Appendix 17.4-D

Peterson Creek Diversion Alternatives Assessment

AJAX PROJECT

Environmental Assessment Certificate Application / Environmental Impact Statement for a Comprehensive Study

KGHM AJAX MINING INC.
AJAX PROJECT

PETERSON CREEK DIVERSION ALTERNATIVES ASSESSMENT
C002-KA39-RPT-10-006

PREPARED FOR:

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VA101-246/26-7
Rev 1
June 16, 2015

ISO 9001 - FS 64925
ISO 14001 - EMS 550121
OHSAS 18001 - OHS 550122

KGHM AJAX MINING INC.
AJAX PROJECT

PETERSON CREEK DIVERSION ALTERNATIVES ASSESSMENT
VA101-246/26-7
C002-KA39-RPT-10-006

ORIGINAL SIGNED
[redacted]

Rev	Description	Date
0	Issued in Final	April 9, 2015
1	Issued with Revisions	June 16, 2015

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CONSULTING

EXECUTIVE SUMMARY

The Ajax Mine is a proposed copper-gold project located near Kamloops British Columbia. ▲ R1

Jacko Lake is a fish bearing lake located to the west of the Open Pit. The southeast arm of Jacko Lake supplies flows to Peterson Creek through a spillway and/or a low level outlet operated by the local water steward as needed by the downstream users. The spillway and low level outlet are both located at the Jacko Lake Dam. The development of the Ajax Project requires a section of Peterson Creek to be diverted through or around the mine site to maintain the downstream flows. The Peterson Creek diversion is a critical component in the construction schedule as it needs to be operating very early to facilitate construction of site infrastructure in the Peterson Creek corridor and to maintain steward control of the flows from Jacko Lake to the downstream users during the construction of the project.

A preliminary alternatives assessment was completed in April 2014 which evaluated:

- Gravity discharge options which routed water from the Jacko Lake Dam along alignments near the existing Peterson Creek alignment. The gravity discharge options considered open channel flow and conveyance in a pipeline.
- A pumped option which considered constructing a pump house on the northeast side of Jacko Lake and routing water to the north of the Open Pit along the main access road.

The preliminary results were reviewed with KGHM and pumping the Peterson Creek flows around the north side of the Open Pit was selected as the preferred option for the 2014 preliminary design of the Ajax Mine. This option simplified construction activities in the Peterson Creek corridor, followed the same alignment on the main access road as the fresh water pipeline, and had the best economic value of the options considered.

KGHM requested Knight Piésold complete an additional assessment which included relocating the pump house to the southeast arm of the lake near the Jacko Lake Dam, to maintain the existing flow circulation patterns in this area of the lake. The additional alternatives assessment evaluated:

- Alternative A – North Route: This was the base case for the 2014 preliminary design study.
- Alternative B – South Route: Locating the intake at the southeast arm of Jacko Lake and pumping flows through the mine corridor south of the Open Pit.
- Alternative C – Southwest Route: Locating the intake at the southeast arm of Jacko Lake and pumping flows around the west perimeter of Jacko Lake and around the north side of the Open Pit along the main access road.
- Alternative D – Southeast Route: Locating the intake at the southeast arm of Jacko Lake and pumping flows between the Open Pit and Jacko Lake and around the north side of the Open Pit along the main access road.
- Alternative E – North Route with Flow Circulation: This alternative is similar to Alternative A and includes additional measures to maintain circulation within the southeast arm of Jacko Lake.

A preliminary comparative cost estimate, including capital and operating costs, was developed to evaluate the various alternatives. The results of the cost evaluation indicate the preferred alternative option for diverting Peterson Creek and maintain the existing flow circulation patterns in the lake is Alternative E. However, if maintaining flow circulation in the lake is considered to be impractical as the southeast arm of Jacko Lake is shallow, then the preferred option defaults to Alternative A, the base case from the 2014 preliminary design.

The alternatives assessment assumed the water level for Jacko Lake was approximately at 892 m which is the invert elevation of the current spillway at Jacko Lake Dam.

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FIGURES

APPENDICES

ABBREVIATIONS

Ajax Project .... the Project
KGHM .... KGHM Ajax Mining Inc.
KP .... Knight Piésold Ltd.
TSF .... Tailings Storage Facility

1 – INTRODUCTION

1.1 PROJECT DESCRIPTION

The Ajax Mine is a proposed copper-gold project located near Kamloops British Columbia. ▲ R1

Jacko Lake is a fish bearing lake located to the west of the Open Pit. The development of the project includes the construction of additional dams/dykes around the perimeter of Jacko Lake to block off flows to Peterson Creek and the Open Pit. The outlet of Jacko Lake is currently controlled by the Jacko Lake Dam located at the southeast arm of the lake (crest elevation 893 m). Discharge is through an overflow spillway (invert elevation 892 m) and a low level outlet controlled by a manually operated gate, which allows for water releases from Jacko Lake to Peterson Creek during periods when there is no flow over the spillway. The low level outlet is controlled by the water steward, who releases water to the downstream users as required.

A section of Peterson Creek will be cut off through the excavation of the Open Pit. A flow diversion system will therefore be required to maintain the lake elevation and the flows in Peterson Creek downstream of the mine site. This flow diversion system is a key component in the development of the project as it has to be constructed and operating prior to developing the mine site infrastructure in the Peterson Creek corridor.

1.2 SCOPE OF WORK

A preliminary assessment of alternatives for the Peterson Creek diversion was conducted in April 2014. The goal was to evaluate whether diversion by gravity flow through the Peterson Creek corridor was a viable option. An additional alternative was also evaluated which considered locating a pump house on the northeast side of Jacko Lake and pumping the diverted flow around the north side of Open Pit. The preferred option carried forward for the 2014 preliminary design included constructing an intake and pump house at the northeast end of Jacko Lake and conveying the flows along the main access road around the north side of the Open Pit. The April 2014 preliminary alternatives assessment is discussed in Section 2 of this report.

Locating the intake structure at the northeast side of Jacko Lake would likely modify the current flow circulation pattern in the lake as there would be no discharge from the Jacko Lake Dam location in the southeast arm of the lake. KGHM requested Knight Piésold complete an additional assessment which included relocating the pump house to the southeast arm of the lake near the Jacko Lake Dam, to maintain the existing flow circulation patterns in this area of the lake. The following alternatives were evaluated:

- Alternative A – North Route: This is the alternative for which the 2014 preliminary design was carried out based on the preliminary alternatives assessment. The intake would be located on the northeast end of Jacko Lake for conveyance of flows north of the Open Pit along the main access road.
- Alternative B – South Route: The intake would be located on the southeast arm of Jacko Lake for conveyance of flows south of the Open Pit through the Peterson Creek corridor.
- Alternative C – Southwest Route: The intake would be located on the southeast arm of Jacko Lake for conveyance of flows around the west perimeter of Jacko Lake and connecting with the main access road.

- Alternative D – Southeast Route: The intake would be located on the southeast arm of Jacko Lake for conveyance of flows around the east perimeter of Jacko Lake and connecting with the main access road.
- Alternative E – North Route with Flow Circulation: Same as Alternative A with the intake located at the northeast end of Jacko Lake. The design would include means to maintain circulation within the southeast arm of Jacko Lake.

The additional Peterson Creek alternatives are discussed in Section 3 of this report. Preliminary capital and operating costs were developed to assist KGHM in the selection of the preferred alternative for the Peterson Creek Diversion.

The recommendations for the preferred alternative for diversion of Peterson Creek are summarized in Section 4 and are based on the anticipated construction costs, constructability, and considerations for interaction with future mine site development.

2 – PRELIMINARY ALTERNATIVES ASSESSMENT

2.1 GENERAL

The initial study for diversion of Peterson Creek considered gravity flow from Jacko Lake through the Peterson Creek corridor, both through an open diversion channel and through a gravity pipeline, in comparison to pumping flows north of the Open Pit along the main access road for the mine. The gravity flow alternatives considered two routes as shown on Figure 1:

- Option 1: Alignment bordering the Open Pit, and
- Option 2: Alignment bordering a 30 m buffer zone around the Open Pit.

The diversion end point location was at Peterson Creek downstream of the Open Pit. The gravity flow alternatives assumed the existing spillway at the southeast arm of Jacko Lake remained operational; whereas the pumped flow alternative assumed no discharge from the southeast arm of the lake (the spillway from Jacko Lake was blocked). The design flow selected for this assessment was a 200-year 24-hour storm event.

2.2 DIVERSION CHANNEL

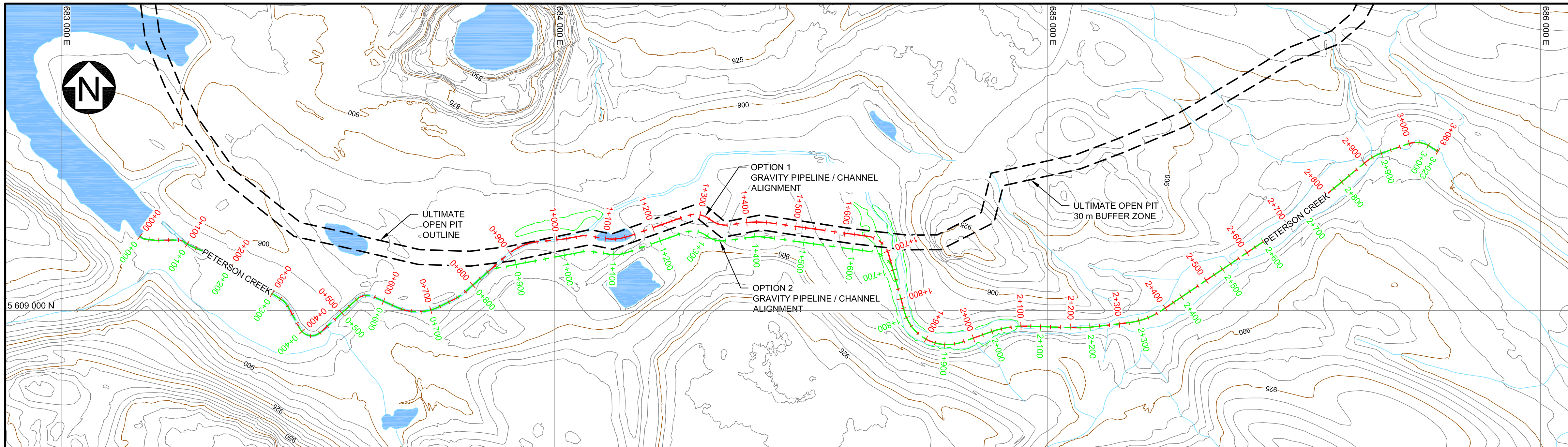
The diversion channel alternative assumed flows from Jacko Lake are conveyed from the existing spillway outlet through an excavated channel aligned around the Open Pit. The diversion channel would be approximately 3,000 m long, with an overall slope of approximately 0.45% to discharge back to Peterson Creek downstream of the Open Pit.

Two alternative alignments were investigated for the diversion channel: one alignment mirrored the outline of the Open Pit excavation and the other allowed for a 30 m buffer from the edge of the Open Pit. The topography along the alignment mirroring the Open Pit (Option 1) has a smaller elevation change resulting in less excavation than Option 2. Option 1 was therefore selected to complete the required sizing of the channel as the reduced excavation volume would reduce the cost of construction. The minimum size of the diversion channel required to convey the design flows from Jacko Lake was 1 m in depth, 1 m base width, and 2H:1V side slopes (Figure 1). Two additional collection ditches would be required adjacent to the main diversion channel for collection of the mine contact water as shown on Figure 1.

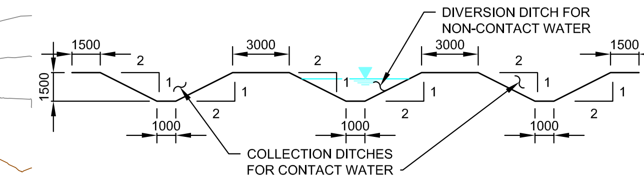
2.2.1 Constructability and Cost

The maximum depth of excavation required to construct the diversion channel for Option 1 to convey flows from Jacko Lake to a point downstream of the Open Pit would be approximately 12 m. The maximum depth of excavation for the alignment of Option 2 would be 31 m; however, the cost for this option was not calculated as part of the preliminary assessment.

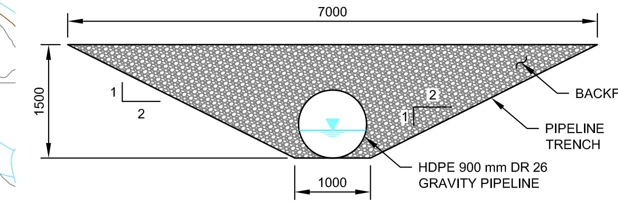
The cost for the Option 1 alignment diversion channel was based on the required excavation for the main channel and the additional collection ditches. The cost included an HDPE liner for the entire length of the diversion channel. The approximate cost was estimated to be in the order of $2.5 million. Costs for the construction of associated access roads were not included in this initial evaluation.



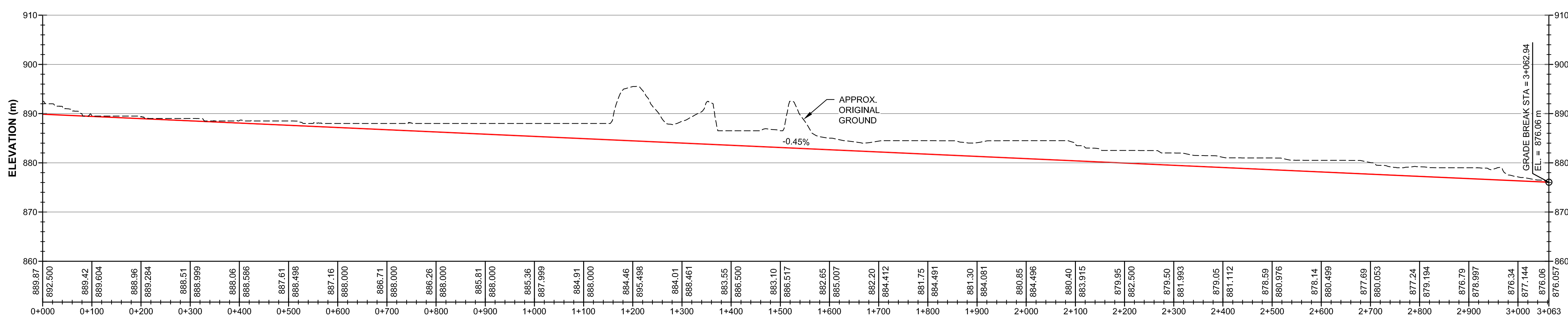
PLAN
GRAVITY FLOW DIVERSION
SCALE A



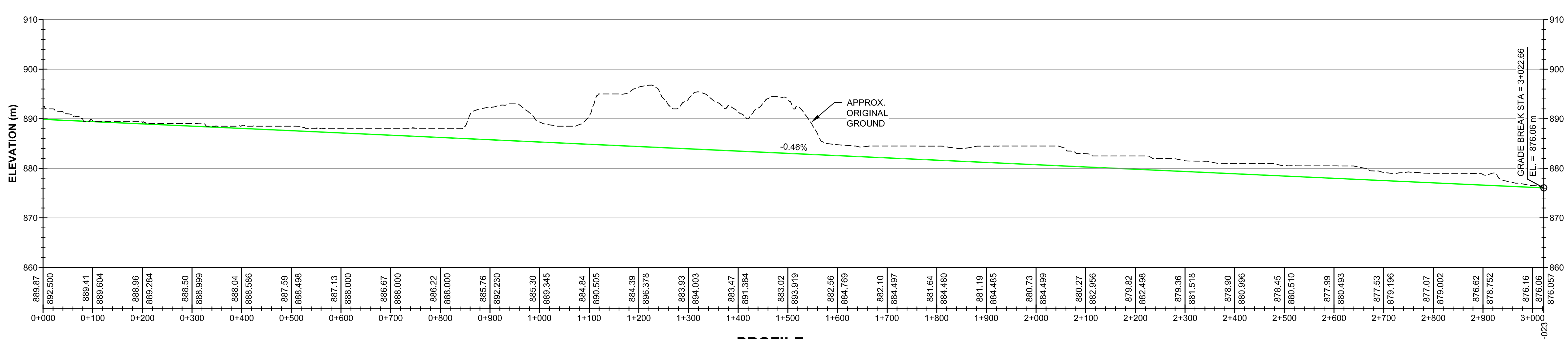
SECTION
OPEN DITCHES
SCALE C



SECTION
DITCH WITH HDPE PIPE
SCALE D



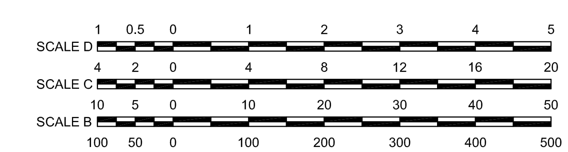
PROFILE
OPTION 1
HORIZONTAL SCALE A
VERTICAL SCALE B



PROFILE
OPTION 2
HORIZONTAL SCALE A
VERTICAL SCALE B

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 10N.
2. CONTOUR INTERVAL IS 5 METRES.
3. SECTIONS SHOW THE MINIMUM REQUIRED SIZE OF DITCHES; THE SIZE WILL VARY WITH EXCAVATION REQUIREMENTS.



KGHM AJAX MINING INC.

AJAX PROJECT

PETERSON CREEK DIVERSION
GRAVITY FLOW PIPELINE / CHANNEL

Knight Piésold CONSULTING

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FIGURE 1 REV 0

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2.3 GRAVITY PIPELINE

A gravity pipeline alternative with an intake at the spillway on the southeast arm of Jacko Lake would keep the Jacko Lake and Peterson Creek water non-contact throughout the diversion. The gravity pipeline option included a 900 mm HDPE DR26 pipeline in an excavated trench with two alignments around the Open Pit as described in Option 1 and Option 2 (Section 2.1). The excavated trench and associated pipeline would be on the same alignment as the diversion channel described in Section 2.2; approximately 3,000 m long, with an overall slope of approximately 0.45%.

The minimum size of the pipeline trench was 1 m in depth, with a 1 m bottom width and 2H:1V side slopes (Figure 1). The pipeline trench was assumed to be backfilled for the entire length.

2.3.1 Constructability and Cost

The trench would be the same as the discharge channel for both Options 1 and 2. The cost for the gravity pipeline placed in an excavated trench is based on the required excavation for Option 1 and includes the HDPE pipe and backfilling. The approximate cost was estimated to be in the order of $3.2 million. Costs for the construction of associated access roads were not included in this initial evaluation.

2.4 PUMPED PIPELINE

The pumped pipeline was designed to divert flows from Jacko Lake around the north side of the Open Pit along the main access road. The spillway on the southeast arm of Jacko Lake would be closed off and flows would be pumped through an approximately 6,300 m long, 400 mm diameter HDPE DR11 pipeline to a discharge location on Peterson Creek downstream of the Open Pit, shown on Figure 2 in Section 3.

The pumped pipeline shares the same corridor with the freshwater/make-up water supply pipeline from Kamloops Lake. A pump house would be constructed on an excavated pad on the northeast shore of Jacko Lake, to house two centrifugal pumps. A section of access road about 450 m long would be constructed to connect the pump station to the main access road.

2.4.1 Constructability and Cost

Excavation of the pump house near the edge of Jacko Lake would require a water management plan to minimize the potential for any sediment laden water to enter the lake; this would apply for construction of the access road as well.

The cost for this alternative was estimated to be in the order of $1.4 million during the preliminary alternatives assessment.

The cost was recalculated in more detail in the preliminary design stage of the project. It included the required earthworks for the pump house and the short connection road to the main access road, the pipeline including the intake screens, the pumps and other mechanical components, and the prefabricated building to house the pumps. The approximate cost for this alternative was estimated to be in the order of $1.6 million and is carried forward for comparison with other pumped alternatives described in Section 3.

2.5 PRELIMINARY ALTERNATIVES ASSESSMENT CONCLUSIONS

The high level preliminary assessment of gravity flow vs. pumped flow diversion alternatives demonstrated that the Peterson Creek diversion by gravity flow would be a costly and impractical solution. The required excavation to ensure gravity flow was large and protecting the diversion channel or gravity pipeline from mining traffic and other mining activities was considered to be challenging. The gravity discharge options were also evaluated to be more expensive than a pumped pipeline that would utilize an existing/planned road and pipeline corridor that bypasses the mine site activities. The decision was made by KGHM to develop the preliminary design for the pumped pipeline option.

3 – ASSESSMENT OF PUMPED PIPELINE ALTERNATIVES

3.1 GENERAL

KGHM requested KP expand on the previously completed alternatives assessment to include alternative pumping strategies and pipeline alignments which would draw water from the southeast arm of Jacko Lake to maintain the current flow pattern and circulation in the lake:

- Alternative A – North Route: This is the alternative for which the 2014 preliminary design was carried out based on the preliminary alternatives assessment. The intake would be located on the northeast end of Jacko Lake for conveyance of flows north of the Open Pit along the main access road.
- Alternative B – South Route: The intake would be located on the southeast arm of Jacko Lake for conveyance of flows south of the Open Pit through the Peterson Creek corridor.
- Alternative C – Southwest Route: The intake would be located on the southeast arm of Jacko Lake for conveyance of flows around the west perimeter of Jacko Lake and connecting with the main access road.
- Alternative D – Southeast Route: The intake would be located on the southeast arm of Jacko Lake for conveyance of flows around the east perimeter of Jacko Lake and connecting with the main access road.
- Alternative E – North Route with Flow Circulation: Same as Alternative A with the intake located at the northeast end of Jacko Lake. The design would include means to maintain circulation within the southeast arm of Jacko Lake.

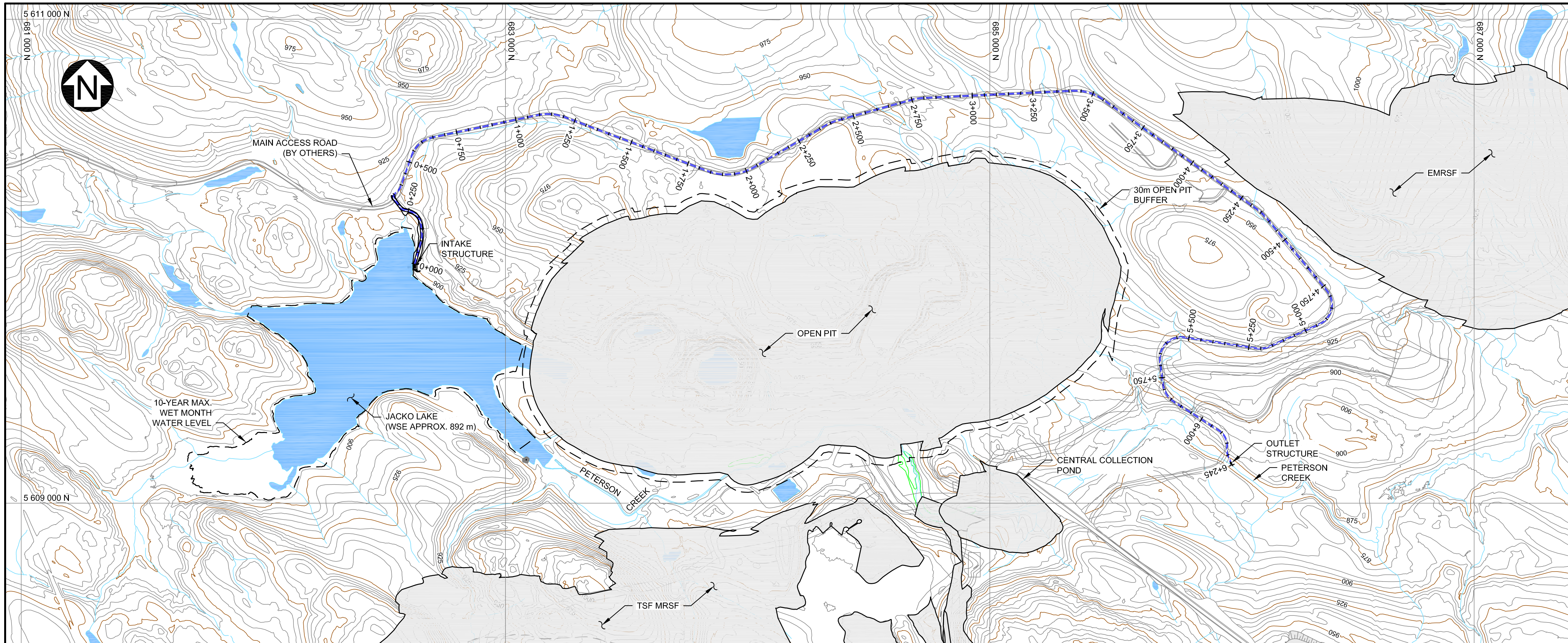
The cost development for each of these alternatives was simplified to allow for a comparative evaluation. The costs included the required earthworks for the pump house and for the pipeline specific access roads, pipelines, intake screens, pumps and other mechanical components, and the prefabricated building to house the pumps. The alternatives assessment assumed the costs for the intake and prefabricated pump house were the same for all options. However, constructing an intake structure and pump house in the shallow end of the southeast arm of Jacko Lake (Alternatives B through D) would be more challenging and likely more expensive to construct. The costs for each of these options do not include the outlet works for the diversion pipeline, as the construction of these works is identical for each of these five alternatives and does not have an impact on the assessment outcome.

3.2 ALTERNATIVE A – NORTH ROUTE

Alternative A is the alternative carried forward from the preliminary assessment described in Section 2.3 and includes an approximately 6,300 m long, 400 mm diameter HDPE DR11 pumped pipeline.

3.2.1 Constructability and Cost

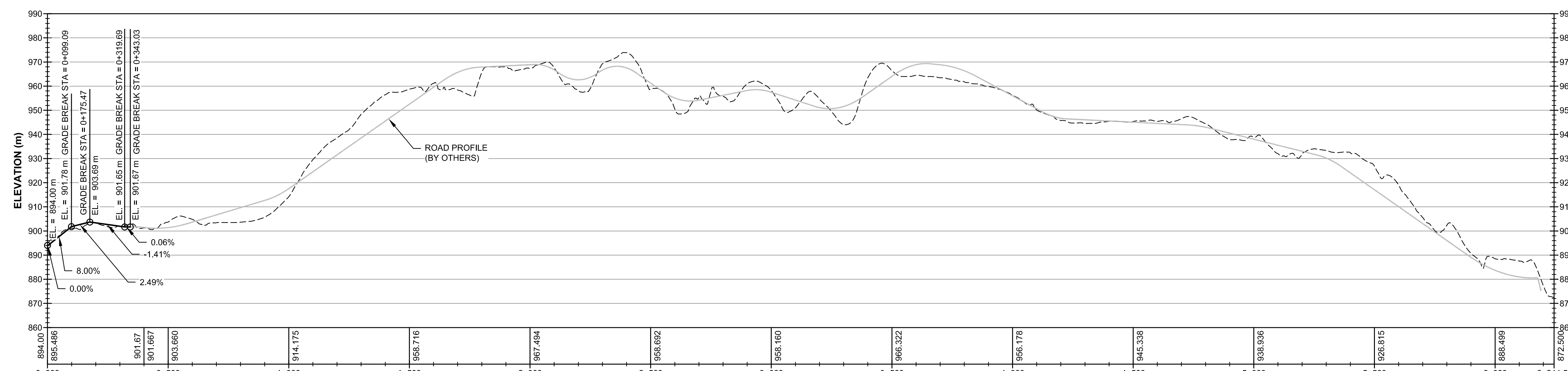
The approximate cost for this alternative was estimated to be in the order of $2.1 million.



PLAN

ALTERNATIVE A ALIGNMENT

SCALE A



PROFILE

ALTERNATIVE A ROAD

HORIZONTAL SCALE A

VERTICAL SCALE B

LEGEND:

JACKO LAKE WATER DIVERSION PIPELINE

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 10N.
2. CONTOUR INTERVAL IS 5 METRES.

SCALE B 20 10 0 20 40 60 80 100 m

SCALE A 200 100 0 200 400 600 800 1000 m

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PETERSON CREEK DIVERSION
ALTERNATIVE A

Knight Piésold CONSULTING

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FIGURE 2 REV 0

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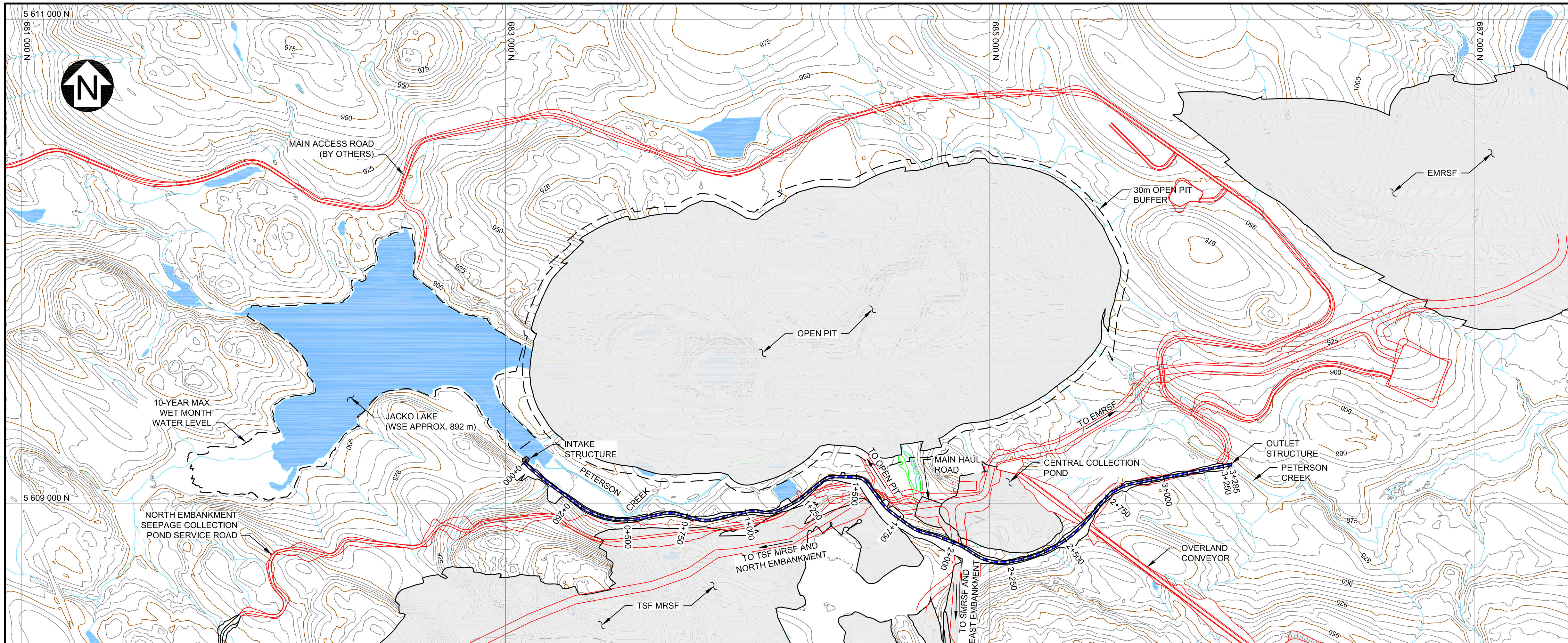
3.3 ALTERNATIVE B – SOUTH ROUTE

Alternative B includes an approximately 3,500 m long, 350 mm HDPE DR 11 pumped pipeline that would be routed south of the Open Pit along the Peterson Creek corridor (Figure 3). The intake and the pump house are located at the shallow end of the southeast arm of the lake near the current spillway location. The pipeline alignment needs to accommodate the site infrastructure in this area including: the narrow corridor between the TSF and Seepage Collection Pond 2, the Central Collection Pond, the main haul road that would cross over the pipeline in two locations, and the overland conveyor. Routing of the pipeline for this alignment would require construction of an approximately 3,500 m long access road to create a pipeline corridor and provide access to the intake structure and the outlet works.

3.3.1 Constructability and Cost

Construction of Alternative B requires that the pipeline alignment avoids the major mine facilities constructed south of the Open Pit, in addition to remaining outside of a 30 m buffer around the Open Pit. The conveyor corridor and main haul road from the Open Pit both cross the pipeline alignment. This would result in additional loads on the pipeline that would require remedial measures to protect the pipeline. The estimate therefore incorporates additional costs, which may include additional excavation and the installation of culverts, associated with constructing a pipeline in the Peterson Creek corridor.

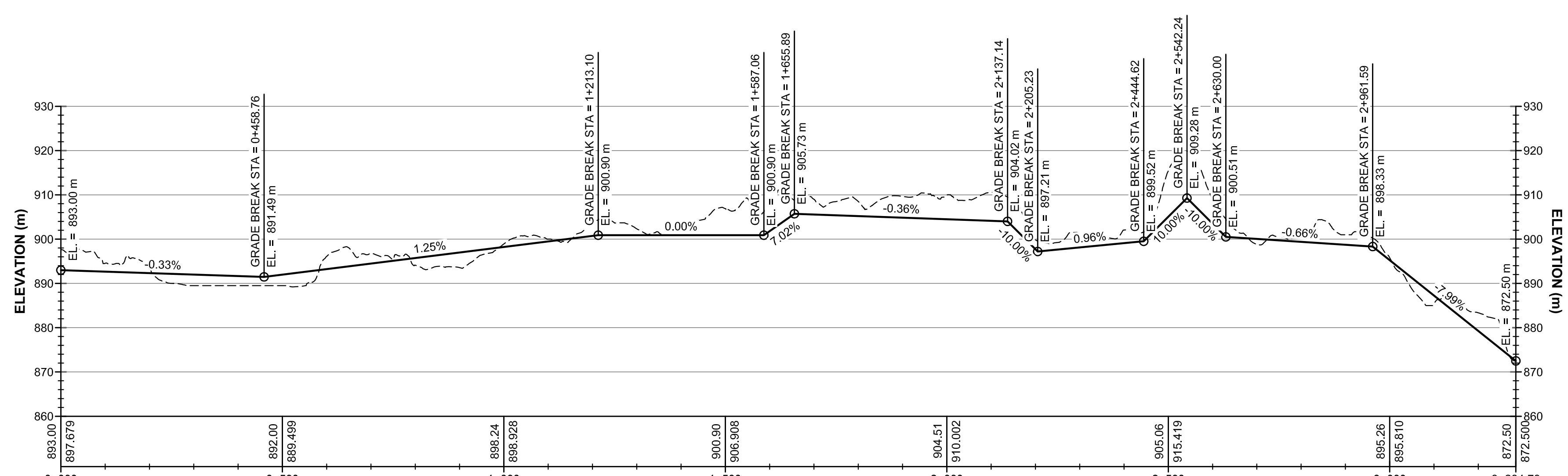
The access roadway alignment was selected to bypass major mine facilities as much as possible. Further modifications to this alignment that may be required in the future to accommodate the modifications to the mine site development are not considered in the cost calculations. The approximate initial cost to construct Alternative B is $5.6 million. All design details associated with the complex pipeline routing through the active mine corridor have not been determined for this assessment and could cause delays in the development of this Project. Additional costs associated with subsequent modifications that will be required due to the development of the mine site, construction of haul roads and the overland conveyor could be expected.



PLAN

ALTERNATIVE B ALIGNMENT

SCALE A



PROFILE

ALTERNATIVE B ROAD

HORIZONTAL SCALE B

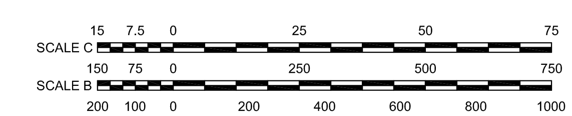
VERTICAL SCALE C

LEGEND:

JACKO LAKE WATER DIVERSION PIPELINE

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 10N.
2. CONTOUR INTERVAL IS 5 METRES.



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PETERSON CREEK DIVERSION ALTERNATIVE B

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FIGURE 3 REV 0

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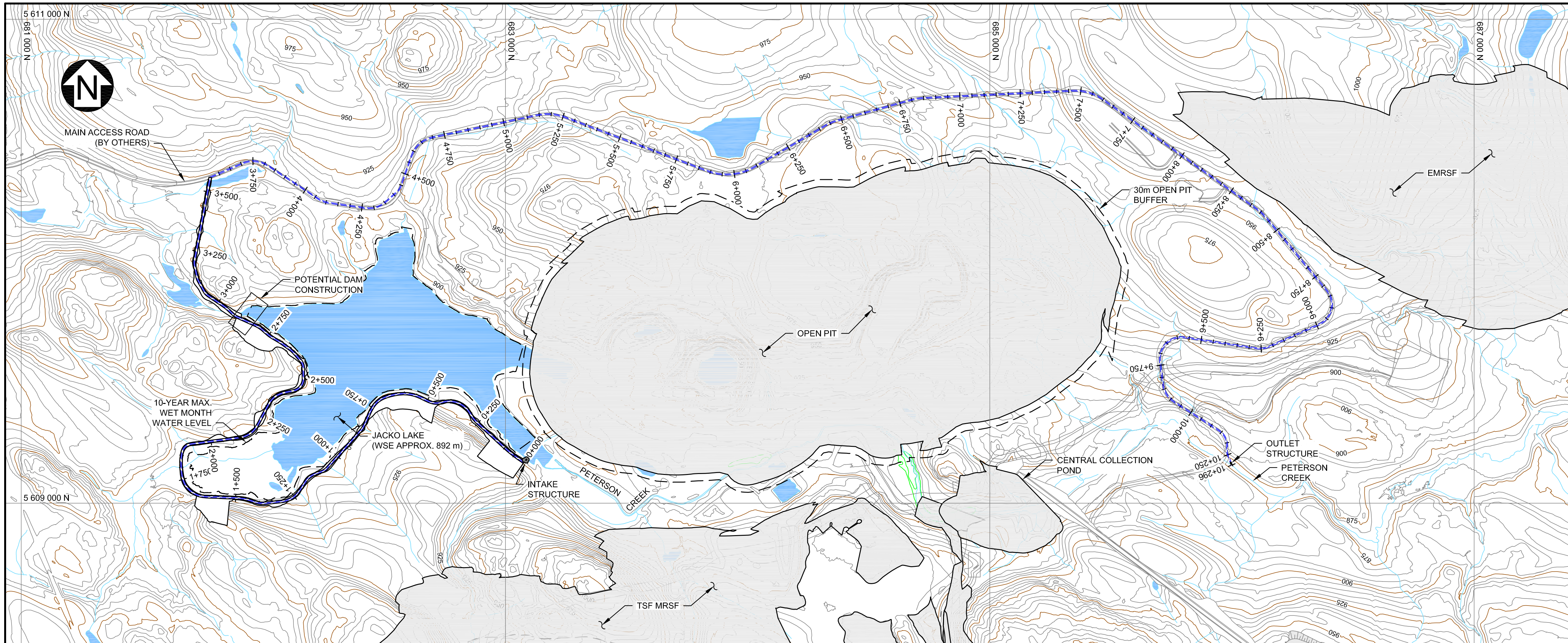
3.4 ALTERNATIVE C – SOUTHWEST ROUTE

Alternative C includes an approximately 10,300 m long, 450 mm diameter HDPE DR 11 pumped pipeline that would be routed around the west side of Jacko Lake, for connection to the main access road (Figure 4). The intake and the pump house are located at the shallow end of the southeast arm of the lake near the current spillway location. The pipeline alignment was selected to be outside of the 10-year maximum wet month water level of Jacko Lake at elevation 893.4 m (KP letter VA14-01370, attached as Appendix A), and to bypass a potential dam construction site on the west arm of Jacko Lake. The required access road connecting the intake and the main access road is approximately 3,500 m long.

3.4.1 Constructability and Cost

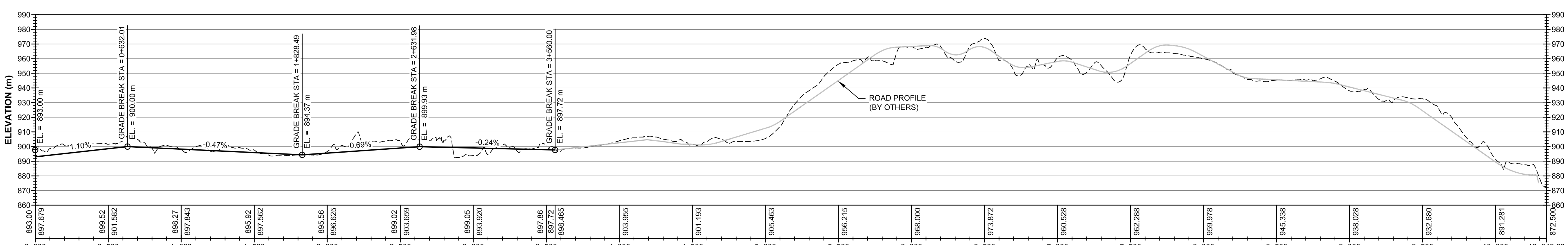
The alignment of Alternative C is well removed from any future mine facilities, but does require crossing the access road for the boat launch to Jacko Lake. The terrain around the perimeter of Jacko Lake is quite steep, resulting in construction of the access road in close proximity to the lake. A large volume of material must be excavated for construction of this alignment and would need to be locally stockpiled, either for future use or permanent storage. A substantial construction water management plan would need to be put in place to keep sediment laden water from entering Jacko Lake during construction. The approximate cost to construct Alternative C is $6.5 million.



PLAN

ALTERNATIVE C ALIGNMENT

SCALE A



PROFILE

ALTERNATIVE C ROAD

HORIZONTAL SCALE B

VERTICAL SCALE C

LEGEND:

- - - - JACKO LAKE WATER DIVERSION PIPELINE

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 10N.
2. CONTOUR INTERVAL IS 5 METRES.

SCALE C: 30 15 0 50 100 150 m

SCALE B: 300 150 0 500 1000 1500 m

SCALE A: 200 100 0 200 400 600 800 1000 m

KGHM AJAX MINING INC.

AJAX PROJECT

PETERSON CREEK DIVERSION ALTERNATIVE C

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FIGURE 4 REV 0

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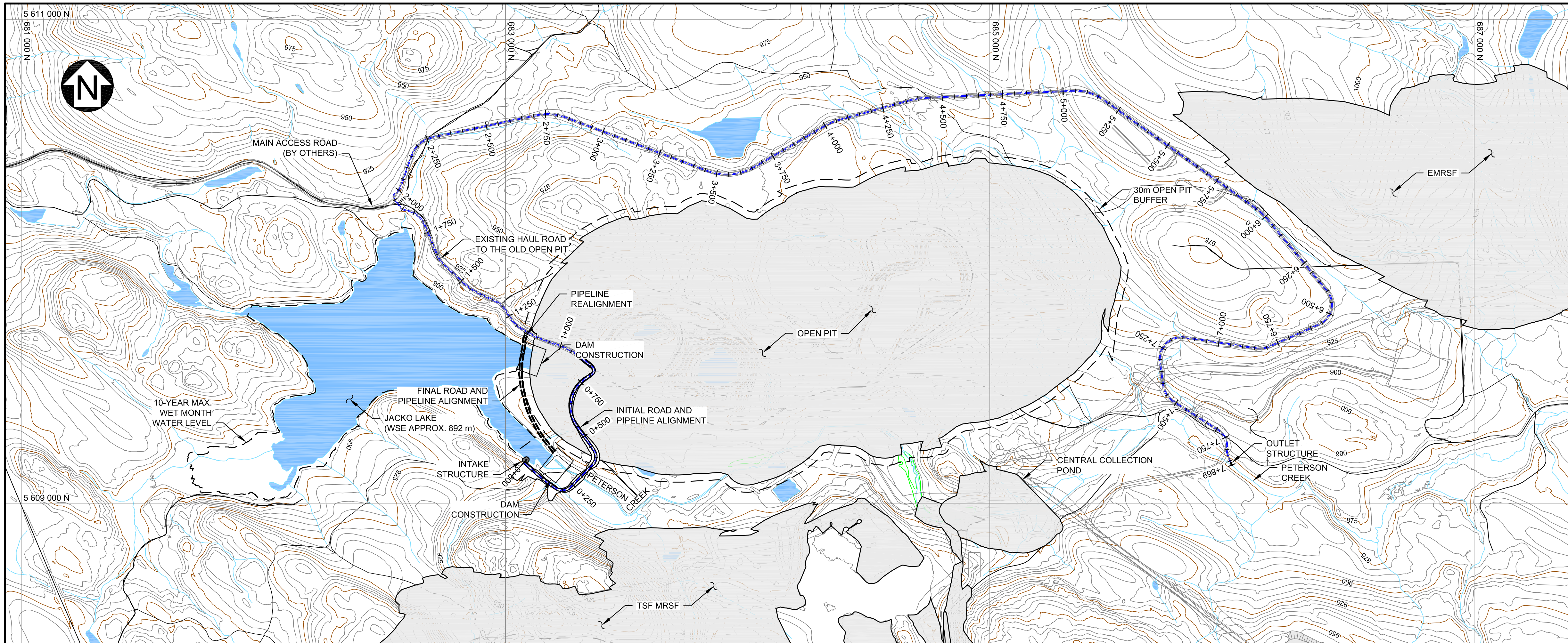
3.5 ALTERNATIVE D – SOUTHEAST ROUTE

Alternative D includes an approximately 8,000 m long, 450 mm diameter HDPE DR 11 pumped pipeline that would be routed around the east side of Jacko Lake, for connection to the main access road (Figure 5). The intake and the pump house are located at the shallow end of the southeast arm of the lake near the current spillway location. The pipeline would be initially placed around Jacko Lake through the future footprint of the Open Pit, which partially follows the existing haul road. This alignment is necessary to allow for uninterrupted construction of the dams on the southeast and northeast arms of the lake. The pipeline and the access road would need to be relocated once the cut-off dam on the northeast arm of the lake is constructed and the Open Pit excavation is started. The new pipeline and access road alignment would follow the buffer zone perimeter around the Open Pit. The required access road initially connecting the intake and the main access road is approximately 3,500 m long. About 1,000 m of this road will need to be relocated.

3.5.1 Constructability and Cost

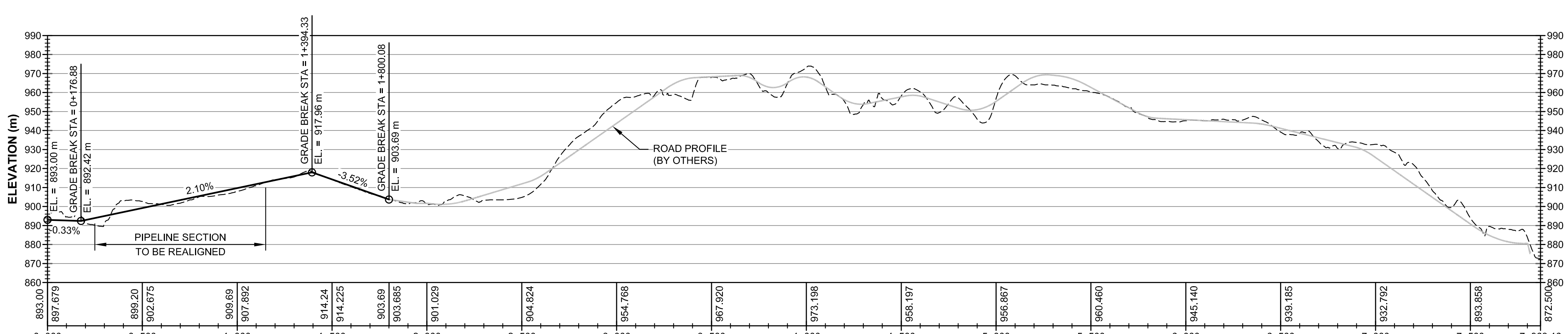
The alignment of Alternative D partially follows the existing haul road access to the current Open Pit, and as such would not require much work to construct in the initial stages. The alignment however, is within the footprint of the Open Pit, and would have to be relocated once the northeast dam in Jacko Lake has been constructed. The construction timing of the Peterson Creek diversion and the two dams needs to be carefully planned for this alternative. Realignments of the pipeline and the access road are not considered in the cost calculations. The approximate initial cost to construct Alternative D is $3.3 million.



PLAN

ALTERNATIVE D ALIGNMENT

SCALE A



PROFILE

ALTERNATIVE D ROAD

HORIZONTAL SCALE B

VERTICAL SCALE C

LEGEND:

JACKO LAKE WATER DIVERSION PIPELINE

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 10N.
2. CONTOUR INTERVAL IS 5 METRES.

SCALE C: 30 15 0 50 100 150 m

SCALE B: 300 150 0 500 1000 1500 m

SCALE A: 200 100 0 200 400 600 800 1000 m

KGHM AJAX MINING INC.

AJAX PROJECT

PETERSON CREEK DIVERSION ALTERNATIVE D

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FIGURE 5 REV 0

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3.6 ALTERNATIVE E – NORTH ROUTE WITH FLOW CIRCULATION

Alternative E is the same as Alternative A described in Sections 2.3 and 3.2 with the pipeline routed north of the Open Pit, along the main access road. Alternative E includes a circulation system in the southeast arm of the lake to preserve the current flow patterns in the lake. This circulation system would consist of a small pump located near the existing spillway that would draw water into a small diameter recirculation pipeline, which would be placed along the lake shore and extended back to the beginning of the southeast arm. The recirculation pipeline would discharge the water back in to the lake at the head of the southeast arm (no separate figure was prepared for this option).

3.6.1 Constructability and Cost

Construction of Alternative E would require very little if any future work to accommodate future mine development. It would utilize the existing/planned road and pipeline corridor along the main access road, minimizing the construction works required for this option. The addition of a flow circulation system is an inexpensive option to preserve the flow conditions in the southeast arm of the lake, if such requirement proves to be necessary. This system is outside of the active mine development zone and would not require modifications during mining operations. The approximate cost for Alternative E is $2.3 million.

3.7 PUMPED PIPELINE ALTERNATIVES CONCLUSIONS

Two intake locations and several pipeline alignments were evaluated in this assessment of Peterson Creek diversion alternatives. The intake locations were located at the northeast end of the lake and at the end of the southeast arm of lake, near the existing Jacko Lake Dam. The intake located at the northeast end of the lake is in an area with reasonably steep shores, which allows for a relatively simple intake structure with fish protection screens in combination with larger centrifugal pumps on the shore. The intake located at the southeast arm of the lake will be more complicated as the lake is very shallow in this area and occasionally dries up. It would likely require a decant-type intake structure with smaller submersible pumps to draw water from the lake, and larger centrifugal pumps on shore to provide sufficient head to push the water to the discharge end of the pipeline.

The pipeline alignments considered in combination with the two intake locations either followed a northern route outside of the active mine site, or a southern route through the active mine site. The alignments outside of the active mine site are simpler to construct and maintain, but are more expensive if the alignment is around the western perimeter of Jacko Lake due to the overall length of the pipeline and the new access road. The construction of a new access road required for the pipeline is the major component of each of the alternatives assessed.

Alternative E is somewhat different from the other four alternatives assessed in that it contains a self-standing smaller re-circulating system to aid in mimicking the existing flow patterns in the southeast arm of Jacko Lake. This re-circulating system is used in combination with Alternative A and offers a solution that integrates a simpler and less expensive pipeline alignment with a system that addresses the flow circulation in the lake.

Capital and annual operating cost estimates were prepared for each of these alternatives for comparison purposes (Table 1). The cost estimates cover the required earthworks for access roads and pump house construction, structural works along with the prefabricated building to house the pumps, and the pipelines, the pumps and other mechanical components for each alternative. In this cost comparison, it is assumed that the main access road for the mine would be constructed by others and is not included in the individual alternatives estimates. The cost calculation does not include the outlet works for any of the options, as the construction of these works would be identical for each of the five alternatives and would not have an impact on the assessment outcome. The cost also does not consider future modifications that may be required for Alternatives B and D as the mine site develops and the new major infrastructure is constructed. Alternatives A and E are the preferred options as they are the least expensive and the simplest to construct and maintain.

A Basis of Estimates and details of the individual cost estimates for the proposed Peterson Creek alternatives is presented in Appendix B.

Table 1 Peterson Creek Diversion – Alternatives Comparative Cost Summary

ALTERNATIVE	TOTAL CAPITAL COSTS	ANNUAL OPERATING COSTS ($/y)
A	**$ 2,100,000**	**$ 15,750**
B	**$ 5,600,000**	**$ 5,850**
C	**$ 6,500,000**	**$ 15,750**
D	**$ 3,300,000**	**$ 15,300**
E	**$ 2,300,000**	**$ 17,500**

4 – RECOMMENDATIONS

The constructability, cost, and the interaction with the active mine site were reviewed and compared for various gravity flow and pumped flow options to assess the preferred alternative for the Peterson Creek diversion system. The preliminary assessment of gravity vs. pumped flow options resulted in selection of a flow diversion through a pumped pipeline.

An additional assessment of various pumped pipeline options was conducted to maintain the existing flow circulation patterns in the southeast arm of Jacko Lake. Alternative A with the intake on the northeast end of the lake is the preferred option as it is the simplest to construct and the least expensive, but does not address the flow circulation in the southeast arm of the lake. Alternatives B through D have an intake in the southeast arm of the lake, located there to address the flow circulation in that area of the lake. These alternatives, however, all require new long access roads, with Alternatives B and D interacting with the active mine site, which complicates the construction of these alternatives and makes them more expensive and less suitable than Alternative A. Alternative E combines the simpler to construct and less expensive Alternative A with a small and inexpensive re-circulating pump/pipeline system in the south arm of the lake to maintain the flow circulation in that area if proven necessary.

Alternative E is the recommended alternative that utilizes the main access road corridor for the Peterson Creek diversion through a pumped pipeline in combination with a re-circulating pumping system in the southeast arm of Jacko Lake.

5 – REFERENCES ▲R1

CDA, 2007. Dam Safety Guidelines 2007. The Canadian Dam Association.

Knight Piésold Ltd (KP). 2015. Ajax Project – Basis of Estimates Report. Ref. No. VA101-246/26-5, Rev 0, December 18, 2014.

6 – CERTIFICATION

This report was prepared and reviewed by the undersigned.

PROFESSIONAL PROVINCE OF Dr. V. MARTIN # 29814 BRITISH COLUMBIA ENGINEER
16 June, 2015.

Prepared: ______________________________
Violeta Martin, Ph.D., P.Eng.
Senior Hydrotechnical Engineer

Reviewed: ______________________________
Les Galbraith, P.Eng.
Specialist Engineer | Associate

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Approval that this document adheres to Knight Piésold Quality Systems:

APPENDIX A

JACKO LAKE CAPACITY DURING FLOOD EVENTS

(Pages A-1 to A-8)

April 9, 2015

File No.:VA101-246/26-A.01
Cont. No.:VA14-01370

ISO 9001 - FS 64925
ISO 14001 - EMS 550121
OHSAS 18001 - OHS 550122

Mr. Daniel Lefebvre
Manager of Engineering
KGHM Ajax Mining Inc.
200 - 124 Seymour Street
Kamloops, British Columbia
Canada, V2C 2E1

Dear Daniel,

Re: Ajax Project – Jacko Lake Capacity during Flood Events

Knight Piésold (KP) was requested by KGHM Ajax Mining (KGHM) to assess potential storage in Jacko Lake for various return period floods, which are presented in this letter. This assessment provides information on the Jacko Lake elevation and required capacity to store the runoff from the investigated storm events for two scenarios:

1. Jacko Lake dammed in three locations with water backing up into the existing Jacko Creek channel, and
2. Jacko Lake dammed in two locations with water flowing west through a natural low point out of the Jacko Lake catchment into the adjacent Inks Lake catchment.

INTRODUCTION

Jacko Lake collects runoff from the headwaters of Jacko Creek to the south and a smaller catchment north of Jacko Lake which drains an unnamed creek, as shown on Figure 1. The total catchment area of Jacko Lake is 39.7 km^2. The outlet of Jacko Lake is controlled by an existing dam (crest elevation 893 m) and overflow spillway (invert elevation 892 m), which discharges into Peterson Creek on the east side of the lake. At the dam location, there is also a low level outlet controlled by a manually operated gate, which allows for regulated releases of water from Jacko Lake to Peterson Creek during periods when there is no flow over the spillway. The low level outlet is controlled by the water steward, who releases water to the downstream users as required.

The current alignment of Peterson Creek is through the future mine site with one reach encroaching into the Open Pit area. The water management plan for the Ajax Mine proposes to divert a section of Peterson Creek through a pipeline around the pit. The proposed pipeline is designed to handle annual flows and the flows for a 10-year wet month with small temporary storage in Jacko Lake, but not large storm events. The pipeline design is not discussed further in this letter.

This letter focuses on the required storage in Jacko Lake that would be needed to store flood events with various return periods. Specifically, the events investigated are the inflows generated from a 10-year wet month, the 200-year 24-hour rain event, the Probable Maximum Flood (PMF) generated from Probable Maximum Precipitation (PMP) modelled as rain, and the PMF generated from a PMP in addition to a snowmelt generated from a 100-year snowpack.

The two scenarios for which the required Jacko Lake capacity and dam height were determined are:

1. Jacko Lake is dammed in three locations with two dams on the east side of the lake blocking the outflows into Peterson Creek and the open pit, and one dam on the west side blocking the outflows into the Inks Lake catchment.
2. Jacko Lake is dammed in two locations on the east side as described in #1, with outflows allowed west into the Inks Lake catchment through a current low point in Jacko Lake that is at elevation 892.5 m.

DESIGN STORM EVENTS

Annual extreme daily rainfall values for the project site were presented in the Ajax hydrometeorology report (KP, 2013a) and calculated by applying an orographic factor to the historical extreme rainfall record from the Kamloops Airport. The estimated return period 24-hour extreme rainfall values for the project site are presented in Table 1. Also presented in Table 1 is an estimate of the PMP and a PMP with snowmelt from a 1 in 100 year extreme snowfall. The values assessed in this study are shown in bold.

Table 1 24-hr Extreme Rainfall Values

Return Period (years)	Extreme Event (mm)
10	43
25	51
50	57
100	63
200	**69**
PMP	**221**
PMP plus snowmelt	**329**

In addition to the longer return period events, the 10-year wet month was also evaluated. The inflow volume for Jacko Lake for this assessment was based on the largest 10-year wet monthly flow for the hydrology station JACINF (shown on Figure 1), as presented in the Ajax hydrometeorology report (KP, 2013a).

FLOOD HYDROLOGY

In order to assess peak lake elevations during storm events, return period storms were modeled with the stormwater runoff software *HydroCAD*© using return period precipitation values. The following inputs were used in the flood routing model:

- The U.S. Soil Conservation Service (SCS) storm type: Type II
- Antecedent moisture condition: 2
- 24 hour extreme rainfall as highlighted in Table 1
- Contributing catchment surface area as shown on Figure 1

The other inputs required for the model are Time of concentration (T_c) and the SCS curve number (CN). These parameters were used to make the Jacko Lake rainfall-runoff model consistent with previous models prepared by KP for flows resulting from 24-hour 200-year precipitation and PMP events in the adjacent catchment of Alkali Creek, which were developed as part of the Alkali Creek diversion channel design (KP, 2013b) and dam safety reviews for the Afton TSF (KP, 2014).

PROBABLE MAXIMUM FLOOD

The PMF inflow hydrograph for Jacko Lake was generated using the estimated PMP plus corresponding snowmelt, as per standard practice, which is outlined by the Canadian Dam Association (CDA, 2007) as follows:

1. *Determine PMP on the basin.*
2. *Determine rainfall and snow accumulation statistics over the basin.*
3. *Establish a rainfall-runoff model of the basin based on historic rainfall and runoff data.*
4. *Define initial conditions on the basin that prevail when the PMP occurs. These conditions should be such that the soil moisture is at a maximum.*
5. *Compute PMF with the rainfall-runoff model, using established PMP and initial conditions.*

Two PMFs are computed:

- *The summer-autumn PMF, which is generated by the summer-autumn PMP*
- *The spring PMF, which is defined as the maximum of the following two cases:*
  - *PMF computed with spring PMP and snow accumulation with frequency of 1/100 year*
  - *PMF computed with probable maximum snow accumulation and rainstorm with frequency of 1/100 year*

The PMF modelling scenario envisioned for Jacko Lake was a spring "pineapple express" storm rapidly delivering huge amounts of moisture to a frozen basin covered by snow and ice. This involved a PMP of 221 mm in 24 hours occurring in conjunction with 108 mm of snow water equivalent snowmelt, resulting in a PMF peak inflow in the order of 200 m^3/s and a corresponding flood volume in the order of 9.7 Mm^3. This volume equates to an average runoff coefficient of 0.74, which was computed with CN values ranging from 70 to 80 for different areas. This is not an unreasonably high runoff coefficient given that reasonably wet antecedent moisture conditions are required for PMF estimation and the fact that in this case the ground is assumed to be covered by snow and ice at the onset of the PMP. These values are for a drainage area of 39.7 km^2 and correspond to a peak unit runoff of approximately 5 $m^3/s/km^2$, which is not particularly exceptional when considered in the context of historical flood events in other regions of BC.

While these values may seem excessively large when compared to historical peak flow values for the Kamloops region, and are at the upper end of the regional range presented by Abrahamson and Pentland (2010) in their evaluation of PMF values for BC, the PMF is so extreme that it is typically very poorly represented by historical flood data. Furthermore, it must be kept in mind that the Abrahamson and Pentland values are based on a very small dataset, and there is huge uncertainty associated with their results, as they strongly urge readers to recognize. One would have to review the Abrahamson and Pentland dataset in detail and understand the historical context of each PMF estimate before accepting their regional PMF equation as appropriate for the sizing of hydraulic structures at the Ajax Mine site. It is worth noting that the Abrahamson and Pentland's PMF equation for the Kamloops region produces flow values that are an order of magnitude smaller than their equations for all other regions in BC.

The definition of the PMF, as presented by the CDA (1995), is "Estimate of hypothetical flood (peak, volume and hydrograph shape) that is considered to be the most severe 'reasonably possible' at a particular location and time of year, based on relatively comprehensive hydrometeorological analysis of critical runoff-producing precipitation (snowmelt if pertinent) and hydrologic factors favorable for a maximum flood runoff." When viewing this definition, it is very important to recognize what is meant by the term 'reasonably possible.' It does not mean a flood event that one might expect to see once in 100 years, or even once in 1,000 years. Rather, the PMF is considered to be such an extreme event that it must be derived deterministically because it cannot be calculated statistically. The available historical records, regardless of length, are insufficient to provide an appropriate basis for a meaningful statistical analysis. Nonetheless, if one was to assign a return period to the PMF, it is commonly thought to be in the order of 10^4 years to 10^6 years. Examples of reasonably possible hydrometeorological conditions commonly used to determine PMF values include (i) probable maximum precipitation (PMP) plus the 100 year snowpack in combination with a high temperature sequence; (2) probable maximum snowpack (PMS) with an extreme temperature sequence, combined with a 100 year rainfall event; (3) a 100 year rainfall event followed by the PMP occurring within a few days. In this setting, a winter "pineapple express" storm rapidly delivering huge amounts of moisture to a frozen basin covered by snow and ice can be considered to be a reasonably possible condition for the Jacko Lake basin. In contrast, having the PMP occurring coincidentally with the PMS and an extreme temperature sequence would not be considered to be 'reasonably possible.'

PEAK FLOOD VOLUMES AND JACKO LAKE ELEVATIONS

Modeled return period flood volumes and resulting Jacko Lake elevations are presented in Tables 2 and 3. The flood volumes indicate the required additional storage in Jacko Lake, with the assumption that the lake was full to the current spillway elevation of 892 m at the onset of the storm event or at the beginning of the 10-year wet month. All events were modelled with the assumption that the Peterson Creek diversion pipeline and pumping system were not operating, since they are not designed for large storm events.

SCENARIO 1

The first layout with three proposed dams confines the lake within the existing topography and does not allow for any water release when the pumping system is not operating. The storm volume is contained within the three dams with the lake backwatering into the existing Jacko Creek floodplain.

Figure 2 presents peak lake elevations for the three storm events and the 10-year wet month, with elevations and volumes also summarized in Table 2. The Jacko Lake level is assumed to be at 892 m at the onset of each storm. During the 10 year wet month, all inflows are assumed to be captured and no losses are considered.

Table 2 Modeled Peak Lake Volumes and Elevations for Jacko Lake with no Lake Outlets

Return Period	Inflow Volume (m^3)	Peak Lake Elevation (m)
10 year wet month	671,000	893.4
1:200 year	200,000	892.4
PMP	5,850,000	900.2
PMP plus snowmelt	9,650,000	902.3

SCENARIO 2

The second layout maintains two dams on the east side of the lake and allows the lake to spill to the west through an existing low point at elevation 892.5 m. Figure 3 presents the peak lake elevation for the two PMP events using this water management strategy. The resulting lake elevations are also summarized in Table 3. In this scenario, the lake level was also assumed to be at 892 m at the onset of each storm.

This model only considered the Jacko Lake catchment; the impacts to the Inks Lake catchment or further downstream were not investigated. The capacity of the west outlet downstream of Jacko Lake was not assessed for potential backwatering or scouring effects. The 10-year wet month and the 200-year 24-hour storm events were not analyzed in this scenario because it was shown in Scenario #1 that increases in lake elevations with these events were small.

Table 3 Modeled Peak Lake Volumes and Elevations for Jacko Lake with a West Outlet

Return Period	Inflow Volume (m^3)	Peak Lake Elevation (m)	Peak Outflow (m^3/s)
PMP	5,850,000	895.0	133
PMP plus snowmelt	9,650,000	895.5	184

CONCLUSION

This study indicates that the 200-year event could be handled with the current Jacko Lake configuration and that a 10-year wet month could be contained with small dams, with lake elevations rising to 892.4 m and 893.4 m respectively. The dams required for containment of the 10-year wet monthly flow volume would need to be sufficiently high to include a freeboard allowance. The current lake outlet is through a spillway with an invert elevation of 892 m and the current dam crest elevation is 893 m.

The containment of the PMF volume resulting from the PMP only, or a combination of the PMP and the 100-year snow pack, would require considerably higher dams than the current arrangement for Jacko Lake. If these two events were to be fully contained, the lake elevation would rise to 900.2 m and 902.3 m, respectively. This is an increase of 8.2 m and 10.3 m with respect to the current spillway invert of 892 m. If the lake outflow into the Inks Lake catchment to the west is enabled, the lake would rise to 895 m and 895.5 m for the two PMF events, respectively. The dams in all cases investigated above would need to be higher than the maximum lake elevation to include freeboard.

The outflows from Jacko Lake towards Inks Lake would be considerable, potentially causing additional flooding and erosion outside of the Jacko Lake catchment. These impacts were not assessed as part of this study. In addition, no assessment of dam consequence classification for the potential future Jacko Lake dams was undertaken in this study.

We trust that this information meets your needs. If you have any questions or comments please contact the undersigned.

Yours truly,
KNIGHT PIESOLD LTD.

ORIGINAL SIGNED [redacted]

Prepared: [redacted]
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Senior Engineer - Hydrotechnical

ORIGINAL SIGNED [redacted]

Reviewed: [redacted]
Jaime Cathcart, Ph.D., P.Eng.
Specialist Hydrotechnical Engineer

Approval that this document adheres to Knight Piésold Quality Systems:

Attachments:

Figure 1 Rev 0	Jacko Lake Catchments
Figure 2 Rev 0	Jacko Lake Water Levels for Various Storm Events with No Outlets
Figure 3 Rev 0	Jacko Lake Water Levels for PMP Storm Event with West Outlet

References:

Abrahamson, B.T. and R.S. Pentland, 2010. Probable Maximum Flood Estimator for British Columbia. Agriculture and Agri-Foods Canada, Agri-Environment Services Branch.

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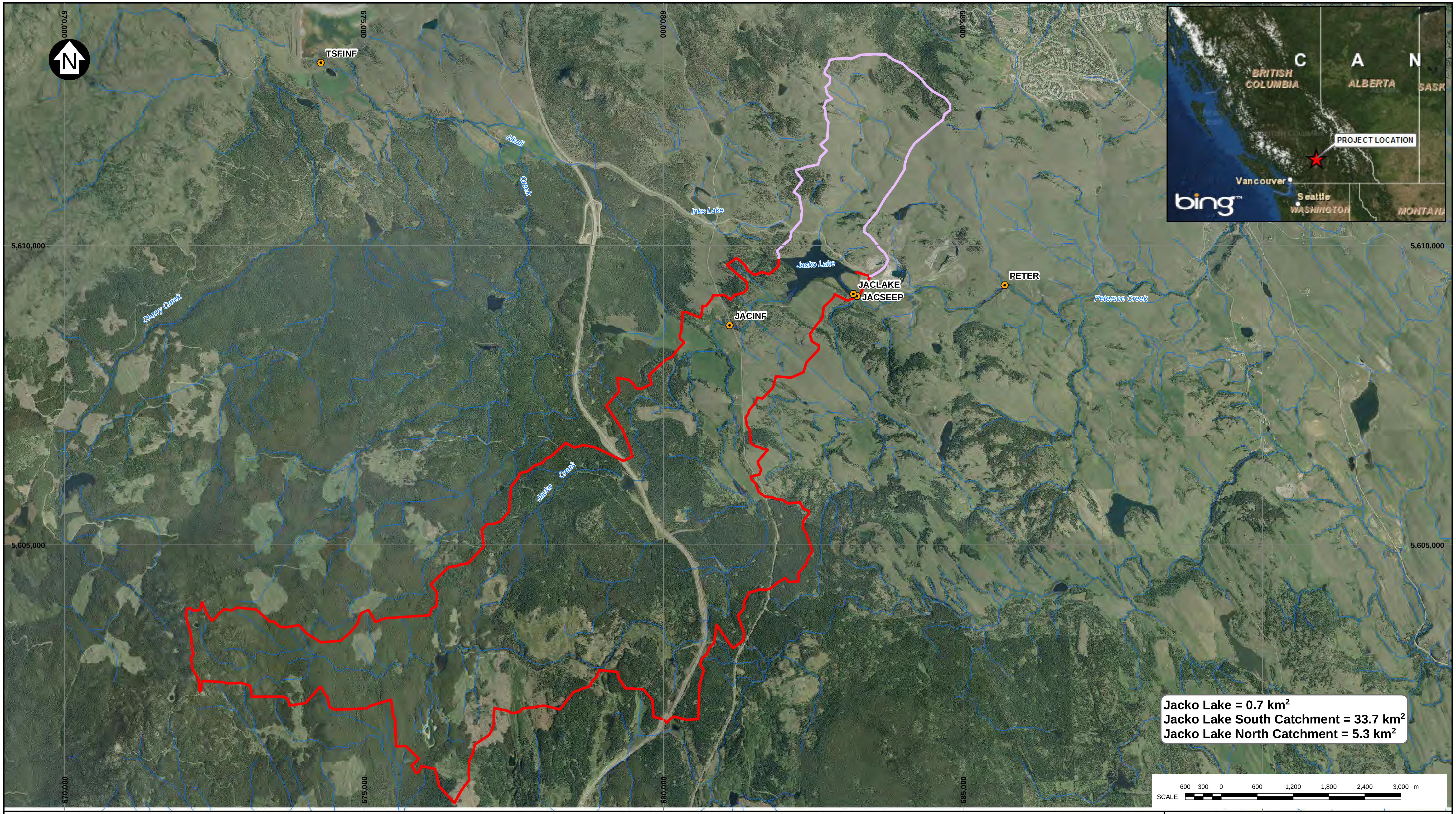
Knight Piésold Ltd (KP). 2014. Dam Safety Review – Afton Tailings Storage Facility. Ref. No. VA101-246/16-2, Rev 0, March 28, 2014.

Smith, C.D., 1998. The PMF Does Have a Frequency. Canadian Water Resources Journal, Vol.23, No.1, pp. 1-7.



LEGEND:

- HYDROMETRIC GAUGING STATION
- JACKO LAKE NORTH CATCHMENT
- JACKO LAKE SOUTH CATCHMENT

NOTES:

1. BASE MAP: BC TRIM AND NTS BACKGROUND IMAGERY PROVIDED BY ABACUS.

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:60,000
FOR 11X17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER
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AJAX PROJECT

JACKO LAKE CATCHMENTS

Knight Piésold CONSULTING

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FIGURE 1		REV 0

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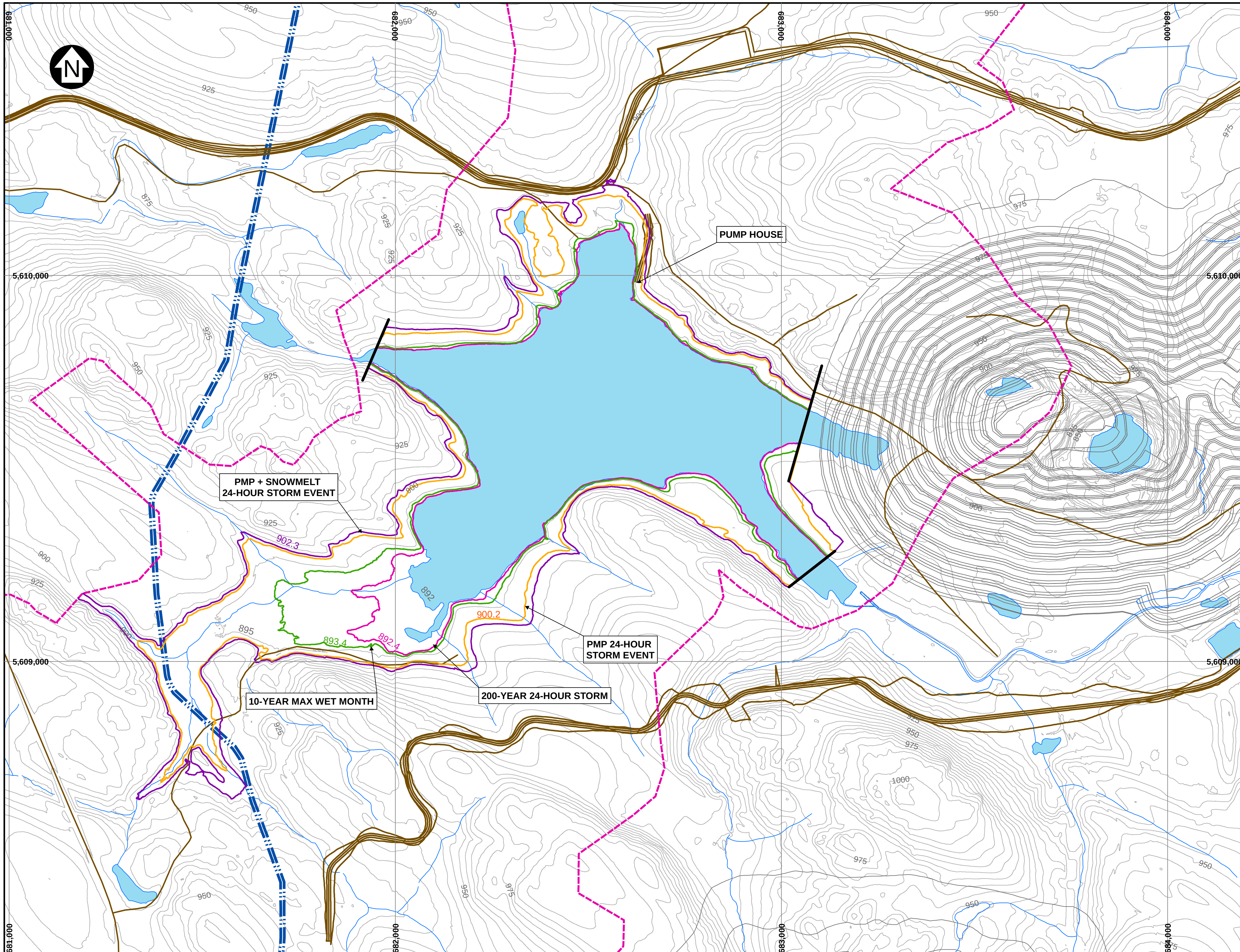

LEGEND:

- KINDER MORGAN PIPELINE
- ROADS
- RIVER/CREEK
- DAM LINE
- 200-YEAR 24-HOUR STORM EVENT (ELEVATION 892.4 m)
- 10-YEAR MAX WET MONTH (ELEVATION 893.4 m)
- PMP 24-HOUR STORM EVENT (ELEVATION 900.2 m)
- PMP + SNOWMELT 24-HOUR STORM EVENT (ELEVATION 901.8 m)
- CONTOUR (5 m)
- MINE INFRASTRUCTURE
- JACKO LAKE CATCHMENT

NOTES:

1. BASE MAP: ABACUS AERIAL ORTHOPHOTOGRAPHY AND KGHM AJAX MINING INC.
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 83 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:10,000 FOR 11X17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. TERRAIN MAPPING EXTENT FROM 101-246\8\A\CORRESPONDENCE\INCOMING\2013-07-07 POLAR GEOSCIENCE REPORT
5. MINE FACILITIES FROM M:\1\01\00246\26\A\ACAD\DWGS\5100-10-007\C0002-KA39-5100-10-007_RB.DWG
6. JACKO LAKE WATER SURFACE ELEVATION ASSUMED TO BE AT 892 M AT THE START OF EACH STORM EVENT.
7. MODEL INCLUDES JACKO LAKE CATCHMENT ONLY.

SCALE 100 50 0 100 200 300 400 500 m

KGHM AJAX MINING INC.

AJAX PROJECT

JACKO LAKE WATER LEVELS FOR VARIOUS STORM EVENTS WITH NO OUTLETS

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-246/26	VA14-01370

FIGURE 2 REV 0

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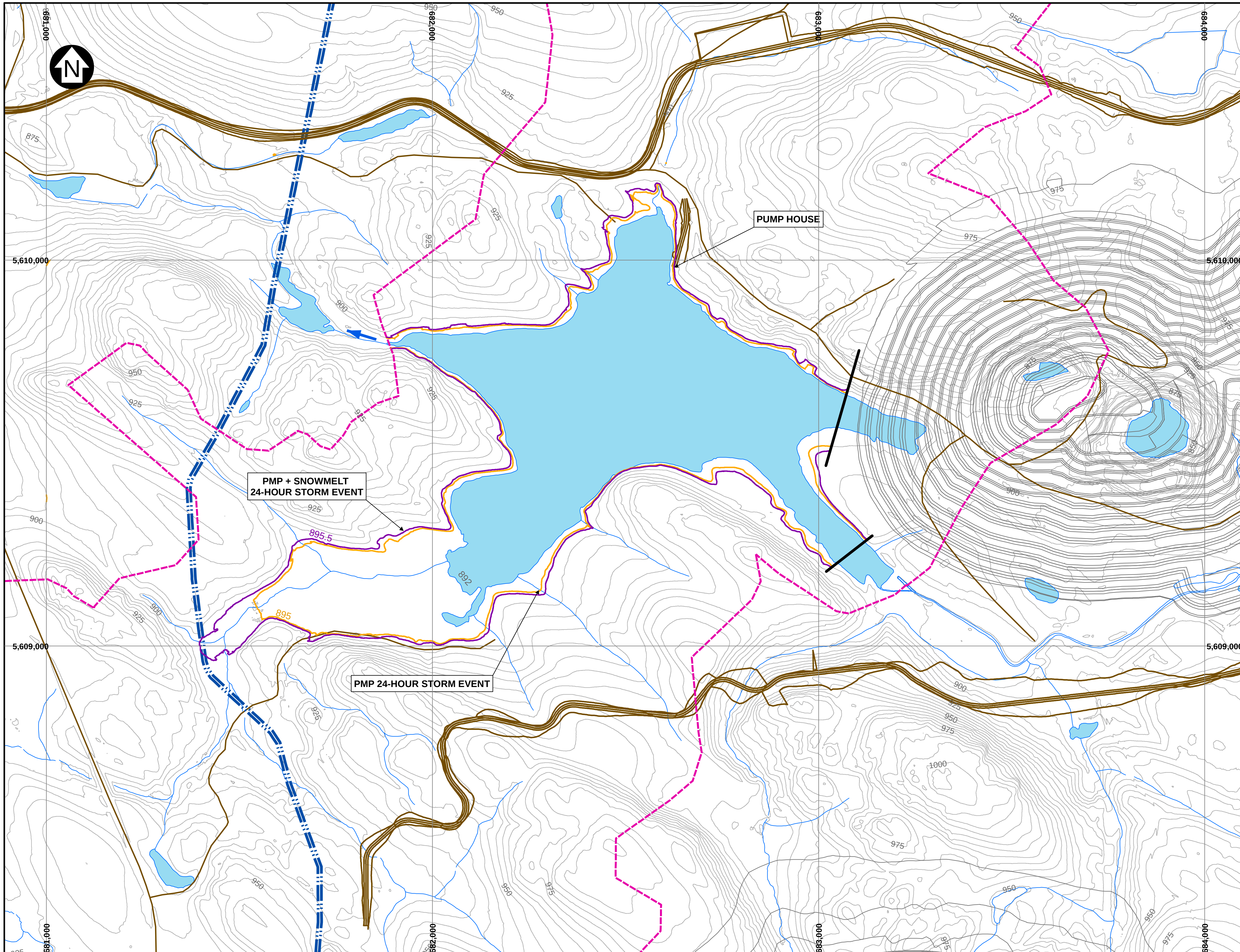

LEGEND:

- KINDER MORGAN PIPELINE
- ROADS
- RIVER/CREEK
- DAM LINE
- PMP 24-HOUR STORM EVENT (ELEVATION 895.0 m)
- PMP + SNOWMELT 24-HOUR STORM EVENT (ELEVATION 895.9 m)
- CONTOUR (5 m)
- MINE INFRASTRUCTURE
- JACKO LAKE CATCHMENT

NOTES:

1. BASE MAP: ABACUS AERIAL ORTHOPHOTOGRAPHY AND KGHM AJAX MINING INC.

2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 83 UTM ZONE 10N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:10,000 FOR 11X17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

4. TERRAIN MAPPING EXTENT FROM 101-246\8\A\CORRESPONDENCE\INCOMING\2013-07-07 POLAR GEOSCIENCE REPORT

5. MINE FACILITIES FROM M:\1\01\00246\26\A\ACAD\DWGS\5100-10-007\C0002-KA39-5100-10-007_RB.DWG

6. JACKO LAKE WATER SURFACE ELEVATION ASSUMED TO BE AT 892 M AT THE START OF EACH STORM EVENT.

7. MODEL INCLUDES JACKO LAKE CATCHMENT ONLY.

SCALE 100 50 0 100 200 300 400 500 m

KGHM AJAX MINING INC.

AJAX PROJECT

JACKO LAKE WATER LEVELS FOR PMP STORM EVENT WITH WEST OUTLET

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-246/26	VA14-01370

FIGURE 3 REV 0

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APPENDIX B

SUMMARY OF COST ESTIMATE DEVELOPMENT

(Pages B-1 to B-8)

APPENDIX B

LIST OF UNIT RATES DEVELOPED

Knight Piésold Ltd. (KP) has been requested by KGHM Ajax Mining Inc. (KGHM) to provide an alternatives assessment report for the diversion of Peterson Creek around the mine site, and rough order of magnitude costs to support these alternatives. These costs were developed and based on previous rates prepared in the Basis of Estimates Report for the Ajax Preliminary Design (Knight Piésold, 2014). The cost estimate contains preliminary costs for the following items:

- Earthworks Unit Rates
    - Clearing, Grubbing & Topsoil Stripping
    - General Cut/Fill
    - Pipeline Burial Costs
    - Access Road Wearing Course
    - Riprap
- Mechanical Unit Rates
    - HDPE Pipes and Valves
    - Prefabricated Steel Intake Superstructure
    - Pumps and Pump Motors
    - Fish Screens
    - Galvanized Steel Culvert & Couplers
- Indirects

The following assumptions have been made for all unit rate development:

- All work to be carried out by a contractor fleet.
- CAT 777D Haul Trucks, CAT 992K Large Wheel Excavators and CAT D10T Dozers assumed for construction; CAT 740 Haul Trucks assumed for smaller scale hauls and excavations (e.g. riprap liner haul).
- Labour rate of $103.98/hr for Heavy Civil Works provided by KGHM.
- Productivity Factor of 1.15 provided by KGHM.
- Haul distances measured along access roads and haul roads from centroid to centroid of construction objects and material sources.
- Maximum on-site speed limit of 25 km/hr provided by KGHM.
- Densities of all materials are assumed from typical values and previous experience.
- All equipment productivities and capacities from the CAT Performance Handbook, Ed. 44.
- All rental rates of equipment referenced from the 2013/2014 BC Blue Book (B.C. Road Builders & Heavy Construction Association, 2013).
- Quantities are rough order of magnitude estimates based on the length of the proposed alternatives.

BASIS OF UNIT RATE DEVELOPMENT

1.1 EARTHWORKS UNIT RATES

1.1.1 Clearing, Grubbing & Topsoil Stripping

Foundation preparation works will necessitate the removal of topsoil material prior to construction. This involves the removal of the topsoil layer (approximately 300 mm thick) to windrow through the use of a CAT D10T dozer. The stripped material will then be loaded to CAT 777D trucks through the use of CAT 992K Large-Wheel excavators before being hauled to stockpiles (average one-way haul distance of 1 km). The unit rate for topsoil stripping ($6.98/m^3$) will also account for clearing and grubbing operations in areas where foundation preparation works are required.

1.1.2 General Cut/Fill Material

For construction of roads and pipeline alignments a certain volume of general cut/fill of overburden material will be required. Unit rates of $5.54/m^3$ and $6.02/m^3$ for cut and fill respectively include costs for the excavation, load and haul of material using CAT 992K Large-Wheel Loaders and CAT 777D Haul Trucks within an average 0.5 km haul distance, and the spreading of material using a CAT D10T dozer.

1.1.3 Pipeline Burial Material

The unit rate for general fill of $6.02/m^3$ (above) has been adopted as the unit rate for pipeline burial.

1.1.4 Access Road Wearing Course

New roads will need to be pioneered using a contractor fleet for access to construction areas for haul trucks, and perimeter access roads for the TSF. A surface course for these roads will be generated using random fill material from a local borrow source (within 0.5 km of where it is to be placed). The unit rate of $5.21m^3$ for road surface material includes the cost of loading and hauling of random fill material from the borrow source to where it is to be placed using CAT 992K Large-Wheel Loaders and CAT 777D Haul Trucks, placed and spread using CAT D10T dozers, and compacted by haul truck/pickup truck traffic on the roads.

1.1.5 Riprap Lining

Drilling and blasting of material will be required to generate blast rock for riprap material. This material will then have to be screened to meet the required D_{50} size for the specified riprap. This unit rate includes a unit rate for drilling and blasting of material ($5.38/m^3$), and a unit rate for the screening of material ($7.01/m^3$), followed by the loading and hauling of material to a local stockpile using CAT 992K Large-Wheel Loaders and CAT 740 Haul Trucks, and spread using a CAT D10T dozer. The unit rate of $26.25/m^3$ has been developed for an average one-way haul distance of 5 km.

1.2 MECHANICAL UNIT RATES

1.2.1 HDPE Piping and Valves

Quotes were obtained from vendors such as Sandale Utility Products and Corix Water Products for the larger diameter pipelines and valves. If no quotes were obtained, KP has in-house programs to estimate the material, labour, and equipment cost of HDPE pipe on a per metre basis. Valves are estimated based on diameter.

Air release/vacuum breaker valve supply prices were obtained from vendor Summit Valve, installation prices were estimated from previous project experience.

1.2.2 Prefabricated Pump-Houses and Superstructures

Estimates for prefabricated pump-houses and other related superstructures were developed from KP in-house estimates which included lump sum superstructure cost, and slab construction based on structural concrete unit rate of $1,000-$1,500/m^3$ installed cost depending on volume and geometry of structure.

1.2.3 Pumps and Pump Motors

Vendor quotes were obtained for specific equipment such as pumps. Smaller equipment prices may be extrapolations of quotes for similar products. Installation and equipment costs were estimated by KP.

1.2.4 Fish Screens

Vendor quotes were obtained for fish screens from Johnson Fish Screens. Installation and equipment costs were estimated by KP.

1.2.5 Galvanized Steel Culvert and Couplers

Vendor quotes were obtained for galvanized steel culverts and couplers for linking sections of steel culvert from Menards Home Improvement. Installation and equipment costs were estimated by KP.

1.3 ANNUAL OPERATING COSTS

Preliminary operating costs have been developed for the electrical operation (when required) of the Peterson Creek Diversion System. Operating costs were developed from an estimated unit rate of CAD$45/MWhr for electrical power supply. Pumping requirements were developed based on design parameters for pump system operating hours as follows:

- Peterson Creek pumps operating 5 months at 100% capacity, (average annual operating percentage of approximately 42%).

1.4 INDIRECTS

There are a number of other items relating to the preliminary cost estimate that have not been captured in unit rate development for Earthworks. These items include Quality Assurance and Quality Control (QA/QC), mobilization and demobilization from site, long-term management of the facility and on-going water quality monitoring. Table A1 contains a contingency of 30%, the same factor as used for the Preliminary Design Cost Estimate.

REFERENCES

Knight Piésold Ltd. 2014. *Preliminary Design Cost Estimate Basis of Estimates Report.* VA101-256/26-5.

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TABLE B.1

KGHM AJAX MINING INC.
AJAX PROJECT

PETERSON CREEK DIVERSION
ALTERNATIVE COST SUMMARY

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ALTERNATIVE	CAPITAL COSTS					OPERATING COSTS		
	EARTHWORKS	INTAKE STRUCTURE	MECHANICAL	INDIRECTS	TOTAL CAPITAL COSTS	Required Pump Horsepower (HP)	Annual Power Consumption (MWh)	ANNUAL OPERATING COSTS ($/y)
A	$ 179,000	$ 152,000	$ 1,276,000	$ 482,000	**$ 2,100,000**	135	350	**$ 15,750**
B	$ 3,512,000	$ 151,000	$ 632,000	$ 1,289,000	**$ 5,600,000**	50	130	**$ 5,850**
C	$ 2,435,000	$ 151,000	$ 2,429,000	$ 1,505,000	**$ 6,500,000**	135	350	**$ 15,750**
D	$ 550,000	$ 151,000	$ 1,872,000	$ 772,000	**$ 3,300,000**	130	340	**$ 15,300**

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NOTES:

1. TOTAL COST REPRESENTS MECHANICAL, STRUCTURAL AND EARTHWORKS.
2. OPERATING COSTS ASSUME ELECTRICAL POWER SUPPLY COST OF $45/MWhr.

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TABLE B.2

KGHM AJAX MINING INC.
AJAX PROJECT

PETERSON CREEK DIVERSION
PIPELINE ALTERNATIVE A

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TASK NO.	DESCRIPTION	UNIT	UNIT RATE ($/unit)	QUANTITY (unit)	COST ($CAD)
2000	**PETERSON CREEK DIVERSION**				
2100	**EARTHWORKS**				
	Clearing, Grubbing & Topsoil Stripping	m3	$ 6.98	2,250	$ 15,705
	General Cut	m3	$ 5.54	21,000	$ 116,340
	General Fill	m3	$ 6.02	6,000	$ 36,120
	Access Road Wearing Course	m3	$ 5.21	2,055	$ 10,707
				SUB-TOTAL:	**$ 178,872**
2300	**INTAKE STRUCTURE**				
	Structural Concrete	m3	$ 1,267	55	$ 69,685
	Lock Block Pipe Supports Type 1 or 2	ea.	$ 620	10	$ 6,200
	Peterson Creek Intake Structure Prefab Steel Superstructure	ea.	$ 75,873	1	$ 75,873
				SUB-TOTAL:	**$ 151,758**
2400	**MECHANICAL AND ELECTRICAL**				
	Peterson Creek Centrifugal Pump 200 HP Self Priming	ea.	$ 36,500	2	$ 73,000
	HDPE 400mm HDPE DR11	m	$ 185	6,200	$ 1,147,000
	HDPE 200mm HDPE DR26	m	$ 62	100	$ 6,200
	Fish Screen	ea.	$ 17,458	2	$ 34,916
	Combination Air Release/Vacuum Valve	ea.	$ 1,478	10	$ 14,780
				SUB-TOTAL:	**$ 1,275,896**
2500	**INDIRECTS AND CONTINGENCIES (30%)**				
				SUB-TOTAL:	**$ 481,958**
				ALTERNATIVE A TOTAL:	**$ 2,088,483**

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TABLE B.3

KGHM AJAX MINING INC.
AJAX PROJECT

PETERSON CREEK DIVERSION
PIPELINE ALTERNATIVE B

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TASK NO.	DESCRIPTION	UNIT	UNIT RATE ($/unit)	QUANTITY (unit)	COST ($CAD)
2000	**PETERSON CREEK DIVERSION**				
2100	**EARTHWORKS**				
	Clearing, Grubbing & Topsoil Stripping - Access Roadway	m3	$ 6.98	30,000	$ 209,400
	General Cut - access road and intake	m3	$ 5.54	255,000	$ 1,412,700
	General Fill - access road and intake	m3	$ 6.02	31,000	$ 186,620
	Pipeline Burial - areas of cut only	m3	$ 6.02	254,000	$ 1,529,080
	Access Road Wearing Course	m3	$ 5.21	16,000	$ 83,360
	24" Riveted Galvanized Corrugated Steel Pipe	m	$ 79.44	847	$ 67,313
	24" Culvert Band Coupler	ea.	$ 48.43	138	$ 6,683
	Riprap Liner	m3	$ 26.25	650	$ 17,063
				SUB-TOTAL:	**$ 3,512,219**
2300	**INTAKE STRUCTURE**				
	Perforated Galvanized CSP (2000mm Diameter)	m	$ 275	5	$ 1,375
	Reinforced Concrete Footing	m3	$ 1,267	58	$ 73,486
	Prefab Steel Superstructure	ea.	$ 75,873	1	$ 75,873
				SUB-TOTAL:	**$ 150,734**
2400	**MECHANICAL**				
	Peterson Creek Centrifugal Pump 200 HP Self Priming	ea.	$ 36,500	2	$ 73,000
	Peterson Creek Submersible Sump Pump	ea.	$ 16,500	2	$ 33,000
	HDPE 350mm HDPE DR21	m	$ 152	3,400	$ 516,800
	Combination Air Release/Vacuum Valve	ea.	$ 1,478	6	$ 8,868
				SUB-TOTAL:	**$ 631,668**
2500	**INDIRECTS AND CONTINGENCIES (30%)**				
				SUB-TOTAL:	**$ 1,288,386**
				ALTERNATIVE B TOTAL:	**$ 5,583,007**

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TABLE B.4

KGHM AJAX MINING INC.
AJAX PROJECT

PETERSON CREEK DIVERSION
PIPELINE ALTERNATIVE C

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TASK NO.	DESCRIPTION	UNIT	UNIT RATE ($/unit)	QUANTITY (unit)	COST ($CAD)
2000	**PETERSON CREEK DIVERSION**				
2100	**EARTHWORKS**				
	Clearing, Grubbing & Topsoil Stripping - Access Roadway	m3	$ 6.98	54,000	$ 376,920
	General Cut - access road and intake	m3	$ 5.54	295,000	$ 1,634,300
	General Fill - access road and intake	m3	$ 6.02	52,000	$ 313,040
	Access Road Wearing Course	m3	$ 5.21	18,000	$ 93,780
	Riprap Liner	m3	$ 26.25	650	$ 17,063
				SUB-TOTAL:	**$ 2,435,103**
2300	**INTAKE STRUCTURE**				
	Perforated Galvanized CSP (2000mm Diameter)	m	$ 275	5	$ 1,375
	Reinforced Concrete Footing	m3	$ 1,267	58	$ 73,486
	Prefab Steel Superstructure	ea.	$ 75,873	1	$ 75,873
				SUB-TOTAL:	**$ 150,734**
2400	**MECHANICAL**				
	Peterson Creek Centrifugal Pump 200 HP Self Priming	ea.	$ 36,500	2	$ 73,000
	Peterson Creek Submersible Sump Pump	ea.	$ 16,500	2	$ 33,000
	HDPE 450mm HDPE DR11	m	$ 222	10,350	$ 2,297,700
	Combination Air Release/Vacuum Valve	ea.	$ 1,478	17	$ 25,126
				SUB-TOTAL:	**$ 2,428,826**
2500	**INDIRECTS AND CONTINGENCIES (30%)**				
				SUB-TOTAL:	**$ 1,504,399**
				ALTERNATIVE C TOTAL:	**$ 6,519,061**

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TABLE B.5

KGHM AJAX MINING INC.
AJAX PROJECT

PETERSON CREEK DIVERSION
PIPELINE ALTERNATIVE D

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TASK NO.	DESCRIPTION	UNIT	UNIT RATE ($/unit)		QUANTITY (unit)	COST ($CAD)	
2000	**PETERSON CREEK DIVERSION**						
2100	**EARTHWORKS**						
	Clearing, Grubbing & Topsoil Stripping - Access Roadway	m3	$	6.98	30,000	$	209,400
	General Cut - access road and intake	m3	$	5.54	25,000	$	138,500
	General Fill - access road and intake	m3	$	6.02	22,000	$	132,440
	Access Road Wearing Course	m3	$	5.21	10,000	$	52,100
	Riprap Liner	m3	$	26.25	650	$	17,063
					SUB-TOTAL:	**$**	**549,503**
2300	**INTAKE STRUCTURE**						
	Perforated Galvanized CSP (2000mm Diameter)	m	$	275	5	$	1,375
	Reinforced Concrete Footing	m3	$	1,267	58	$	73,486
	Prefab Steel Superstructure	ea.	$	75,873	1	$	75,873
					SUB-TOTAL:	**$**	**150,734**
2400	**MECHANICAL**						
	Peterson Creek Centrifugal Pump 200 HP Self Priming	ea.	$	36,500	2	$	73,000
	Peterson Creek Submersible Sump Pump	ea.	$	16,500	2	$	33,000
	HDPE 450mm HDPE DR11	m	$	222	7,870	$	1,747,140
	Combination Air Release/Vacuum Valve	ea.	$	1,478	13	$	19,214
					SUB-TOTAL:	**$**	**1,872,354**
2500	**INDIRECTS AND CONTINGENCIES (30%)**						
					SUB-TOTAL:	**$**	**771,777**
					ALTERNATIVE D TOTAL:	**$**	**3,344,368**

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