



May 2019 Environmental Update for SLEMA Board

June 3, 2019

Outline

1. Mine Update
2. Reports
3. De Beers Submissions
4. Regulators' Update
5. Aboriginal Update
6. Stakeholders' Update
7. SLEMA's Activities



Acronyms

- AEMP – Aquatic Effects Monitoring Program
- ARD – Acid Rock Drainage
- DFO – Fisheries and Oceans Canada
- ECCC – Environment and Climate Change Canada
- ECM – Extended Care and Maintenance
- ENR – Department of Environment and Natural Resources, GNWT
- EQC – Effluent Quality Criterion
- GNWT – Government of the Northwest Territories
- INAC – Indigenous and Northern Affairs Canada (formerly Aboriginal Affairs and Northern Development Canada [AANDC])
- MVEIRB – Mackenzie Valley Environmental Impact Review Board
- MVLWB – Mackenzie Valley Land and Water Board
- PK – Processed Kimberlite
- SLEMA – Snap Lake Environmental Monitoring Agency
- SNP – Surveillance Network Program
- SSWQO – Site-Specific Water Quality Objective
- TDS – Total Dissolved Solids
- WEMP – Wildlife Effects Monitoring Program
- WTP – Water Treatment Plant
- WMP – Water Management Pond



1. Mine Update

- The Snap Lake Mine is currently under Extended Care and Maintenance (suspended operations);
- Snap Lake Mine resumed Care and Maintenance activities at site on March 4, 2019.



2. Reports

➤ 2.1 De Beers April 2019's SNP Report:

An update of activities at site in April was provided by April 2019 SNP Report submitted by De Beers on June 1, 2019.



2. Reports

- 2.1 April 2019 SNP Report – Water Consumption / Discharge at site:
 - The quantity of water extracted from Snap Lake for camp operations was 1,118 m³;
 - The Sewage Treatment Plant (STP) operated for 30 days in the month of April;
 - Treated sewage volume reported: 150.



2. Reports

➤ 2.1 April 2019 SNP Report – Water Monitoring:

Water monitoring analysis results reported for:

- SNP 2-15 (Water Intake from Snap Lake): Partial monitoring of the following parameters: E. Choli and Giarda;
- SNP 02-16i (Sewage Discharge from STP);
- SNP 02-20 d,e & f (Snap Lake on the e of the mixing zone 200 m from diffuser)



2. Reports

➤ 2.1 April 2019 SNP Report - Monitoring:

Regulatory monitoring of Snap Lake included the following:

- Air Quality monitoring;
- SNP monitoring;
- Visual fuel tank inspections;
- Visual North Pile, ditch and perimeter sump monitoring;



2. Reports

- 2.1 April 2019 SNP Report - Monitoring:
 - North Pile Thermistor and Piezometer monitoring;
 - Meteorological data downloads;
 - Dam and Water Management Pond visual monitoring;
 - North Pile ditch and sump visual monitoring;
 - Wildlife Surveillance audits;
 - Building Visual Inspection;



2. Reports

➤ 2.2 April Inspection Report

- Regulatory inspection was conducted by Jamie Steele on April 16, 2019 and reported on May 30;

Areas inspected:

- Water Management Pond;
- North Pile Perimeter Sumps;
- Landfill;



2. Reports

➤ 2.2 April Inspection Report

- Regulatory inspection areas inspected (cont.):
- Incinerators;
- Waste Transfer Area;
- Sewage Treatment Plant;
- Water Treatment Plant.

The Inspector has not reported any issues resulting from this Inspection.



3. De Beers Submissions to MVLWB

➤ 3. 1. De Beers Water Licence Renewal Application Submission

- On March 29, De Beers submitted an application for the renewal of its type A water licence with the purpose to support the closure and post-closure phases of the Snap Lake Mine;
- On April 12, the Application for renewal was deemed complete by the MVLWB;



3. De Beers Submissions to MVLWB

➤ 3. 1. De Beers WL Renewal (Cont.)

- The Proponent also requested an exemption from preliminary screening, because it believes that the Closure and Post-closure phases were included in the original Environmental Assessment (EA1314-02);
- Reviewers were invited to submit comments, and recommendations by May 17, 2019;
- Proponent Responses were due by June 3, 2019.



3. De Beers Submissions to MVLWB

➤ 3.2 De Beers LUP Amendment Application

On May 8, 2019 DeBeers submitted an application to Amend the Land Use Permit, to amend:

- Condition 1, *the location of a temporary camp.*

Existing Condition: The Permittee shall use an existing campsite.

Proposed Condition: The Permittee shall locate all camps on Durable Land or previously cleared areas.

- Condition 50: Related to security, to align with the planned activities.



3. De Beers Submissions to MVLWB

➤ 3.3 2018 AR Submission under the Snap Lake Environmental Agreement

On May 16, the following 2018 Annual Reports were submitted:

- Wildlife Effects Monitoring Program;
- Wildlife and Wildlife Habitat Protection Plan;
- Vegetation Monitoring Program;
- Hydrology;
- Air Quality Meteorological Monitoring and Emissions.



3. De Beers Submissions to MVLWB

➤ 3.4 Snap Lake Environmental Agreement Management Plans for Closure and Post-Closure

On May 20, DeBeers submitted to MVLWB the following environmental programs – closure and post closure phase - required under the EA for the Snap Lake Mine, including:

- Wildlife Effects Monitoring Program;
- Hydrology Program;
- Air Quality and Emissions Monitoring and Management Plan;
- Vegetation Monitoring Program.



4. MVLWB's WL and LUP Review Process for Snap Lake Mine Closure

Reviewer	Number of Comments
Environment and Climate Change Canada: R. Wykes	12
Fisheries and Oceans Canada: D. Coombs	1
GNWT - ENR	198
GNWT Lands North Slave Region J. Steele	7
GNWT Lands M-C Belair	1
GNWT Lands T. Covey	24
MVLWB: A. Love	201
SLEMA: S. Aredes	17
Total Number of Comments	461

Table 1: Parts intervening and comments during the review process of the DB WL application for renewal and LUP amendment application



4. MVLWB's WL and LUP Review Process for Snap Lake Mine Closure

- Main topics commented:
 - Aquatic Effects Monitoring Plan Design;
 - Air quality monitoring throughout Closure and Post Closure;
 - Quality Assurance / Control;
 - Geochemistry Section – ARD;
 - Climate change and constructed ponds capacity;
 - Draft Water Licence;
 - Effluent Quality Criteria for Closure and Post Closure;



4. MVLWB's WL and LUP Review Process for Snap Lake Mine Closure

- Main topics commented (cont.):
 - Final Closure and Reclamation Plan;
 - Hydrodynamic and Water Quality Report;
 - LUP Application;
 - Mixing Zone Delineation in Snap Lake;
 - North Pile;
 - Post Closure Monitoring;
 - Quarries;
 - Risk Problem Formulation;
 - Screening;



4. MVLWB's WL and LUP Review Process for Snap Lake Mine Closure

- Main topics commented (cont.):
 - Security;
 - SCP;
 - Sediments;
 - SNP;
 - Underground Water Disposal;
 - Waste Management;
 - Water Management;
 - Water Quality;
 - Constructed Wetlands.



5. Aboriginal Update

- No news related to aboriginal activities.



6. Stakeholders' Update: ENR- GNWT

- **6.1. ENR response to De Beers' request to cease the Hydrology Program under the EA**
 - On March 25, De Beers requested to cease the Hydrology Program reporting as required per the EA;
 - On May 23, ENR-GNWT responded that it has noted that the Hydrology Program *“has already been incorporated into the AEMP”*.
 - And it requests that after completion of the Licensing process, *“DB provides an update describing how the monitoring programs capture the requirements of the HP”*.



6. Stakeholders' Update: ENR- GNWT

➤ 6.1. ENR response to De Beers' request to cease the Hydrology Program under the EA

(Cont.)

- *"Once that information has been provided, GNWT will further consider the request for DB to cease the Hydrology Program. "*



6. Stakeholders' Update: ENR- GNWT

➤ 6.2. ENR Snap Lake 2017 EAAR Resubmission Review

- On May 24 ENR-GNWT informed that it has reviewed the resubmission of the 2017 EAAR and has determined that Party comments have been addressed.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

1. Construction of the Passive Treatment System (PTS)

The PTS is regarded as a solution to mitigate increasing nitrate concentrations during closure and post closure. It is planned to be constructed in years 2 and 3 of the Closure period.

However, there are uncertainties with regard to the NP water quality in the intermediate term.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

1. Construction of the PTS (cont.)

Freezing of the NP will influence NP seepage water quality decreasing the volume of the drainage and increasing concentration of solutes, those factors are “competing between them” and is not possible evaluate their effect in the mid term.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

1. Construction of the PTS (Cont.)

DB does not elaborate further on the stages of the decision-making process that would help DB to decide whether it will construct the wetlands or not, neither what points are going to be considered during that process.

Recommendation: Recommends DB to elaborate further on the stages of the decision-making process that will help DB to decide about the construction of the WMS.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

2. Proposed SNP stations in Closure and Post Closure

During the early years of closure, following PTS construction, it is possible that passive and active water treatment will simultaneously work until the effluent treated by PTS meets the EQC for discharge.

It is not clear how long will take this transaction period from active to passive treatment.
treatment.



7. SLEMA's Comments on DB Snap Lake Mine WL Renewal & LUP Amendment Applications

2. Proposed SNP stations in Closure and Post Closure (Cont.)

Table 3-1 (Final Closure Plan) presents “Proposed SNP stations in Closure and Post-Closure”. It does not indicate the SNP stations in the period of transaction from active to passive treatment.

Recommendation: Recommends include a column indicating the operating SNP stations during the transaction period from active treatment to passive treatment



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

3. Proposed SNP stations in Closure and Post-Closure

Proponent proposes the removal of some of the SNP monitoring stations at closure. The rationale behind that is that many years of monitoring have not shown evidence of acid generation.

SLEMA notices that, according to the WL, those SNP monitoring stations were aimed to evaluate the composition of the runoff due to physical / chemical weathering of rocks placed at site.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

3. Proposed SNP stations in Closure and Post-Closure (Cont.)

Also, that monitoring values in the 2018 SNP Monitoring Report presented exceedances in some metals and TSS.

Mine closure activities are anticipated to include soil removal, removal of surface structures, regrading, blasting to construct the PST and Quarrying in order to obtain material to cover the North Pile facility.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

3. Proposed SNP stations in Closure and Post-Closure (Cont.)

The removal of some buildings may expose some material at site that can interact with surface runoff impacting water quality.

Overall, these planned activities may impact runoff water quality at site during active reclamation. .



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

3. Proposed SNP stations in Closure and Post-Closure (Cont.)

Therefore, in order to prove that closure activities have not impacted site runoff, SNP monitoring stations at site related to runoff should be maintained.

Recommendation: Recommends to maintain monitoring at SNP Stations during active reclamation activities at site (or closure period). A reduction in the analysis of the parameters to be monitored, based on historical data, is also advised.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

4. Monitoring of extractable petroleum hydrocarbons

Proponent recommends the removal of extractable petroleum hydrocarbons from the list of parameters to be monitored. It states *“Hydrocarbons should be removed as levels are extremely low” and all 2018 hydrocarbon data at this station were non-detectable.*

SLEMA notices that during Closure contaminated HC soils will be treated at the Landfarm located within the area of the NP.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

4. Extractable petroleum hydrocarbons

Therefore, hydrocarbons require to be monitored in order to identify if they are present in water and propose a remediation method.

Recommendation: Recommends to maintain extractable petroleum hydrocarbons in the list of parameters to be monitored at SNP 02-2 for closure



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

5 . Passive Treatment System Maintenance Cost

The PTS will remain after closure and will require maintenance and monitoring.

Wetlands are planned to treat north pile effluent during some years after which water from NP will not need any more treatment

If high loads of contaminants are retained in the sediments, whether in the long term when closure of the PTS is approaching or in the mid-term during operations, there will be a deposit gradually building-up that will eventually need to be removed.



7. SLEMA's Comments on DB Snap Lake Mine WL Renewal & LUP Amendment Applications

5 . PTS Maintenance Cost (cont.)

Appendix L (FCP) states that wetland cleanout will be needed, and cleanout frequency depends on the rate of sediment accumulation.

It will require “*hydraulic dredging pumps or mechanical dredging equipment such as an excavator with a backhoe device or a crane and clamshell bucket with a dragline*”.

SLEMA notices that no provisions have been allocated in the Reclamation Security Estimate regarding wetlands maintenance.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

5 . PTS Maintenance Cost (cont.)

Recommendation: Recommends to allocate provisions/resources to wetland maintenance in the Security Estimate



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

6. AEMP benchmark for Total Dissolved Solids (TDS)

Proponent recommends AEMP Benchmarks for chloride, sulfate, and nitrate instead of AEMP Benchmark for TDS

Recommendation: SLEMA agrees with the approach of considering AEMP benchmark for individual ions rather than TDS



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

7. Nitrite and nitrite measurement, analytical results, sample holding time

SLEMA notices in the 2018 SNP Water Quality Data Report, that from 8 monitoring samples, 8 nitrate lab results were deemed I (suspect results, holding time exceeded upon receipt at lab).

The issue is relevant regarding nitrogen compounds because nitrate monitoring results will be used to assess wetland removal efficiency.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

7. Nitrite and nitrite measurement, analytical results, sample holding time (cont.)

Recommendation: SLEMA recommends either 1) talk to the lab in order to request a priority analysis for nitrogen compounds parameters (and any other that is also time-dependent) 2) do a research on how to increase the holding time of nitrate and nitrite analysis, i.e. storage of samples with H_2SO_4 © ($\text{pH} < 2$) and store at 4 °C preserve the sample for 28 days. The sample should be analyzed as nitrate + nitrite.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

7. Nitrite and nitrite measurement, analytical results, sample holding time (cont.)

A chlorinated sample stored at 4°C can be hold for 14 days. Alternatively, samples may be held for longer periods if the proponent, or monitoring laboratory, has data on file to show that the sample under study are stable for the longer time (U. S. Environmental Protection Agency, Standard Methods for the Examination of Water and Wastewater)



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

8. Total iron in the Effluent Quality Criteria (EQC) for closure

During operations and ECM SNP 2-2 analysis results (North Pile drainage ditch) historically show high amount of total iron in the seepage water.

Although the amount of total iron may be in some cases related to TSS, samples with high content in total iron has been reported at TSS values as low as 4.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

8. Total iron in the EQC for closure (cont.)

Iron has also been analyzed as parameter of interest and carried forward as a parameter with predicted overflow concentrations (Sump 3&5) that were greater than AEMP benchmarks during post closure. However, SLEMA notices proposed EQC for closure does not include criteria for iron.

Recommendation: SLEMA recommends to include iron EQC for closure. CCME WQG for protection of aquatic life: total iron 300 ug/L



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

9. Proposed EQC for the Overflows from Sumps 3 & 5 (SNP 02-17c & SNP 02-17d) for Post Closure

With the intention to propose EQC for post-closure, the Proponent carried over a Screening Procedure to Identify Parameters of Potential Concern (POPC) .

One POPC, nitrate, was identified to be included in the EQC Post-closure.

The screening process uses predicted overflow concentrations at Sump 3 & 5 in order to make comparisons.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

9. Proposed EQC for the Overflows from Sumps 3 & 5 (SNP 02-17c & SNP 02-17d, cont.)

There are some uncertainties with respect to the NP drainage that have been not addressed neither discussed, such for example: 1) Length of time that freezing of the pile will take and its effects on water quality and quantity; 2) The effect of cryoconcentration on NP water quality; 3) The steady increase of annual average sulfate concentration (except for 2018) in SNP2-2 (which was not mentioned at all).



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

9. Proposed EQC for the Overflows from Sumps 3 & 5 at SNP 02-17c & SNP 02-17d (cont.)

All these effects could impact on the water quality of NP drainage during closure (i.e. Diavik and Ekati, where weathering of PK resulted in elevated concentrations of sulfates and cations).

EQC is developed in order to protect the water quality in the receiving environment. With that purpose, when nitrate is considered, other forms of inorganic nitrogen should also be considered (nitrite and ammonium).



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

9. Proposed EQC for the Overflows from Sumps 3 & 5 at SNP 02-17c & SNP 02-17d (cont.)

Recommends a conservative approach in order to protect water quality of SL including in the EQC for post-closure more parameters than nitrate, TSS and PH

To include (in addition to pH, TSS and nitrate)
Major ions: chloride and sulphate. Nutrients: nitrite, total ammonia, and total phosphorus. Total metals: aluminum, cobalt, copper, iron, nickel, and zinc. Strongly recommends to include nitrite and total ammonia



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

10. Landfarm as mine component that requires to be considered for closure

Table 4.2 (FCP) does not include a Landfarm in the list of the waste management facilities (WMF). Section 4.6.1.3 (North Pile Components) states that a landfarm was constructed in the southeast corner of the west cell area for managing hydrocarbon contaminated soils and refers for details to Section 4.6.3.7. Section 4.6.3.7 is missing in the Report.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

10. Landfarm as mine component that requires to be considered for closure (cont.)

The landfarm will require interim and final closure actions/measures to be undertaken to ensure the future chemical stability at site.

Recommendation: Recommends include landfarm in the list of Waste Management Facilities that requires to be closed and details on how it will be closed in order to achieve site final closure objectives.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

11. Pumping of surface water to the underground mine

Surface water were pumped underground and will continue to be pumped as required. The pumping of water to the underground when the water table is high can cause underground water overflow and discharge of highly mineralized water to SL. An overflow incident was reported on May 16, 2017 while surface water was being pumped underground.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

11. Pumping of surface water to the underground mine

Recommends: 1) Establish a safe water level for the flooded mine and when it is reached pumping should stop. 2) Monitoring of the water table of underground water before pumping 3) pumping during freshet is not recommended; the water table may be high because of water infiltration.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

12. Access to underground water for sampling

Access to underground should be granted for sampling if needed

Recommendation: Add lockable access shafts/addits which will facilitate the future monitoring of the level of underground water levels (at least) and which (ideally) could be utilized to sample underground water quality (at least at the top of the underground water column).



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

13. Windblown tailings issue

One closure objective is to prevent PK from entering the surrounding terrestrial and aquatic environment.

Windblown tailings which has potential to contaminate soil and water has not been addressed. Experience with other northern piles indicates that dusting is an issue and therefore the cover should be evaluated with respect to dusting.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

13. Windblown tailings issue

Air Quality monitoring should include several dusting monitoring stations in order to assess if the cover is effectively controlling fugitive dust.

Recommends to discuss windblown tailings and propose monitoring and mitigating measures for soil/water contamination linked to this issue.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

14. Closure Criteria for Chemical stability

The proposed EQC for post closure includes nitrate, pH and TSS.

After screenings, one Parameter of Concern (POC) was selected from a list of Parameters of Interest.

Nitrate (with TSS and pH) was identified as the one to be included in the EQC for Post-closure.

Chapter 9 of EQC Report states that “predicting conditions into the future carries an inherent level of uncertainty”.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

14. Closure Criteria for Chemical stability

And regarding the North Pile drainage water quality “Changes to input water quality may result in changes to predicted parameter concentrations in the sumps beyond the range of concentrations presented in this report, which may result in changes to the outcomes of Steps used to identify POPC”.

To address this uncertainty it recommends to monitor water quality at NP and compare monitoring results to model predictions.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

14. Closure Criteria for Chemical stability

SLEMA agrees that model assumptions require to be validated by monitoring data. Only monitoring data will show with time that POPC parameters' concentrations are, as predicted, no susceptible to trigger any action level in SL.

In other words, the proposed hypothesis will be valid if monitoring shows with time that POPC parameters concentrations are below (or equal) than the model predicted concentrations, and therefore effluent discharge will not impact SL water/sediment/environment quality.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

14. Closure Criteria for Chemical stability

Recommends: Closure Criteria regarding Chemical Stability at site "POPCs meet consistently in a steady manner with time concentrations levels that will allow to achieve in-lake site specific water quality objectives as predicted by models"

And include in POPCs: Major ions: chloride and sulphate. Nutrients: nitrate, nitrite, total ammonia, and total phosphorus. Total metals: aluminum, cobalt, copper, iron, nickel, and zinc. And pH and TSS



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

15. Staged Reduction of Financial Security

The Proponent proposes staged reduction in the amount of security that will be posted to address closure/reclamation activities.

Recommendation: SLEMA agrees that at the end of year 8, when closure/remediation activities are finalized the amount of security posted be reduced (we did not state on how much) after presentation and Board's approval of the Performance Assessment Report.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

16. Term of the Licence

The Proponent proposes a term of 15 years for the WL, that would cover closure and post closure monitoring

Recommends a first renewal term of eight years that will cover the closure and remediation activities at site (nine if we include the ECM period). And a posterior Water Licence renewal that will cover post closure monitoring.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

16. Term of the Licence (cont.)

After the 8 years period of closure and remediation, the presentation and approval of the Performance Assessment Report will lead to a reduction in the security amount posted (if the Report is approved) and an evaluation of the conditions at the site at that time also will indicate whether the site has remained largely stable and no active reclamation activities are required to limit the environmental risks at the site and whether the proposed post closure monitoring is adequate to demonstrate that the Snap Like mine site has been fully reclaimed.



7. SLEMA's Comments on WL Renewal & LUP Amendment Applications

17. Preliminary Screening

SLEMA agrees that Closure and Post-closure activities were included in the original Environmental Assessment (EA1314-02), but wetlands and their related infrastructure (influent storage ponds and NP water management structures) that will require extensive blasting were not evaluated during the EA.

Recommends screening of the activities related to the construction and use of the PTS (wetlands, influent storage ponds and North Pile water management structure)



7. Case Study: An Overview of Constructed Wetlands and Associated Infrastructure



An Overview of Constructed Wetlands

- Passive Treatment Systems (PTS) are planned to be constructed at Snap Lake Mine in years 1 and 2 of the Closure period;
- The PTS are regarded as a solution to treat increasing nitrate concentrations in NP runoff/seepage during closure and post closure ;
- PTS will include two treatment systems, the west passive treatment system (WPTS) and the east passive treatment system (EPTS);



An Overview of Constructed Wetlands

- The WTPS will treat water collected in Sump 4, the West Cell upper catchment area (former location of TS4), and Sump 5;
- The EPTS will treat water collected in Sumps 1, 2, and 3;
- Each system has an influent storage pond (ISP) followed by a constructed wetland (CW), from which treated water is discharged to Snap Lake



An Overview of Constructed Wetlands

Feature	WPTS	EPTS
Design Flow (m ³ /d)	2,156	2,286
ISP Footprint (ha)	8.6	4.3
CW Footprint (ha)	5.4	7.0

Table 2: Design Characteristics for the Passive Treatment System (PTS)



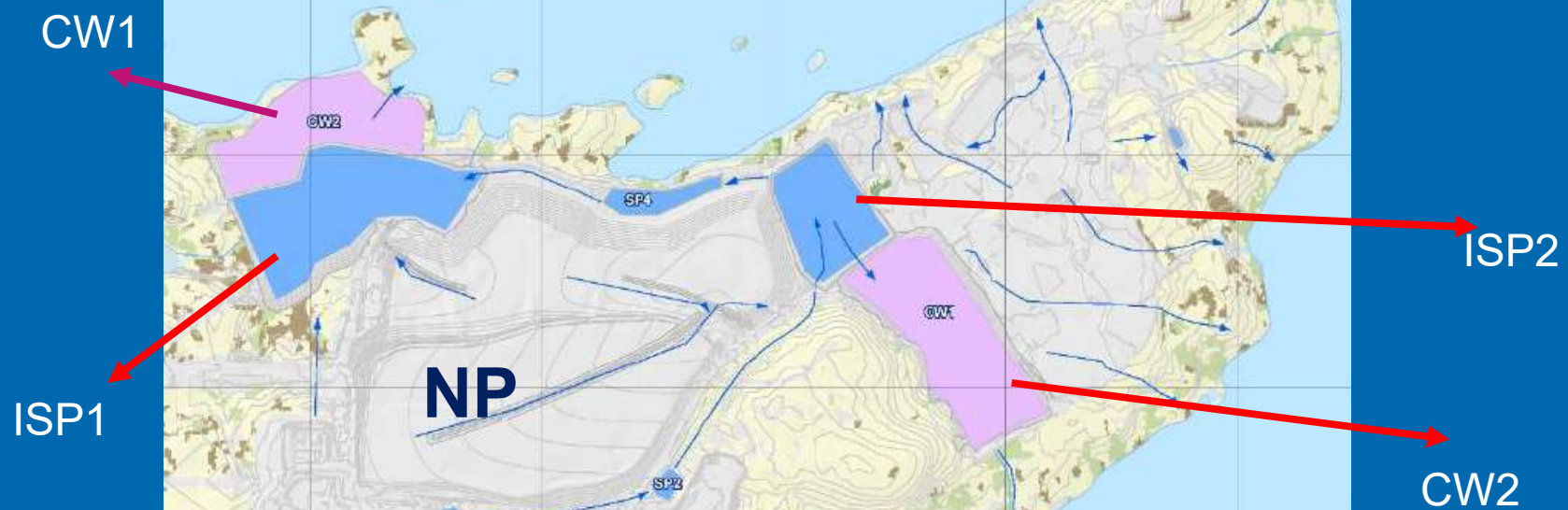


Fig.1 PTS



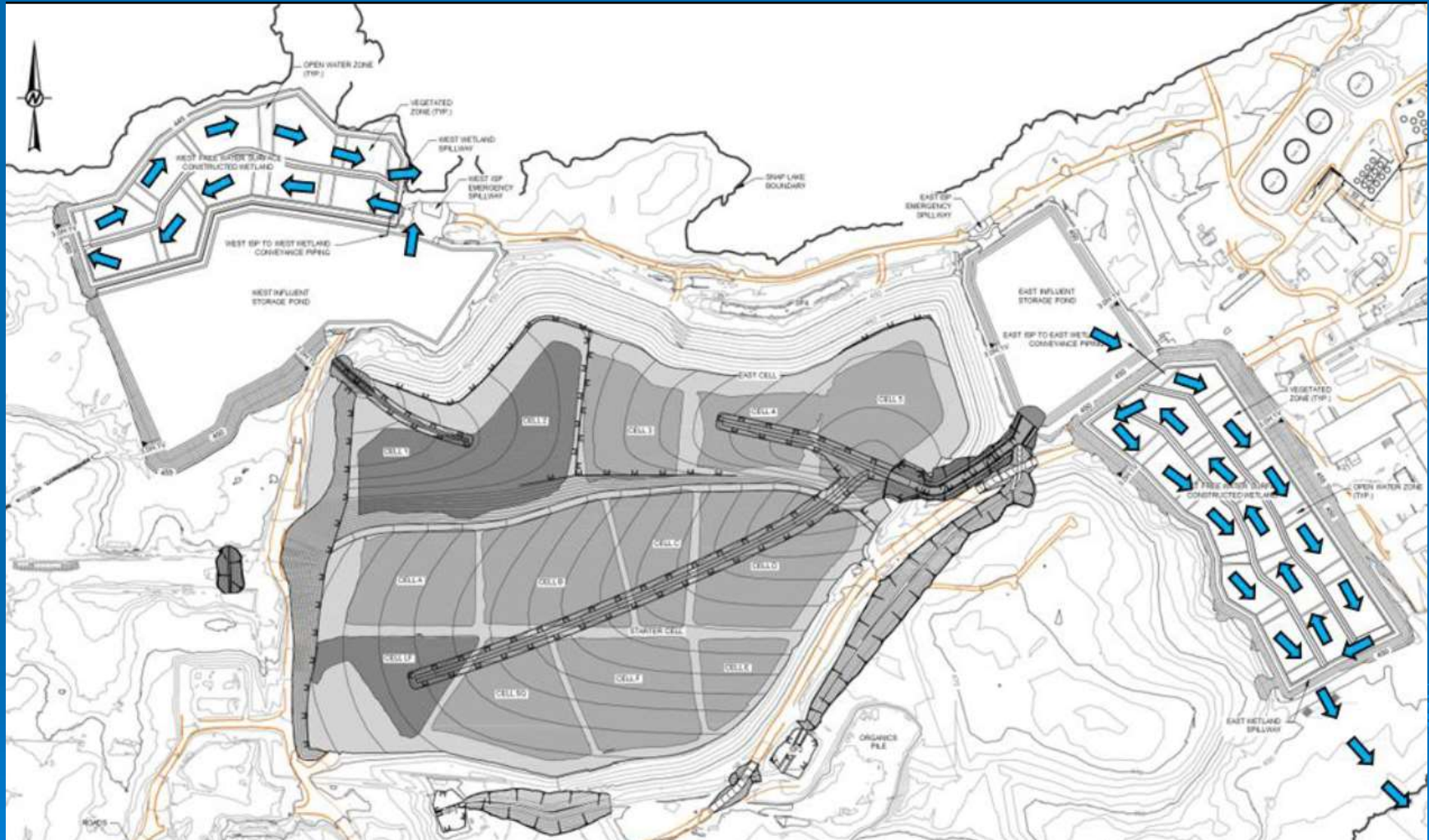


FIG.2 PTS FLOW DIRECTION



An Overview of Constructed Wetlands

- ISPs are ponds where runoff and seepage from the North Pile will be collected and equalized;
- The ponds will be sized to accommodate a year of combined runoff and seepage volume prior to influent being sent to water treatment system



An Overview of Constructed Wetlands

- CWs are engineered systems designed to simulate natural wetlands;
- They include both vegetated cells with wetland plant species and free surface water cells, which resemble shallow mixing basins;
- It is estimated that it will take between 5 and 15 years for vegetation maturation to occur and wetlands to achieve expected performance objectives



An Overview of Constructed Wetlands

- When performance objectives can be met, the wetland will be considered mature and post-closure can begin
- Routine maintenance activities may be limited to occasional monitoring of the microbial populations and addition of macronutrients. Long-term maintenance activity includes periodic sludge or solids removal



An Overview of Constructed Wetlands

- The major nitrate treatment mechanisms of CWs include biological denitrification (by bacteria) and plant uptake;
- In biological denitrification, denitrifying bacteria metabolize inorganic nitrogen such as nitrate and nitrite into nitrogen gas;
- In denitrification by plant uptake, plants typically absorb nitrate via their root structure, and transport it to plant shoots for reduction to ammonia, which is then incorporated into amino acids during plant growth



An Overview of Constructed Wetlands

- The WPTS and EPTS are designed to flow seasonally, beginning with the winter thaw;
- The annual treatment period, when water is flowing through the treatment wetlands, is expected to be approximately 80 to 100 days between late May and early October and will vary with temperature each year.



An Overview of Constructed Wetlands

- The CW are designed for treatment of nitrate, to meet the proposed EQC of 25 mg/L;
- The effectiveness of CW for treating a variety of wastewaters has been established for several decades;
- However, the removal efficiency of nitrate can be low in cold climates, therefore field demonstration testing is required to ensure that EQC can be consistently met at the facility

