SASKATCHEWAN RESEARCH COUNCIL

Options Evaluation for Remediation of the Gunnar Site Using a Decision-Tree Approach

T.L. Yankovich and A. Klyashtorin

Some Relevant Concepts and Terminology:

In general, orphaned or abandoned mines can be defined as:

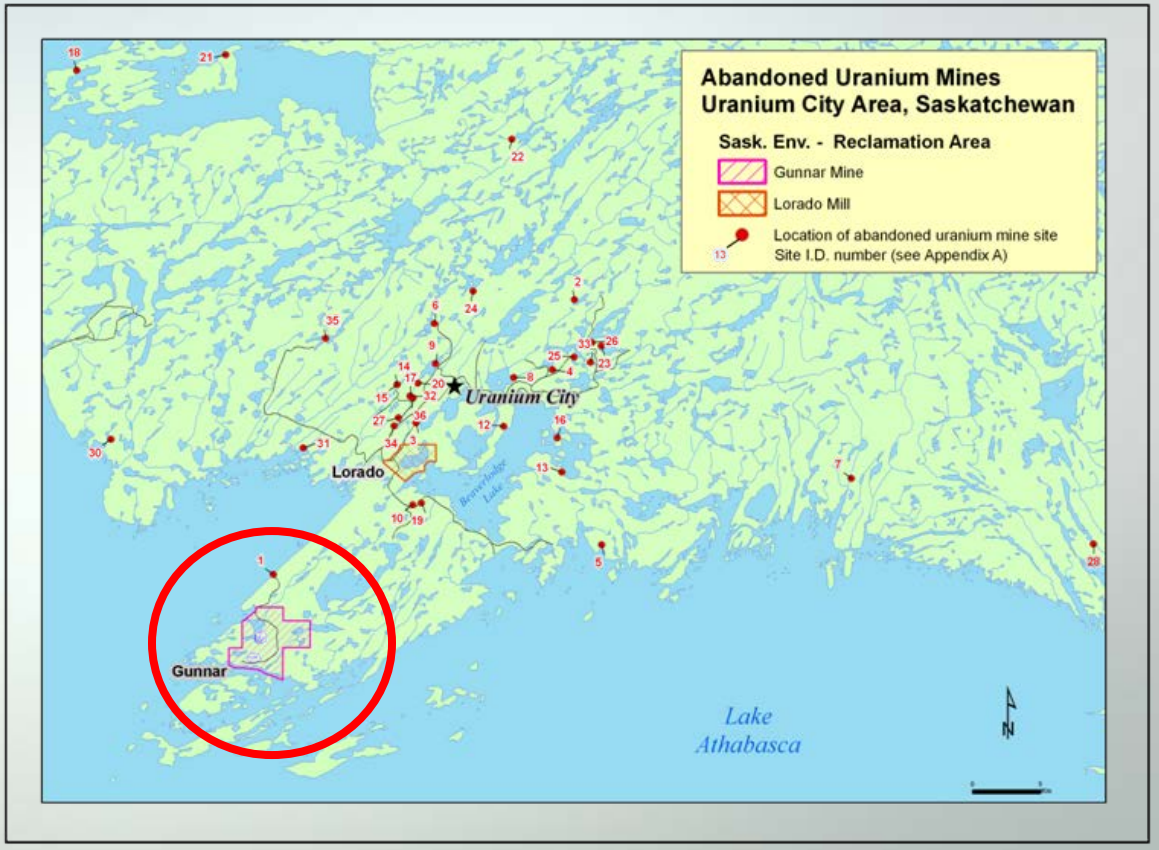
> *Those sites for which there is no owner, or the owner cannot or will not finance the costs of remediation.*

Responsibility for such sites typically ends up with Government (Provincial or Federal).

There are >10,000 such sites in Canada, including a number of uranium mine/mill sites in Northern Saskatchewan.

Reference: Tremblay, 2005

SRC is managing the Cleanup of the Gunnar, Lorado and 36 minor (satellite) abandoned mine sites in Northern Saskatchewan on behalf of the Provincial and Federal Governments under Project CLEANS.



Remediation is scheduled for completion in 2018 with long-term monitoring to follow.

Gunnar Uranium Mine/Mill Site: History

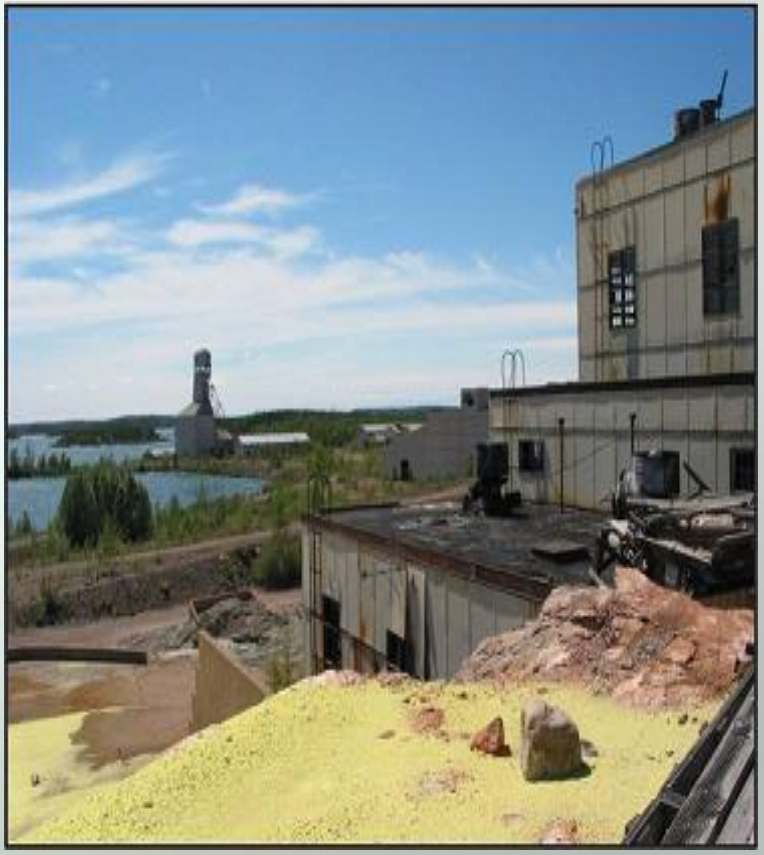
- Operated from 1953-1964
- Average grade was 0.18%.
- ~8.5 million tons of rock mined and processed
- Open pit and underground mine.
- Over 5 million tons of unconfined tailings
- The pit and subsurface workings were flooded, shaft plugged with concrete, and mine site abandoned
- All buildings, tailings, and waste rock piles were left on site “as is”.

Key Aspects of the Gunnar Mine Site:

Under Licence Exemption until December 31, 2016.

Project Objectives:

1. To eliminate or reduce public safety hazards and environmental risks now and in the future.
2. To develop sustainable remediation options that are technically and economically feasible.
3. To establish a responsible and cost-effective environmental monitoring program, while minimizing long-term care and maintenance at the Site.



Project Endpoints:

- Site does not pose unreasonable public health or environmental risks.
- The flora and fauna adjacent to the site are not significantly impacted by contaminants.
- The traditional use of resources adjacent to the site are safely conducted.
- The desire is to have the site managed through the institutional controls program for long- term care and maintenance.

Environmental Assessment (EA) in Canada:

- In Canada, no major project is typically undertaken until the environmental assessment has been approved by regulatory agencies and has undergone a Public consultation process.
- That said, Canadian regulatory agencies permitted deteriorating buildings and structures to be taken down at the abandoned Gunnar Uranium Mine/Mill Site in 2010-2012 to address Public safety issues before completion of EIS document.

2010-2012 – Putting Public Safety First

- To take down buildings on the Gunnar Mine site that fail the structural safety assessment.
- To remove risks on the site related to hazardous substances and materials (including asbestos).
- To address safety issues related to site maintenance (e.g., old sumps, tripping hazards, etc.)

Asbestos Abatement:

Summary of Demolition

2010

2012

Next Step – Securing All Aspects of the Gunnar Site

Environmental Assessment (EA) in Canada:

- In Canada, “preferred” and “alternative” remediation options are typically identified as part of the environmental assessment (EA) process and are documented in the Environmental Impact Statement (EIS) before initiation of the Project.
- However, due to the lack of records and monitoring data, this approach may not be feasible when planning the remediation of abandoned sites that operated under a different regulatory regime, due to the lack of historical information regarding the Site.

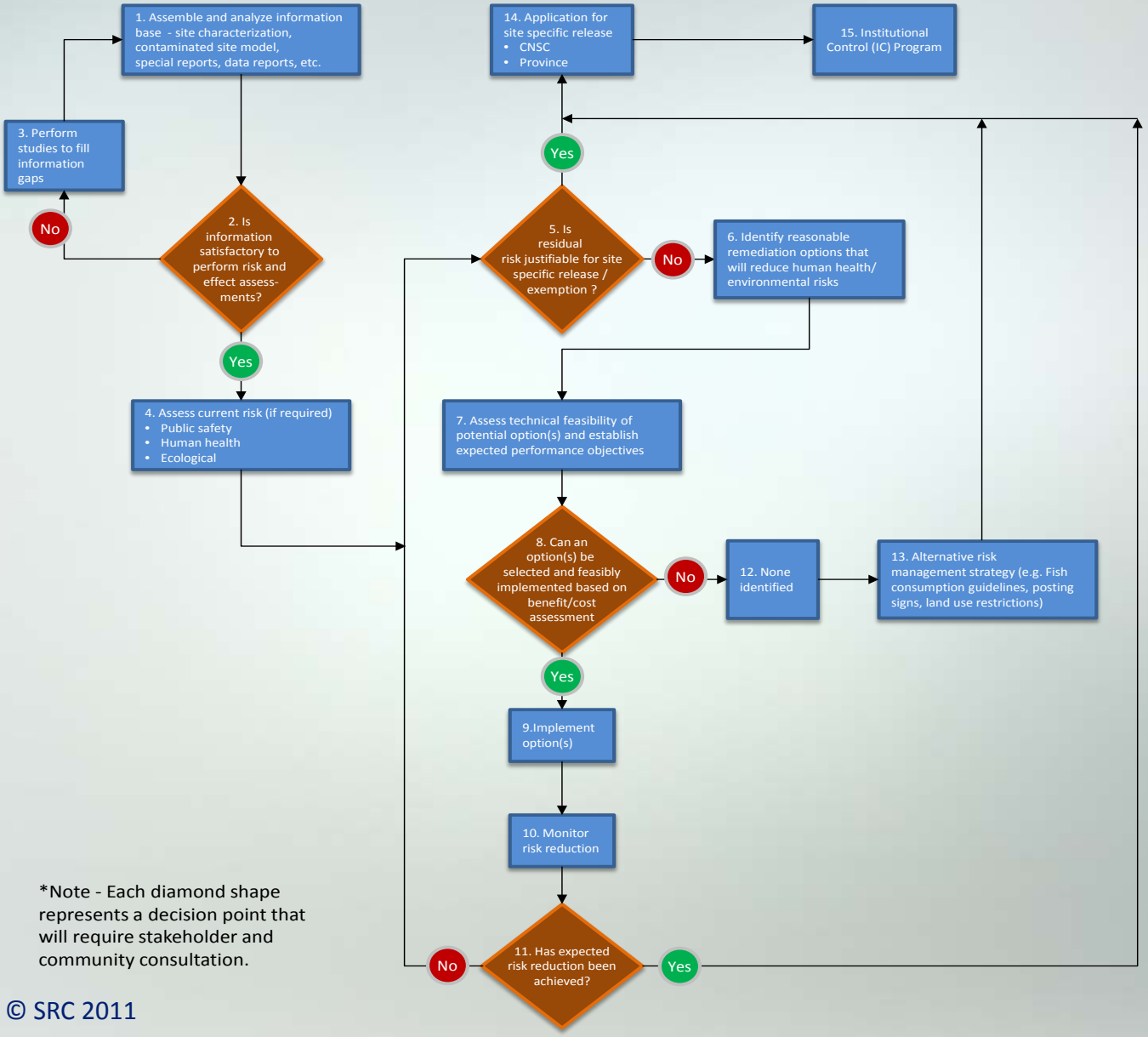
Postponing option selections to licensing stage

- In such cases, it may be logical to collect missing information as part of site licensing process, i.e. after the EA has been approved.
- In this case information gaps required for option analysis can be captured as part of a decision-tree approach, or flow diagrams, that identify key questions that need to be answered once more data and information has been collected to allow informed decisions to be made on remediation options.
- Unlike a typical EA or EIS, through a decision-tree approach, remedial options can be selected later in the process, as more information becomes available

Basic Remediation Alternatives:

- **Mine Pit:**
  - Leave as a water body or dewater and use as a waste disposal site?
- **Tailings and Waste Rock:**
  - Cover or relocate to mine pit?
  - Relocate ‘contaminated’ waste rock to an engineered lined landfill and use ‘clean’ waste rock as cover on tailings?
- **Waste Disposal:**
  - Dispose of in the mine pit or an approved landfill?

Gunnar Project Decision Making Process

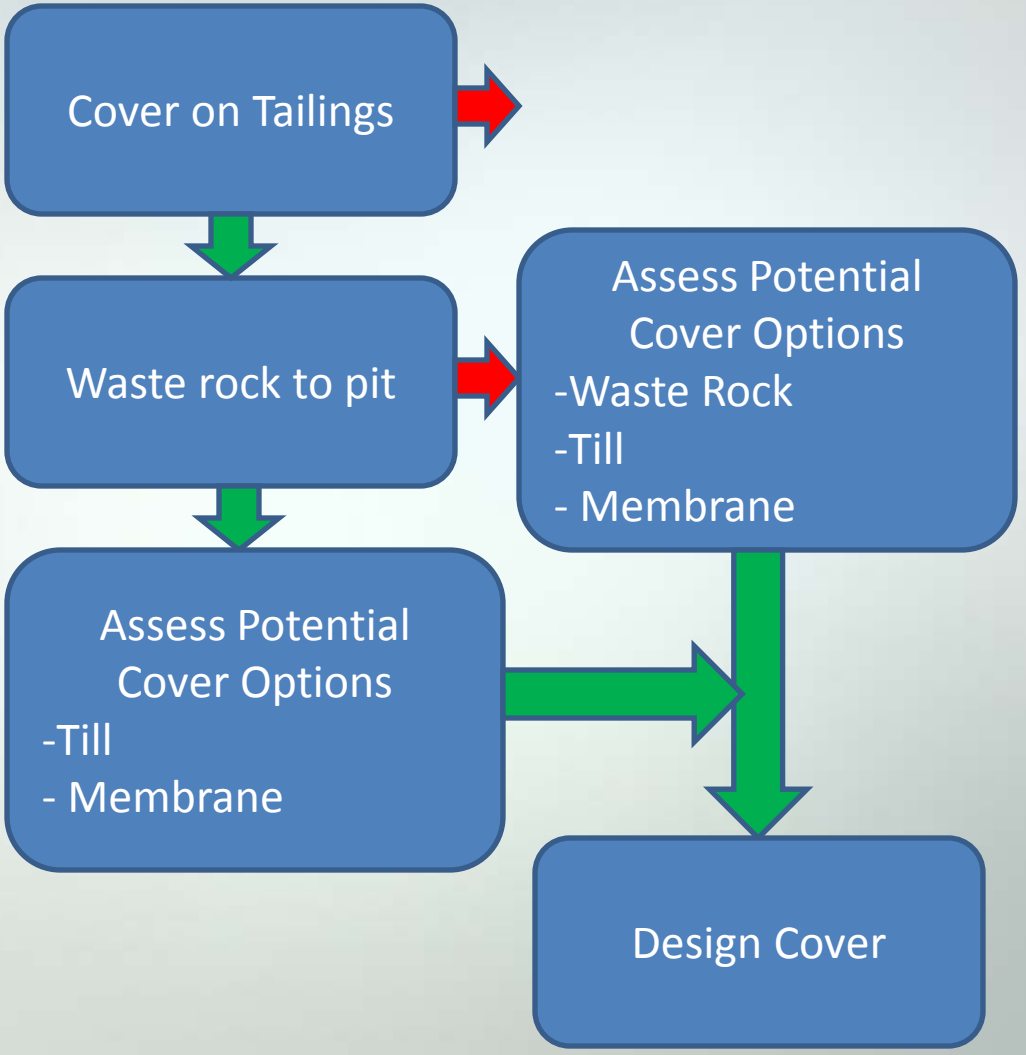


*Note - Each diamond shape represents a decision point that will require stakeholder and community consultation.

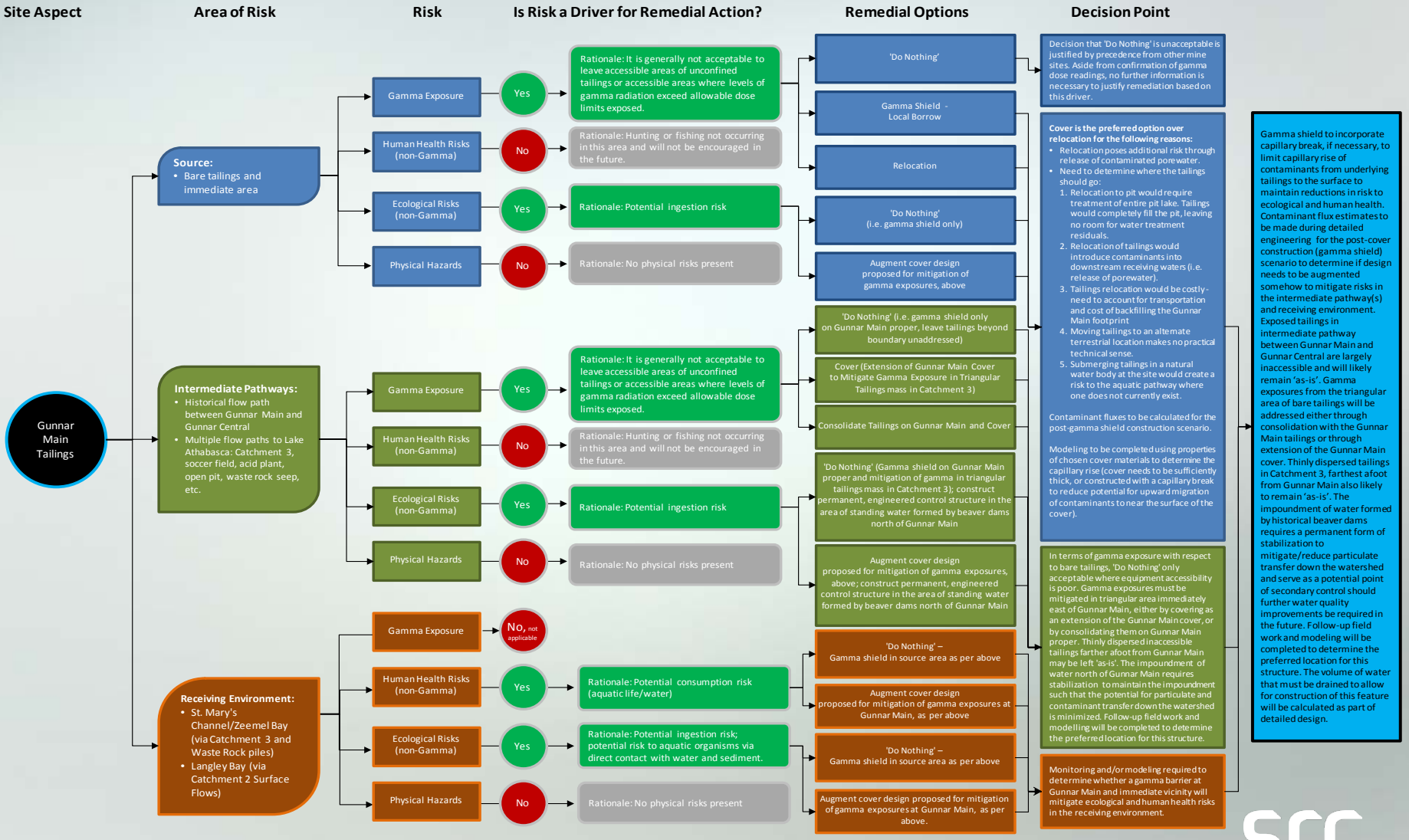
Application of a Decision-tree Approach in Remediation Planning:

- First, all possible remediation options should be identified.
- Each remediation option should then be evaluated and prioritized, and non-viable options should be screened out (e.g., 'Do Nothing' option for unconfined tailings, which need to be covered).
- A gap analysis should be undertaken for all viable remediation options.
- Flow diagrams, or "decision-trees", should be established to map out plans to fill in key information gaps that are required in decision-making (i.e., to identify remediation options).

Gunnar Main Tailings – Conceptual Decision Tree



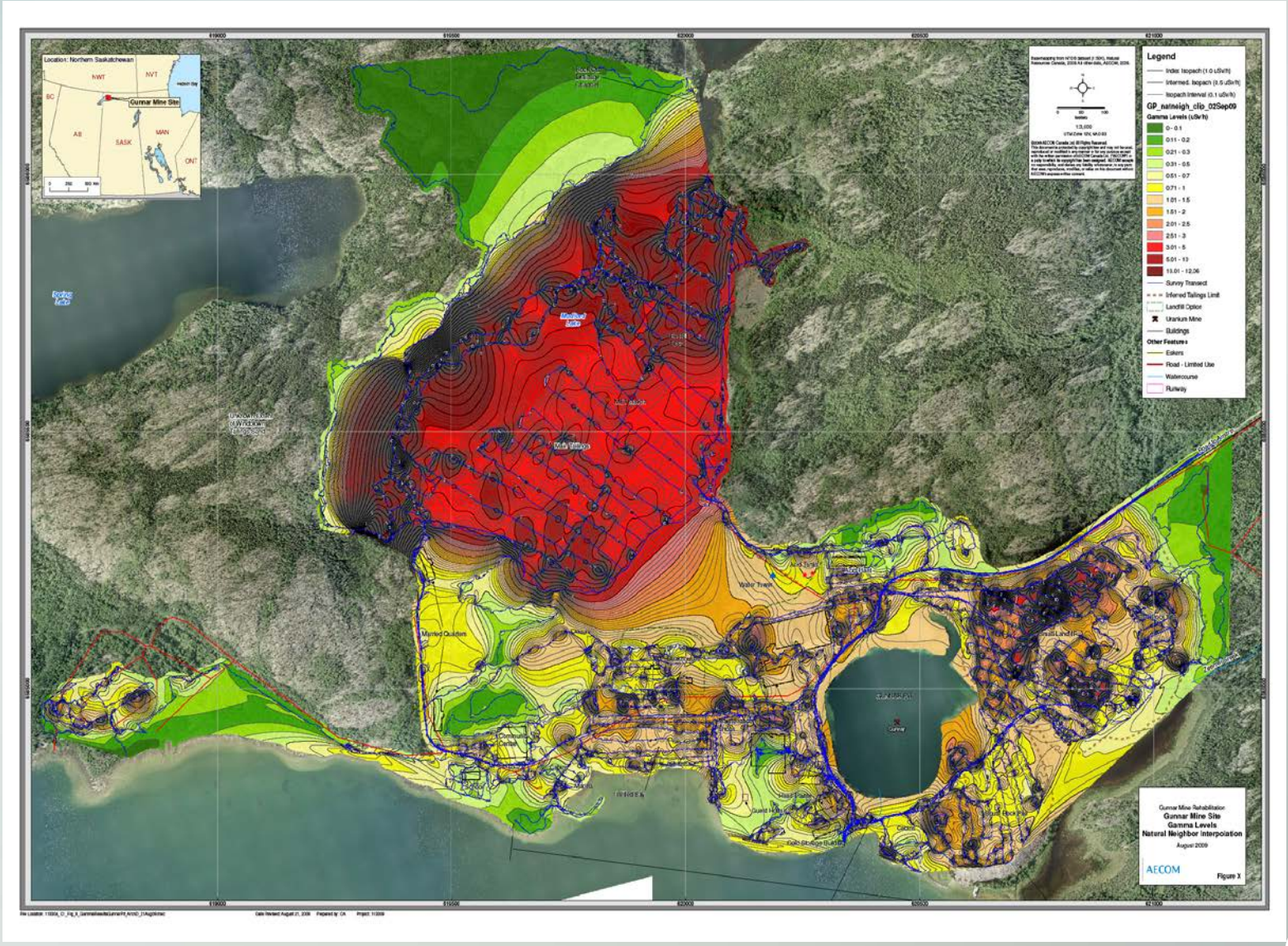
Remedial Option Analysis - Gunnar Main Tailings



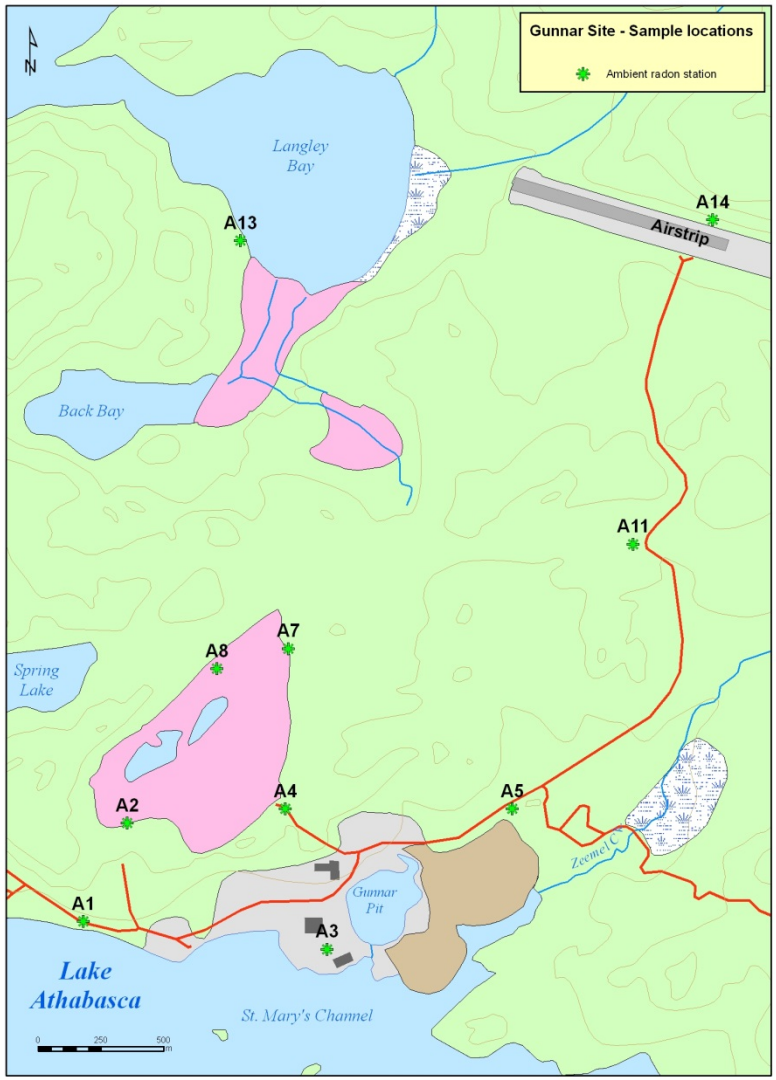
Our Decisions Will be Based on Monitoring Data:

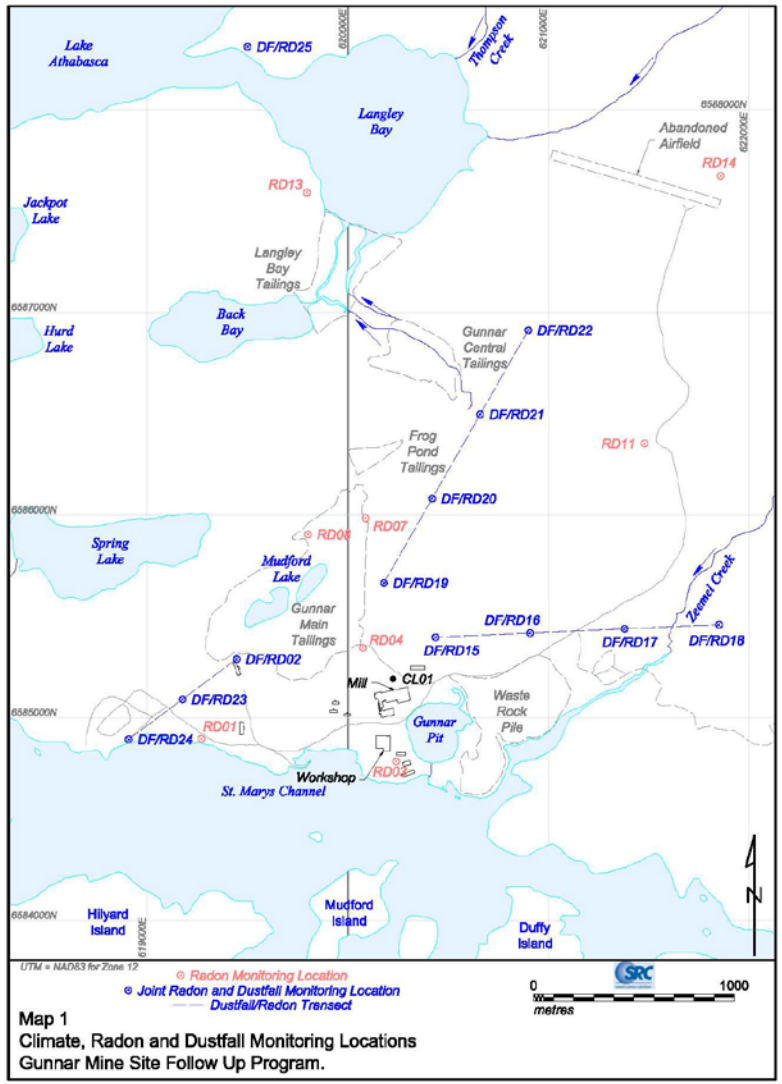
- Gamma dose rates
- Radon monitoring
- Surface water sampling
- Quantification of water flows
- Waste rock characterization
- Groundwater sampling
- Vegetation sampling
- Fish sampling
- Building a quantitative Site-wide model to estimate contaminant flux (or loads)

Gamma Dose Rates

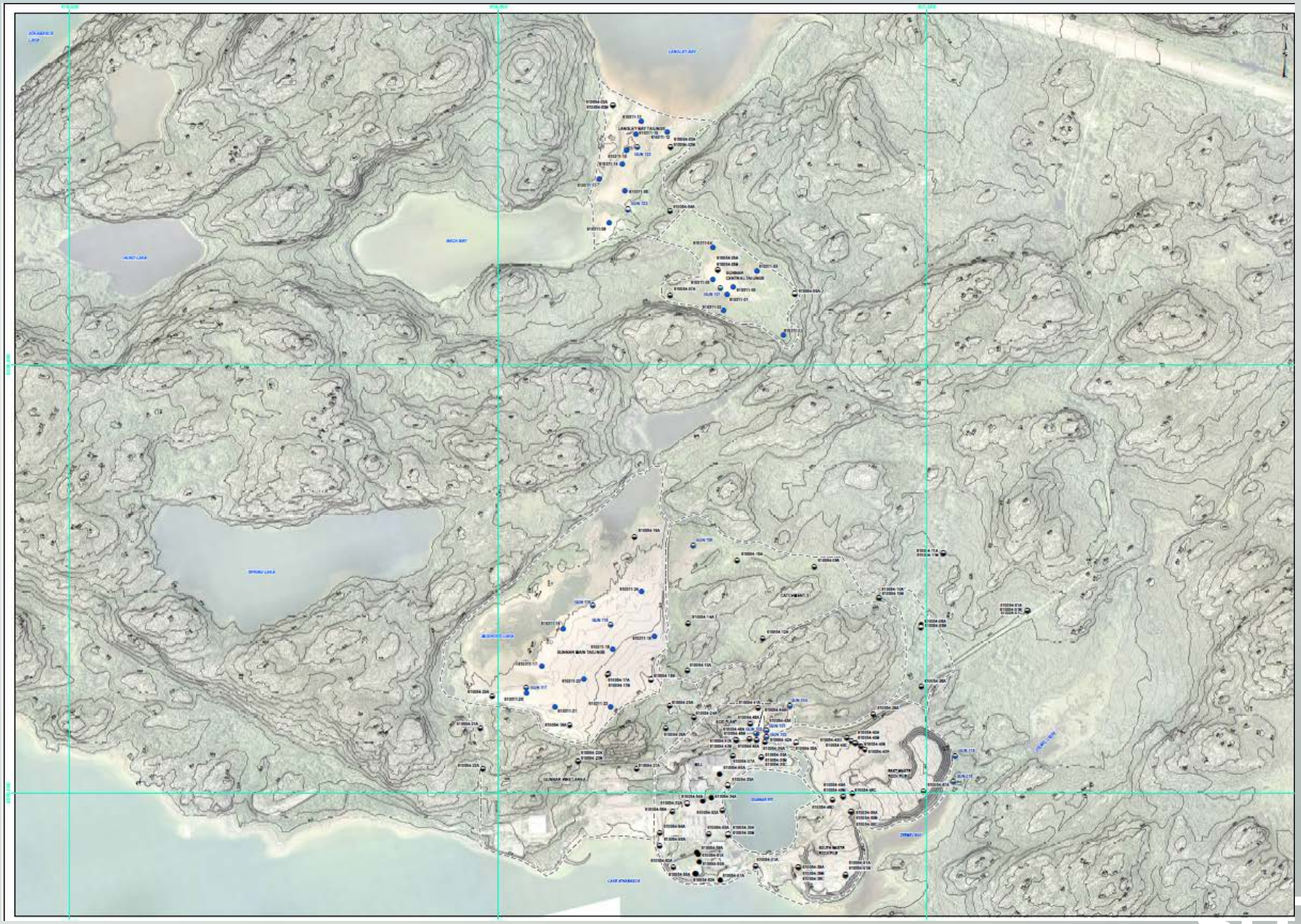


Gunnar Climate, Radon and Dust fall Monitoring Locations:



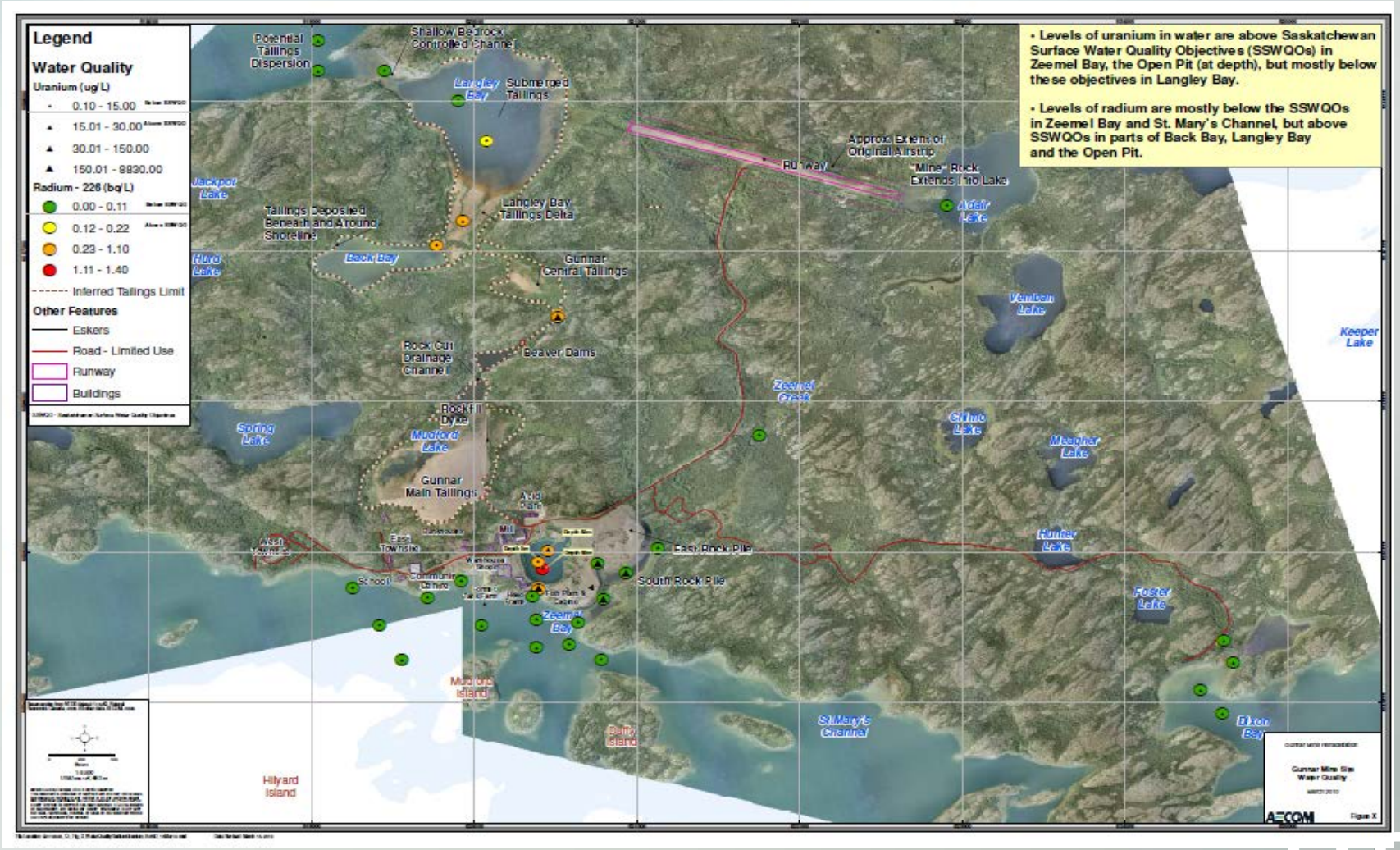


Ground water monitoring: 86 piezometers

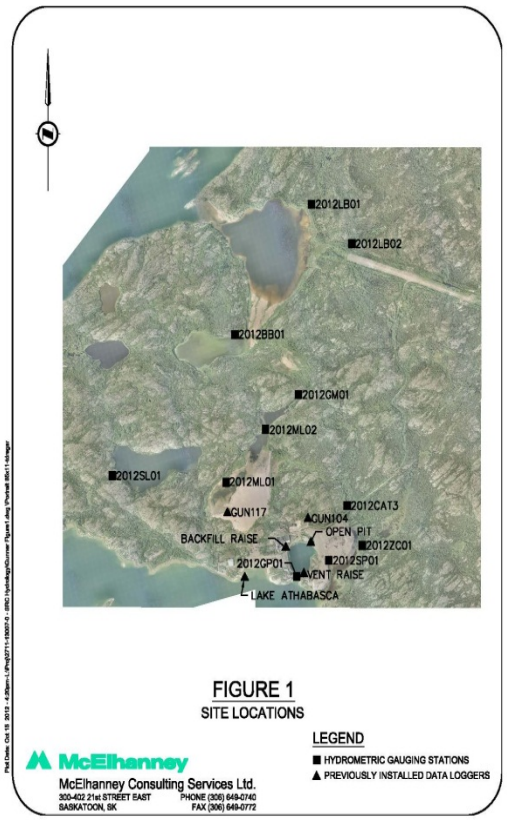


Surface Water Monitoring:

Selection of Routine Monitoring Locations



Characterization of Water Budgets through Flow Monitoring:



Summary of Reported Seepage Flow Rates from 2012SP01

Source	Date Measured	Rate (L/sec)	Data Presented in Report
Tones	1981	3-5	Tones, 1982[1]; SRC, 2005[2]
BBT	June & August 1985	1-2	BBT, 1986[3], SRC, 2005[2]
SRC	August 2004	<1	SRC, 2005[2]
AECOM	Summer 2010	4.5	AECOM, 2010[4]
AECOM	Predicted by GW Model	1.4	AECOM, 2010[4]
McElhanney	September 2012	2.5	Not yet published.

[1]Tones, P.I. 1982. *Limnological and Fisheries investigation of the Flooded Open Pit at the Gunnar Uranium Mine.* Saskatchewan Research Council Publication No. C-805-10-E-82. February 1982.

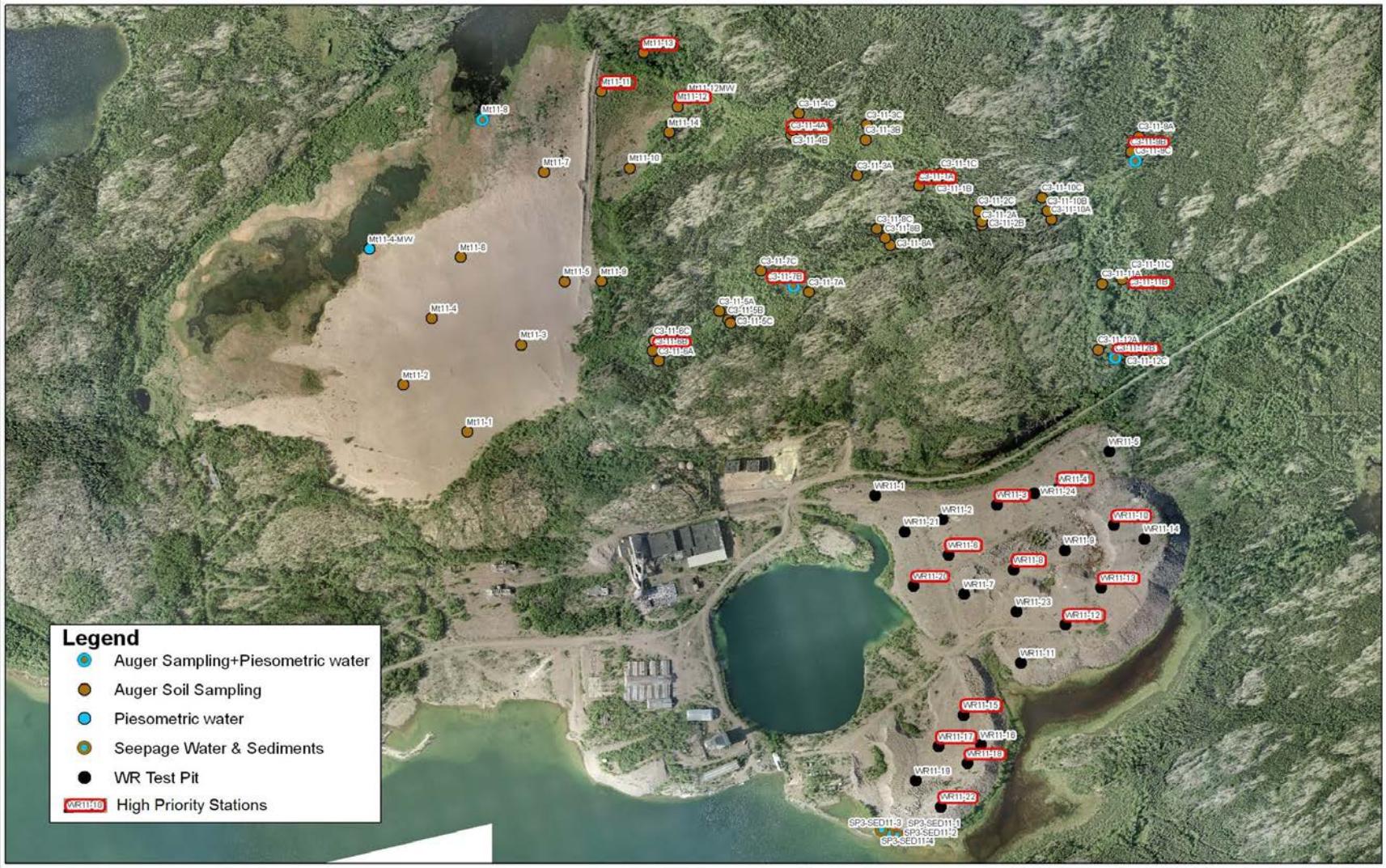
[2]Saskatchewan Research Council. 2005. *Gunnar Site Characterization and Remedial Options Review.* Saskatchewan Research Council Publication No. 11882-1C04. January 2005.

[3]BBT Geotechnical Consultants Ltd. 1986. *Gunnar Field Study.* BBT Geotechnical Consultants Ltd., Saskatoon, Saskatchewan, Report No. S84-1750.95.p.

[4]AECOM. 2010. *Groundwater flow and Mass Transport Model for the Former Gunnar Mine Site (EIS Appendix L).* AECOM. Guelph, ON, Project No. 60119505, 75 p.

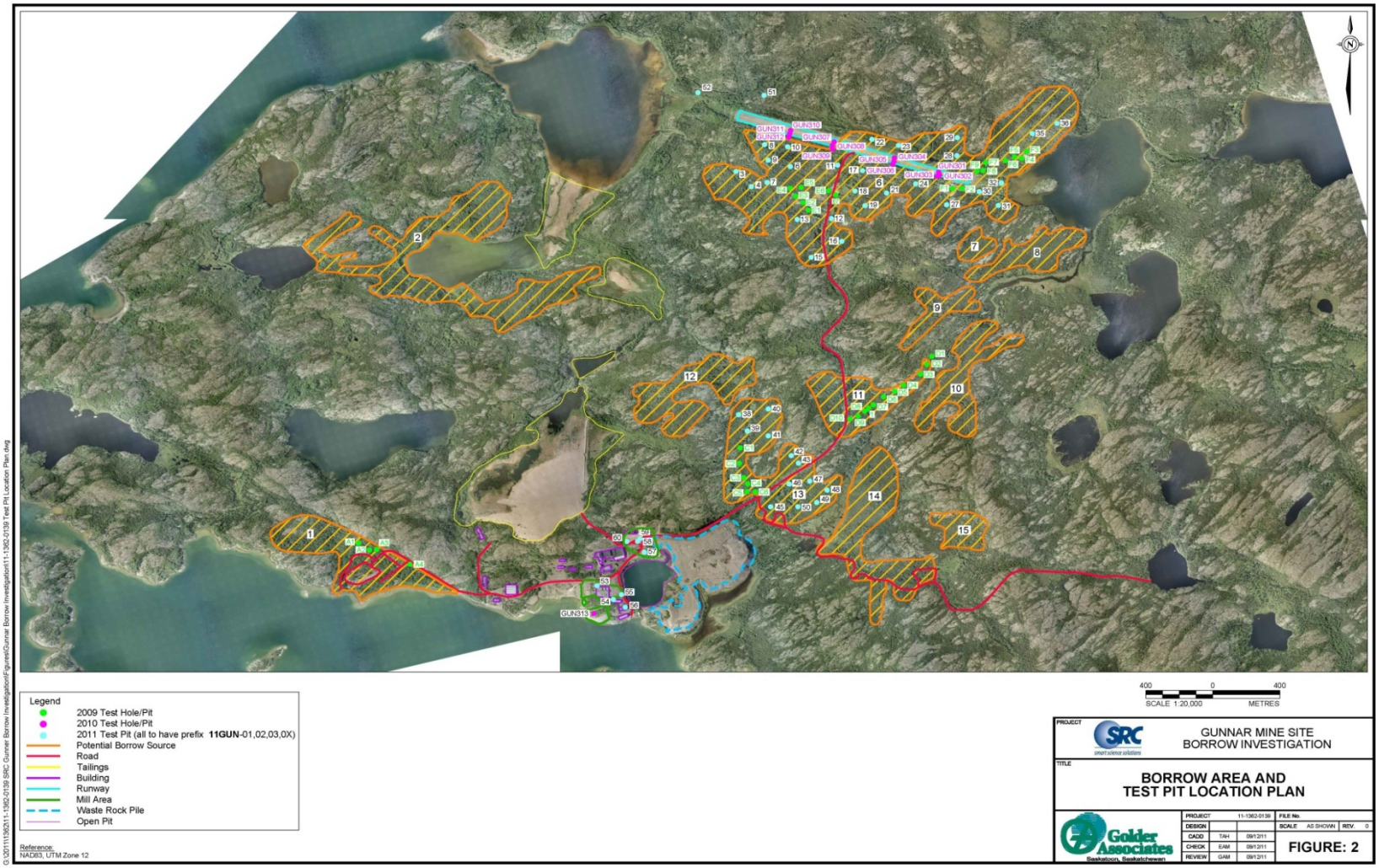
Resultant monitoring data will be used to parameterize a quantitative Site-wide model, which will serve as the basis for decisions a key decision-tree points during Site licensing.

Waste Rock Characterization:



Borrow Characterization:

Where, the amount of borrow material required is dependent upon the remedial option



Getting the Word Out

- Community meetings are routinely held in:
  - Uranium City
  - Camsell Portage
  - Fond du Lac
  - Wollaston Lake
  - Stony Rapids
  - Black Lake

(with periodic visits to Fort Chipewyan)

Uranium City, April 2011

Wollaston, April 2011

- The Main Questions Discussed:
  - What are the impacts of the Project?
  - What types of remediation options could be used?
  - Are there any training opportunities to build capacity?
  - Are there any job opportunities?
  - How can we actively participate in the remediation?

Community Feedback:

- *"Cleanup Options"* flyer
- Briefs on the options and included a *Feedback Form.*
- Request to tick one option and add comments.
- Suggestions on other solutions for any option were welcomed.
- Input from Communities through a *Feedback Form.*
- Outcomes of Community meetings have led to identification of remediation options.

Joint Training Partnerships:
SRC, PAGC and QMLP

- 50% funded by the Government of Canada's Aboriginal Skills and Employment Partnership.
- Objective: To provide capacity building and employment opportunities in the Athabasca Basin Region.
- Seven communities: Hatchet Lake First Nation, Wollaston Lake, Black Lake First Nation, Stony Rapids, Fond du Lac First Nation, Uranium City and Camsell Portage.

Recycling at Gunnar: A ‘Homegrown’ Initiative

Key Conclusions:

- The approach used for remediation planning may differ for abandoned sites, such as the Gunnar Site in northern Saskatchewan.
- Regulator may approve the decision-tree approach to EIS, yet they want to see a clear “road map” for the way forward, and the criteria for option selection must be well defined
- To the extent possible, it is important involve local communities in clean-up efforts so they can play an active role, while gaining skill sets and economic benefits from the remediation.

Thank You!

Any Questions?

For more info – www.saskcleans.ca