel, the waste rock fill will be placed as close to the top of the tunnel as possible to help stabilize the collar of the portal. At surface the waste rock will be sloped from above the top of the portal to the base of the portal at a stable slope and will be contoured to tie into the surrounding terrain for aesthetic purposes. The seals will include two minimum 4 inch diameter pipes (high density polyethylene pipe or equivalent so they don't corrode). The purpose of the pipes is to prevent air from pressurizing within the mine and to provide a conduit for mine water drainage if required. The pipes will be installed at slightly different elevations and one of the two pipes is a backup in case the other becomes plugged. The ground at portal entrance will be sloped away from the portal to ensure precipitation can drain away to prevent ponding of water up against the seal.

An inspection of these portals will be carried out during the annual inspections. Figures 5 and 6 show the location of the portals. The inspection would ensure no blockage of the drainage pipes and that the backfill material has remained stable.

3.5.2 Ventilation Raises

Both ventilation raises at the Jewelbox/Main Zone area will be sealed using an engineered concrete seal in a manner that is in accordance with Mine Safety Regulations. The seals will provide the physical barrier to eliminate the potential for the public or wildlife to access the mine through ventilation raises. In addition, the seals will prevent water and significant airflow from entering the mine workings (the seals will contain a small pipe to allow some airflow through the seal) through these openings.

An inspection of these portals will be carried out during the annual inspections. The inspection would look for possible deterioration or damage of the concrete seal and air pipes by vandals. Observation of any subsidence or ground movement would also be noted.

3.5.3 Open Pits (Jewelbox and Main Zone)

The pit walls will be stabilized by re-sloping and if required by blasting or importing additional fill material. Re-sloping will partially fill the pit. Fill at the base of the pit will consist of coarse waste rock so that it will function like a French drain to ensure that water continues to have a route to discharge out of the pit.

An inspection of these backfilled pits will be carried out during the annual inspections. The inspection would look for any signs of blockage of the drains and instability of the backfill.

3.6 Waste Rock Dumps

3.6.1 Jewelbox

At closure the crest of the waste dumps below the 1408 Portal will be pulled back and rounded for aesthetic purposes and to improve stability. The waste rock dump benches will be recontoured to provide positive drainage away from the hillside.

The waste rock in the Jewelbox Pit dump on the ridge between the Pit and 1408 Portal will be pushed into the Jewelbox Pit.

All safety berms along the access roads will be removed either with an excavator or by dozer and drainage patterns re-established.

An inspection of these dumps will be carried out during the annual inspections. The inspections will look for any tension cracks in the dump slope or top surface, bulging in the slope and any subsidence.

3.6.2 Main Zone

The crest of the waste dump below the 1380 Portal will be pulled back and rounded for aesthetic purposes and to improve stability.

An inspection of these dumps will be carried out during the annual inspections. The inspections will look for any tension cracks in the dump slope or top surface, bulging in the slope and any subsidence.

3.6.3 Burnick

At closure, the crest of the Burnick dump (see Figure 6) will be pulled back to further reduce loading on the crest to improve stability. The bench of the dump will be recontoured to provide positive drainage away from the hillside.

An inspection of these dumps will be carried out during the annual inspections. The inspections will look for any tension cracks in the dump slope or top surface, bulging in the slope and any subsidence.

3.7 North Creek Crossings

At closure the North Creek Dyke and culverts will be removed, the area re-contoured and the drainage channel armoured to ensure it is stable. The culvert at the second crossing will be removed.

The channel would be inspected as part of the annual geotechnical inspection to ensure the integrity of the riprapped channel to safely discharge the design flow.

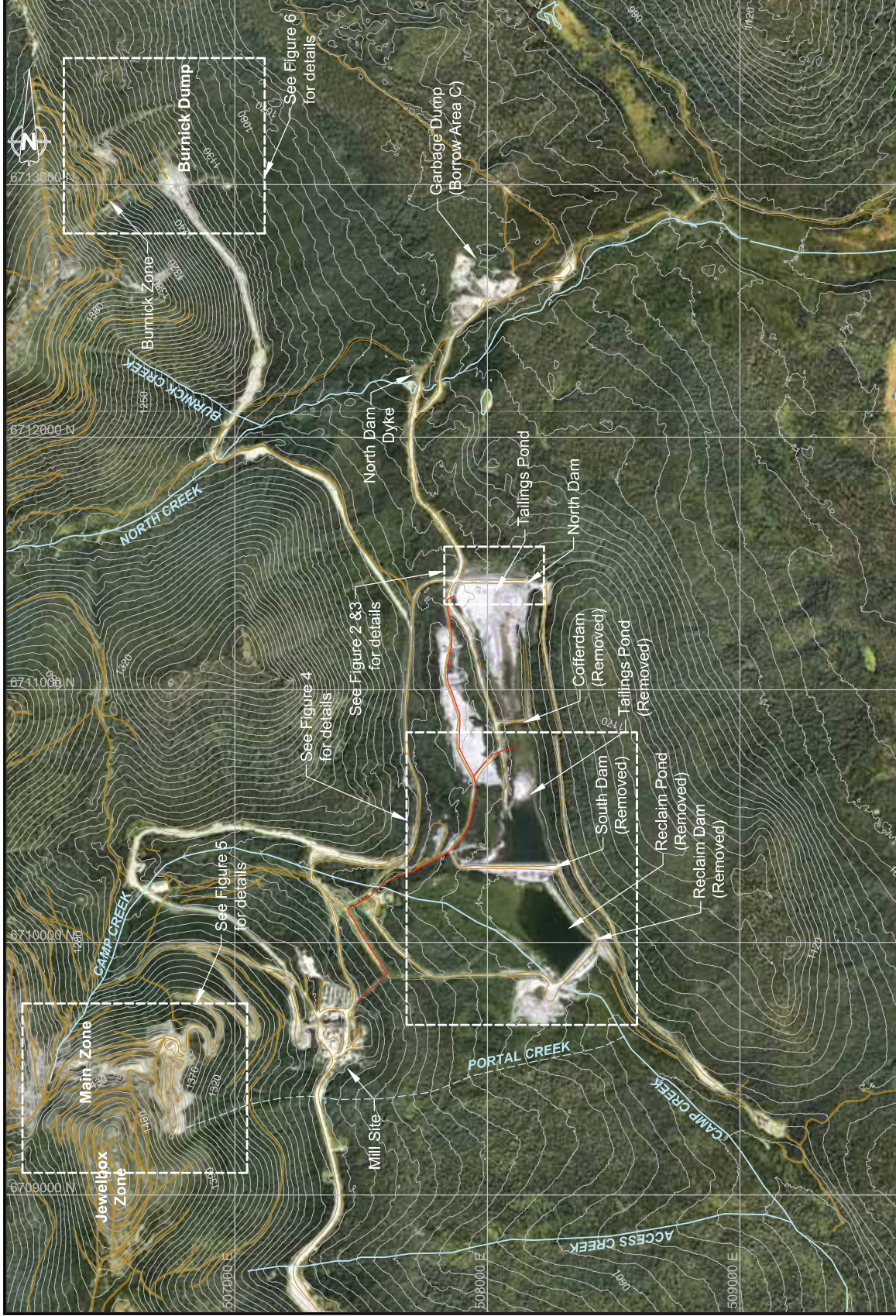
Annual maintenance would include:

- Clearing of any debris in the channel
- Repairing of cavitation or eroded aprons and
- Removal of any vegetation

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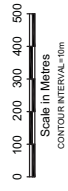
The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

Figures



NOTES

1. Topographic contour data and aerial photos were obtained from McElhenny and are based on August 15, 2012, LIDAR data. Coordinate system is UTM NAD 83 CSRS zone 9V.



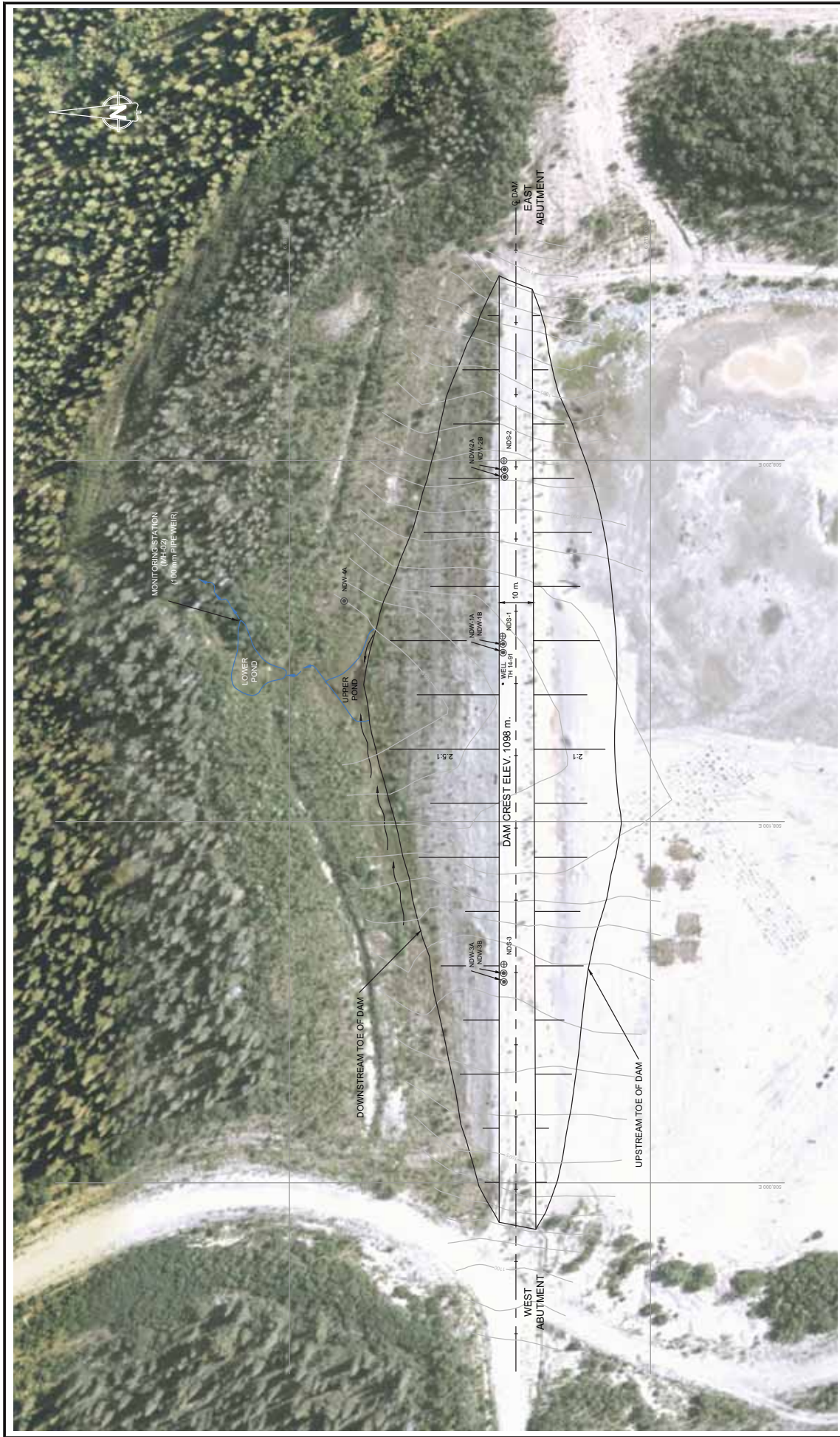
Teck

SRK consulting

SRK JOB NO.: 1CT008.046
FILE NAME: 1CT008.046_Fig1.dwg

Geotechnical Monitoring Program	
Vicinity Map	
DATE: August, 29, 2014	APPROVED: PH
FIGURE: 1	

Sa Dena Hes



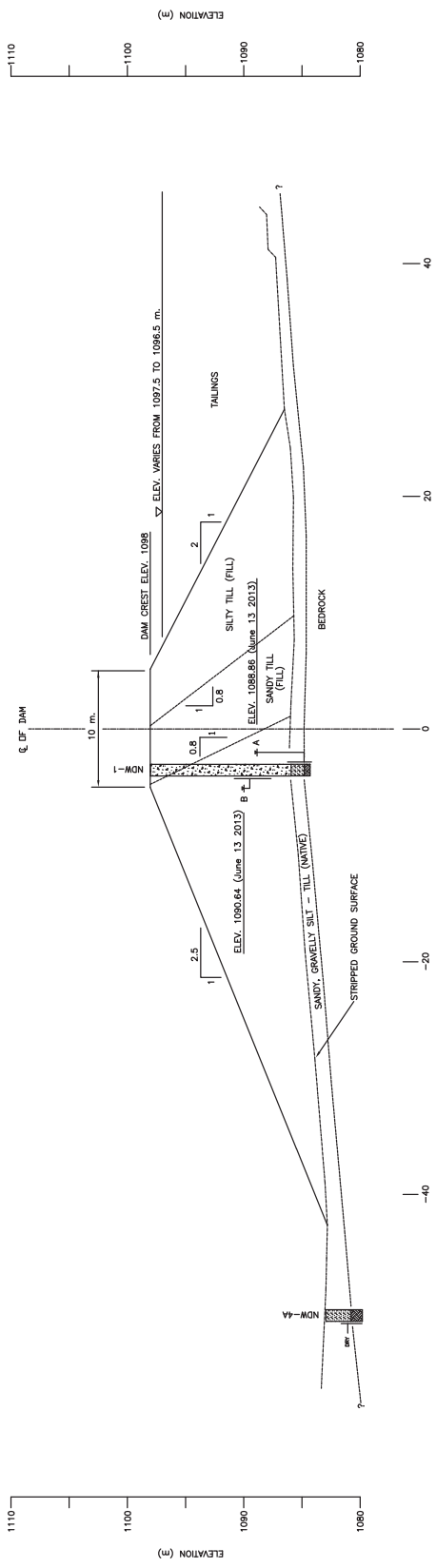
Teck		Geotechnical Monitoring Program	
srk consulting		North Dam Site Plan	
Sa Dena Hes Mine		DATE:	August, 2014
SRK JOB NO.: 1CT008.046		APPROVED:	P.M.H.
FILE NAME: 1CT008046_Fig2.dwg		FIGURE:	2

NOTES:

1. TOPOGRAPHIC DATA REPRESENTS ORIGINAL GROUND (PRE-STRIPPING).
2. FOOTPRINT DATA IS BASED ON STAKING IN THE FIELD (POST-STRIPPING).
3. SEE PAGE MAPPED DURING JULY 1997.
4. BASE TOPOGRAPHY FROM NORTH AMERICAN DATUM 1983 ALL SURFACE FACILITIES AND BOUNDARIES HAVE BEEN ADJUSTED FROM NAD 1927.

KEY

- NDW-1 ○
- NDW-1 ⊕
- SEEPAGE ↘



DATE	T.O.P.	READING	ELEV.
June 13 2013	1098.57	7.93	1090.64
June 13 2013	1098.69	9.83	1088.86

KEY

- SANDY TILL (FILL)
- SILTY TILL (FILL)
- SAND & GRAVEL (FILL)
- SILTY SAND (TILL)
- GRAVELLY SILTY SAND (TILL)
- SAND & GRAVEL (NATIVE)
- BEDROCK
- PIEZOMETRIC HEAD FOR FILTER ZONE INDICATED



Geotechnical Monitoring Program

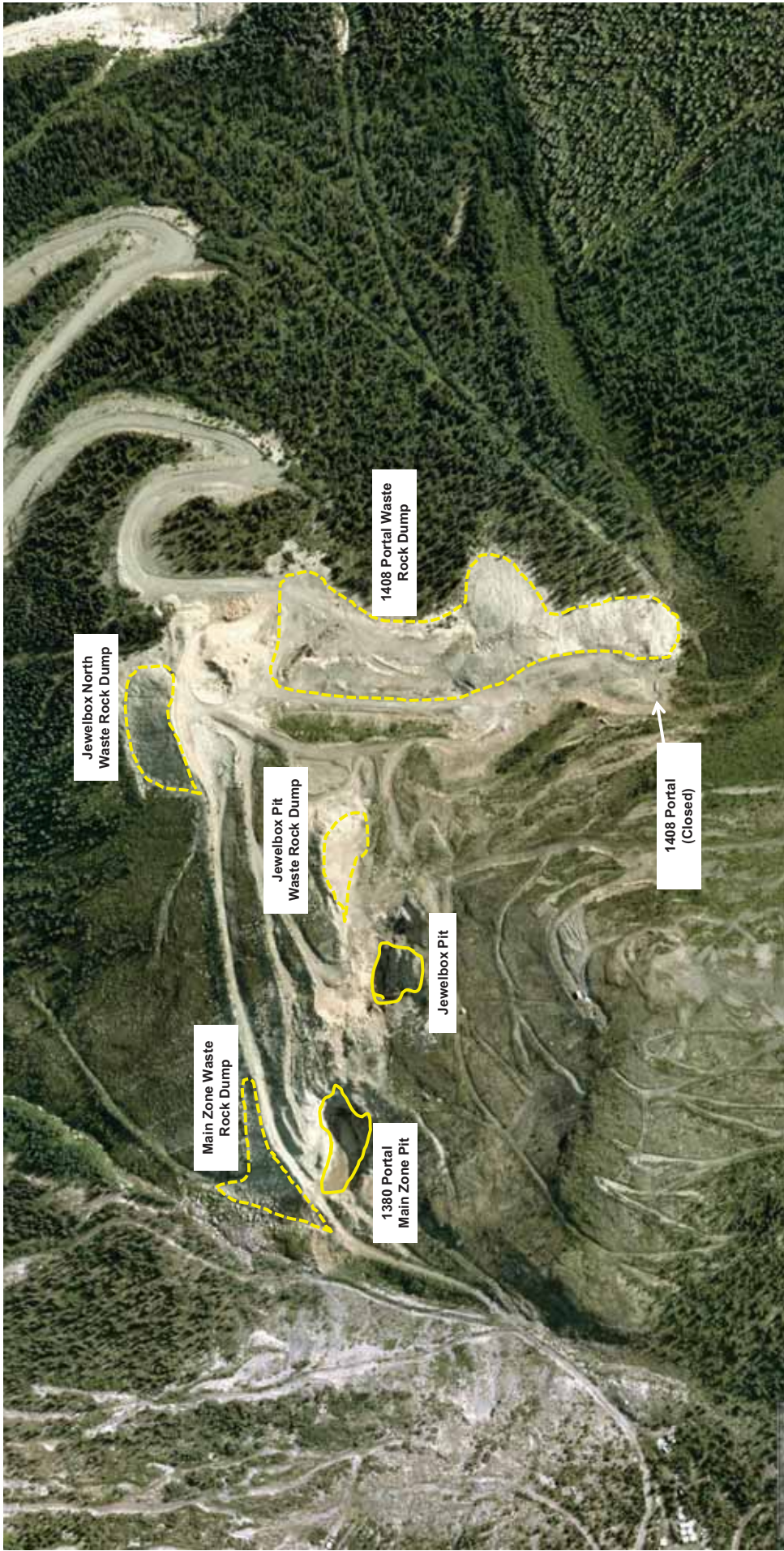
Section 0+400
North Dam

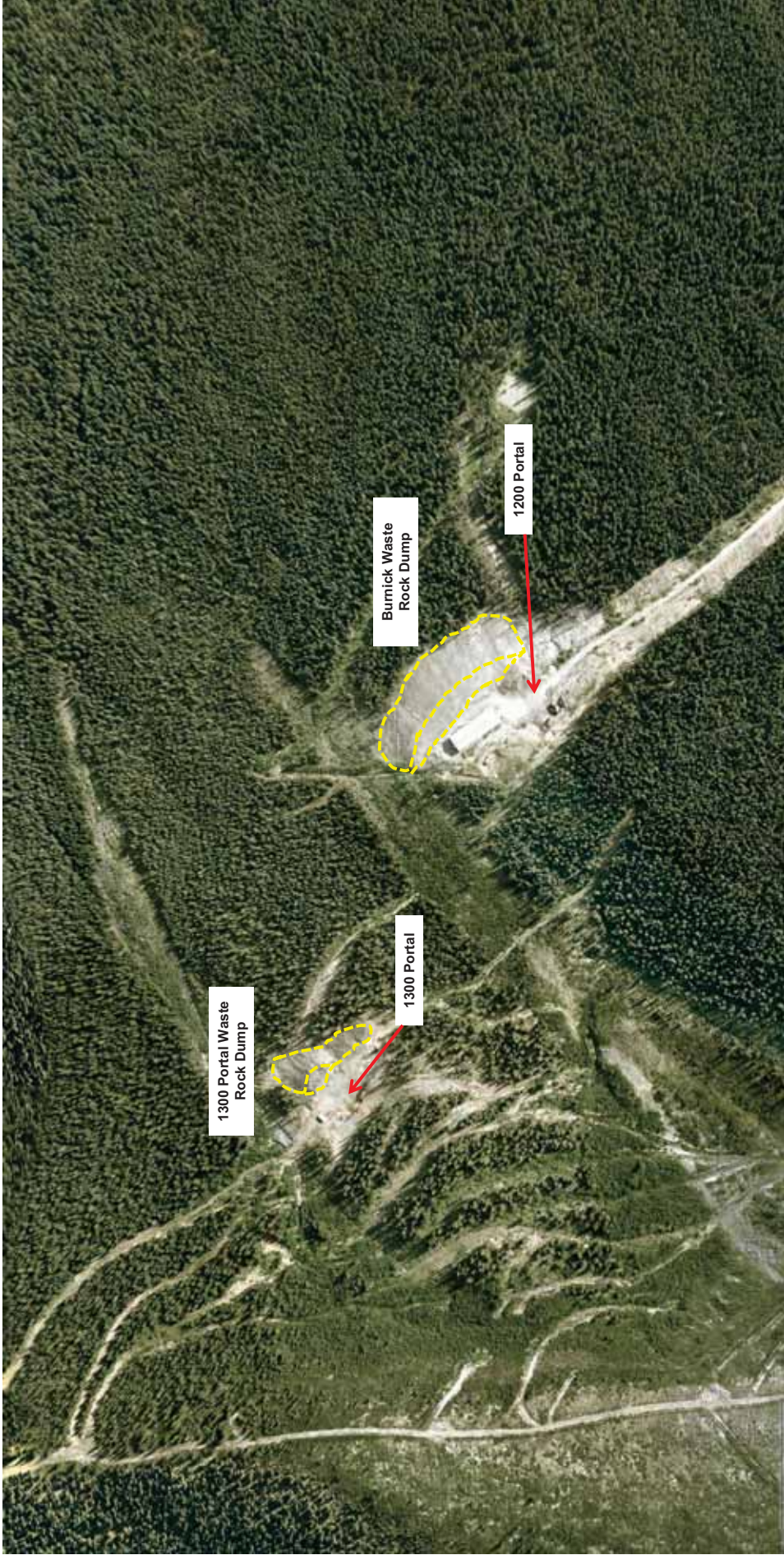
Sa Dena Hes Mine

DATE: Nov. 28 2013 APPROVED: P.M.H.

FIGURE: 3

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1300 Portal Waste
Rock Dump

1300 Portal

Burnick Waste
Rock Dump

1200 Portal



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Sä Dena Hes

Geotechnical Monitoring Program

Burnick Zone Plan View

Date: August 2014
Approved: RMH
Figure: 6