Denison Environmental Services

City of Elliot Lake

Council Presentation

December 2019

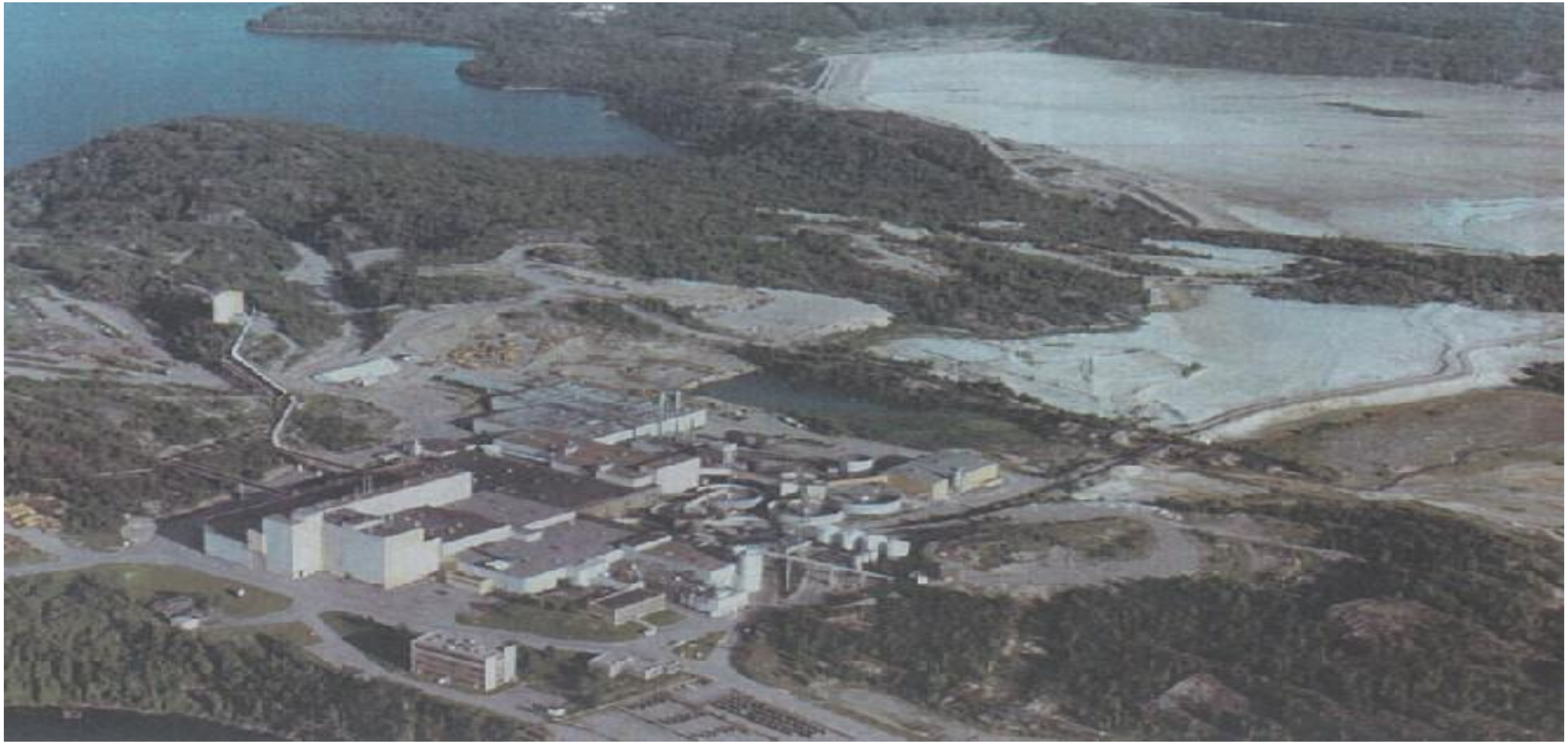
Denison Environmental

Overview

- History of Denison Mines - Denison and Stanrock Mine sites
- Current Site Features
- Current Care & Maintenance Activities
- 1995 Environmental Impact Statement – Predictions
- Water Quality Results
- Adaptive Management
- Reporting and Communications

History Of Denison Mines

Denison Mine Site 1957 - 1992



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History Of Denison Mines

Stanrock Mine Site 1958 - 1990

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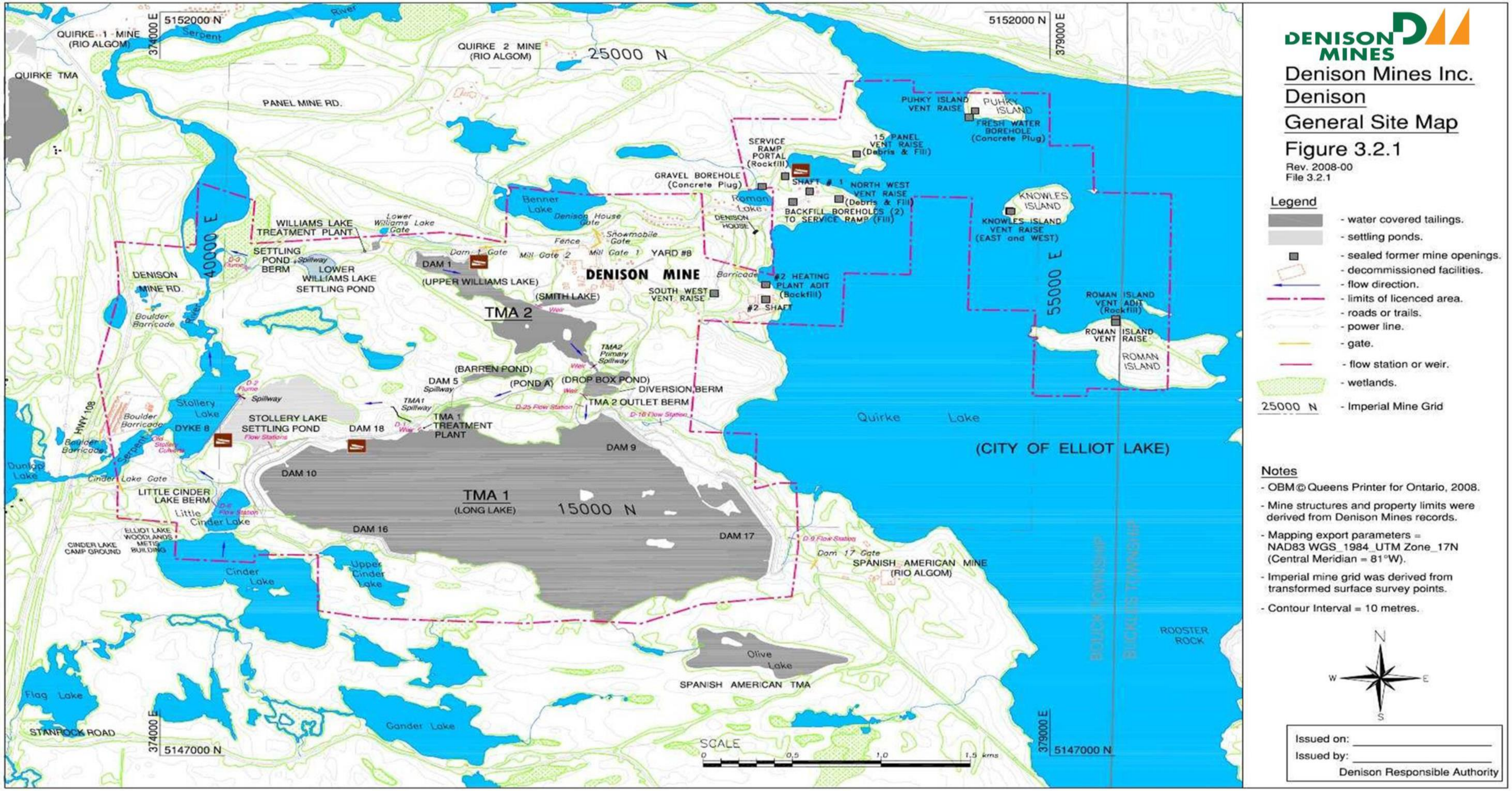

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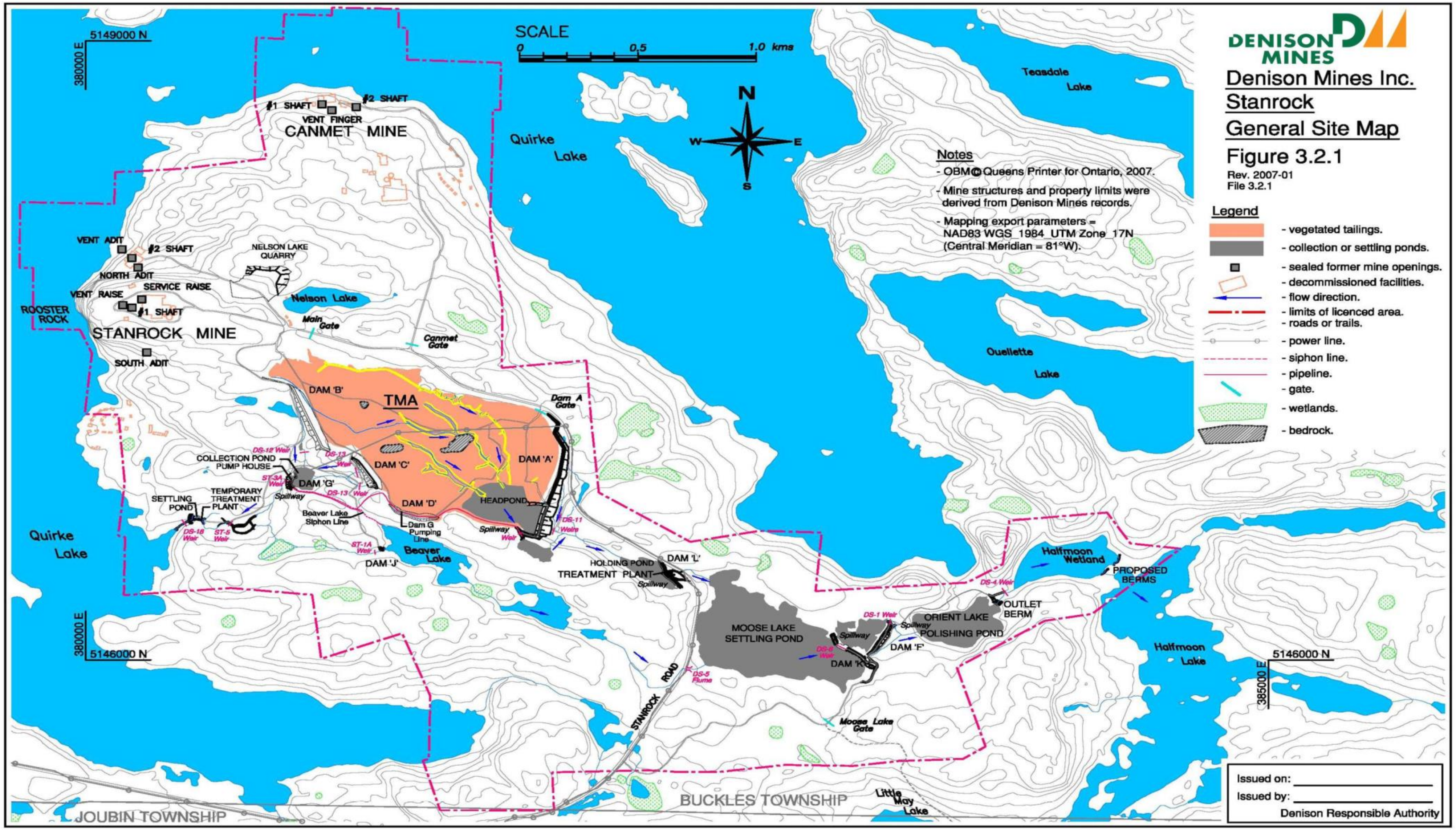
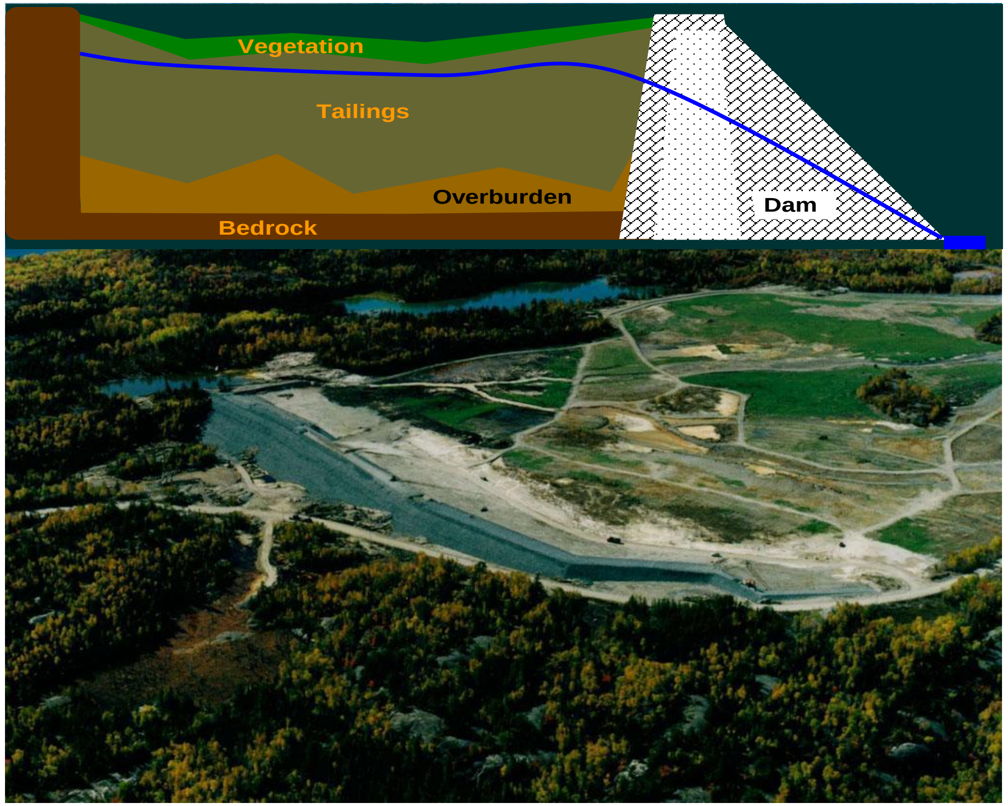
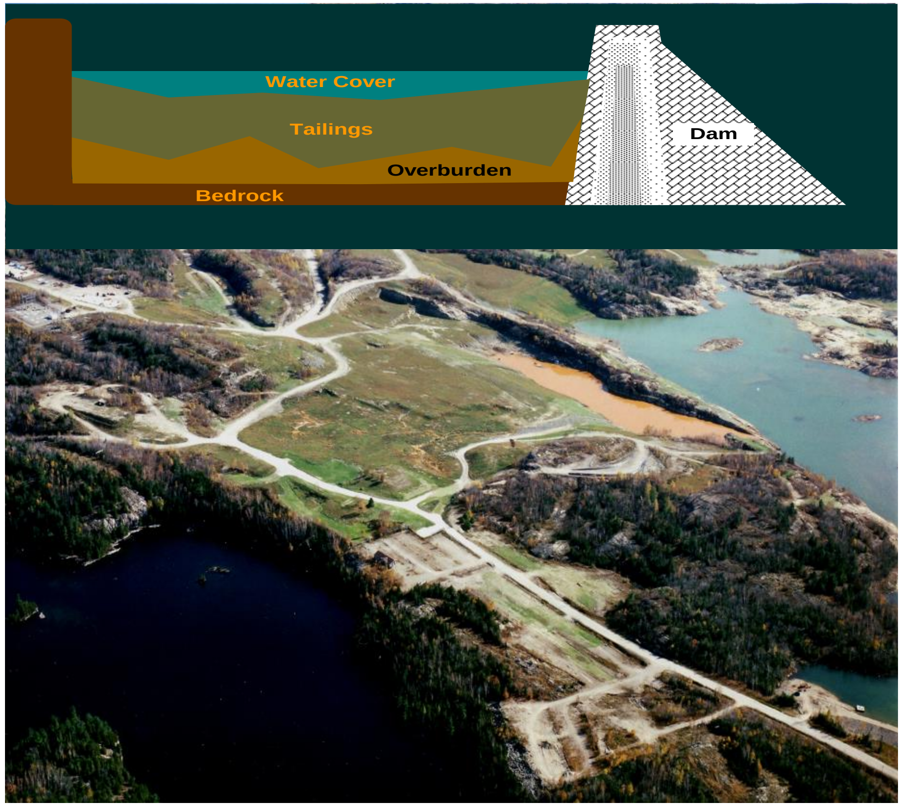

DENISON MINES
Denison Mines Inc.
Stanrock
General Site Map
Figure 3.2.1
Rev. 2007-01
File 3.2.1
Notes
- OBM© Queens Printer for Ontario, 2007.
- Mine structures and property limits were derived from Denison Mines records.
- Mapping export parameters = NAD83 WGS_1984_UTM Zone_17N (Central Meridian = 81°W).
Legend
- vegetated tailings.
- collection or settling ponds.
- sealed former mine openings.
- decommissioned facilities.
- flow direction.
- limits of licenced area.
- roads or trails.
- power line.
- siphon line.
- pipeline.
- gate.
- wetlands.
- bedrock.
SCALE
0 0.5 1.0 kms
N
W E
S
5149000 N
380000 E
5146000 N
385000 E
CANMET MINE
#1 SHAFT
#2 SHAFT
VENT FINGER
STANROCK MINE
VENT ADIT
NORTH ADIT
VENT RAISE
SERVICE RAISE
SOUTH ADIT
ROOSTER ROCK
NELSON LAKE QUARRY
Nelson Lake
Main Gate
Canmet Gate
Quirke Lake
Teasdale Lake
Ouellette Lake
TMA
DAM 'A'
DAM 'B'
DAM 'C'
DAM 'D'
DAM 'G'
DAM 'J'
DAM 'K'
DAM 'F'
DAM 'L'
Dam A Gate
HEADPOND
COLLECTION POND PUMP HOUSE
TEMPORARY TREATMENT PLANT
SETTLING POND
Beaver Lake Siphon Line
Dam G Pumping Line
Beaver Lake
HOLDING POND
TREATMENT PLANT
Spillway
MOOSE LAKE SETTLING POND
ORIENT LAKE POLISHING POND
OUTLET BERM
PROPOSED BERMS
Halfmoon Wetland
Halfmoon Lake
Moose Lake Gate
STANROCK ROAD
BUCKLES TOWNSHIP
JOUBIN TOWNSHIP
Little May Lake
Issued on:
Issued by:
Denison Responsible Authority

Site Features

It has been over 20 years since the sites have been closed, rehabilitated and the treatment plants operating



Stanrock



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Current Care and Maintenance Activities

After 20 years, care and maintenance at the sites now focusses mainly on:

- Equipment repair or replacement (impact of aging infrastructure)
- Herbicide of vegetation on dams
- Brushing of vegetation along roadways and on dams
- Monitoring of water quality and quantity
- Monitoring of dams and dam instrumentation
- Road maintenance/ snow removal
- Removal of beaver dams and debris
- Operation and maintenance of treatment plants
- Community Liaison

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1995 Environmental Impact Statement – Decommissioning Objectives for both the Denison and Stanrock Sites

- Assess, plan and execute all decommissioning work in compliance with all applicable legislation providing for the protection of the environment, employee and the public;
- In the absence of legislation, apply cost-effective, best management practices to advance environmental protection and to minimize environmental risks;
- Maintain an active, continuing self-monitoring program throughout the decommissioning phase to ensure compliance with government and company requirements;
- Utilize best available scientific knowledge to design and execute the decommissioning work to ensure that potential long-term environmental and social impacts are mitigated; and
- Enhance communications and understanding with governments, employees and the public.

1995 Environmental Impact Statement (EIS) - Predictions

On the basis of the environmental screening, the key potential effects were identified as:

- Effects on the receiving water quality and receptor exposures to waterborne pathways. The impacts on surface water quality assumes that the systems will operate as designed and that no system failures occur;
- Based on modelling, a detailed radioactivity pathway analysis was completed assuming routine releases from the closed-out TMAs on various receptors living at selected locations within the watershed; and
- The effects that can arise from non-routine events such as earthquakes or floods were modelled to determine damage to the system and the potential impacts on the environment.

In cases where no models were used, impacts were identified or predicted based on previous experience with uranium mining projects and reasonably foreseeable effects.

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Denison Mine Site EIS Predictions

The modelling results were presented in the EIS for all radionuclides, pH and sulphate with select relevant data provided. This data was considered key for the following reasons:

- Radionuclide results are critical to predict future radioactivity exposures and dose from the closed sites;
- pH is a measure of acidity levels and would confirm whether or not acid generation is happening and/or being released from the closed sites; and
- sulphate is found in tailings, they are very soluble and not toxic but can be used as indicators for performance of the TMAs.

		Pore Water				Pond Water			
		50(1)	100(1)	500(1)	1000(1)	50(1)	100(1)	500(1)	1000(1)
pH	Units	6.7	6.7	6.1	6.1	>7	7	7	7
SO4	mg/L	1,600	1,600	525	200	75	50	25	18
Ra-226	Bq/L	0.3	0.5	1.2	0.6	0.2	0.3	0.5	0.2
Uranium	Bq/L	0.038	0.063	1.20	1.56	0.001	0.002	0.028	0.036
Thorium	Bq/L	0.96	0.96	1.47	1.44	0.022	0.023	0.034	0.034
Pb-210	Bq/L	0.39	0.073	0.24	0.22	0.036	0.003	0.006	0.005

Note: (1) Number of years after closure.

Denison Mine Site Predictions (con't)

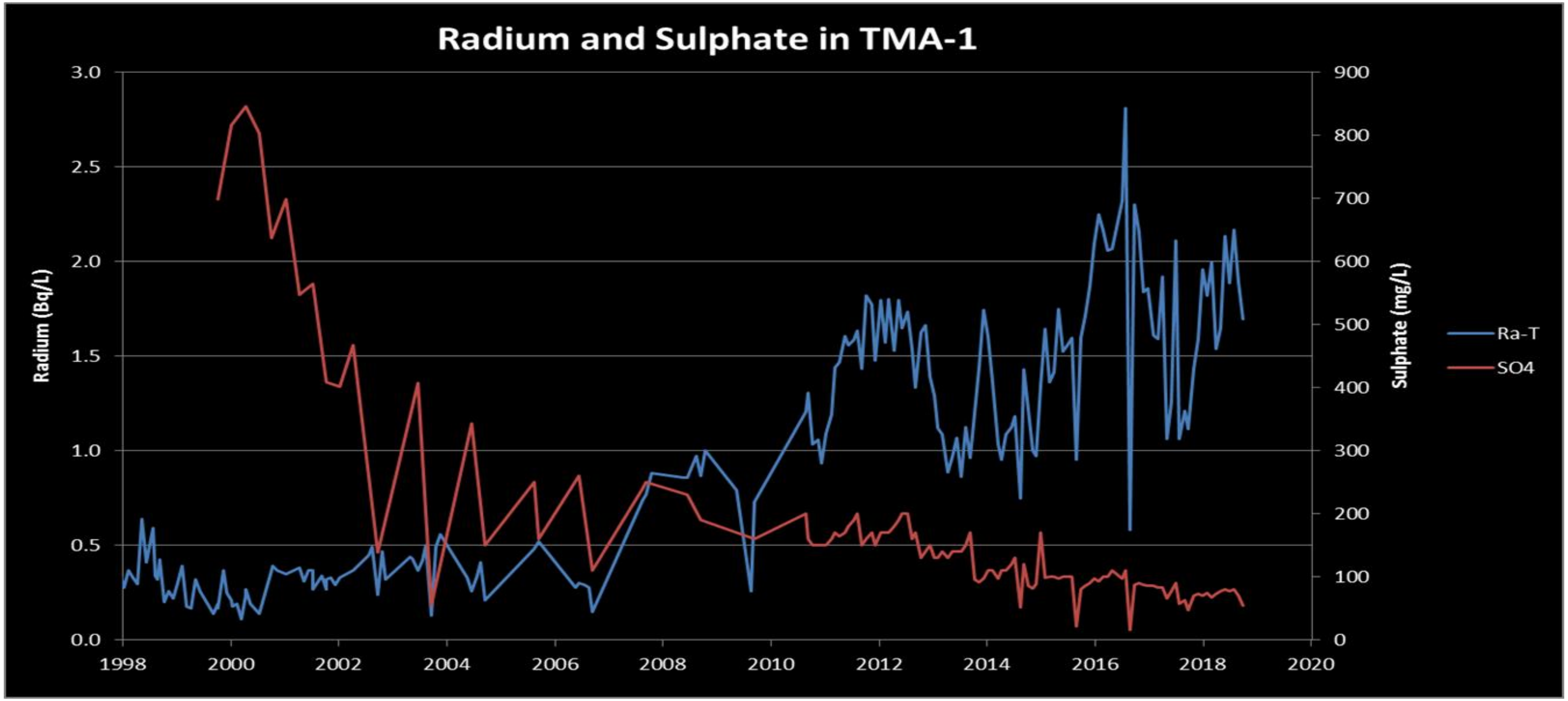
- Based on the results of the modelling, water cover was expected to:
  - minimize the tailings oxidation predicting that pH in both pore water and pond water will remain relatively neutral.
  - following the completion of the flooding, sulphate levels were expected to be about 300 mg/L, declining to less than 100 mg/L after 40 years.
  - Radium-226 levels in pore water were predicted to average about 0.3 to 0.5 Bq/L once the process water has flushed from the system.
  - Over time with the decrease of sulphate, Ra-226 levels will peak at about 1.3 Bq/L and thereafter decline. Pond water levels will be similar to those of pore water but with reduced concentrations.
  - Peak pond water levels are predicted to be about 0.6 Bq/L.
- Uranium and thorium will both reach peak levels in the pore water between 500 and 1,000 years after closure but will always remain very low in pond water.
- Lead-210 levels will decline rapidly in both pore water and pond water but are expected to then increase again after that as they are dependent on ingrowth from Ra-226.

Water Quality

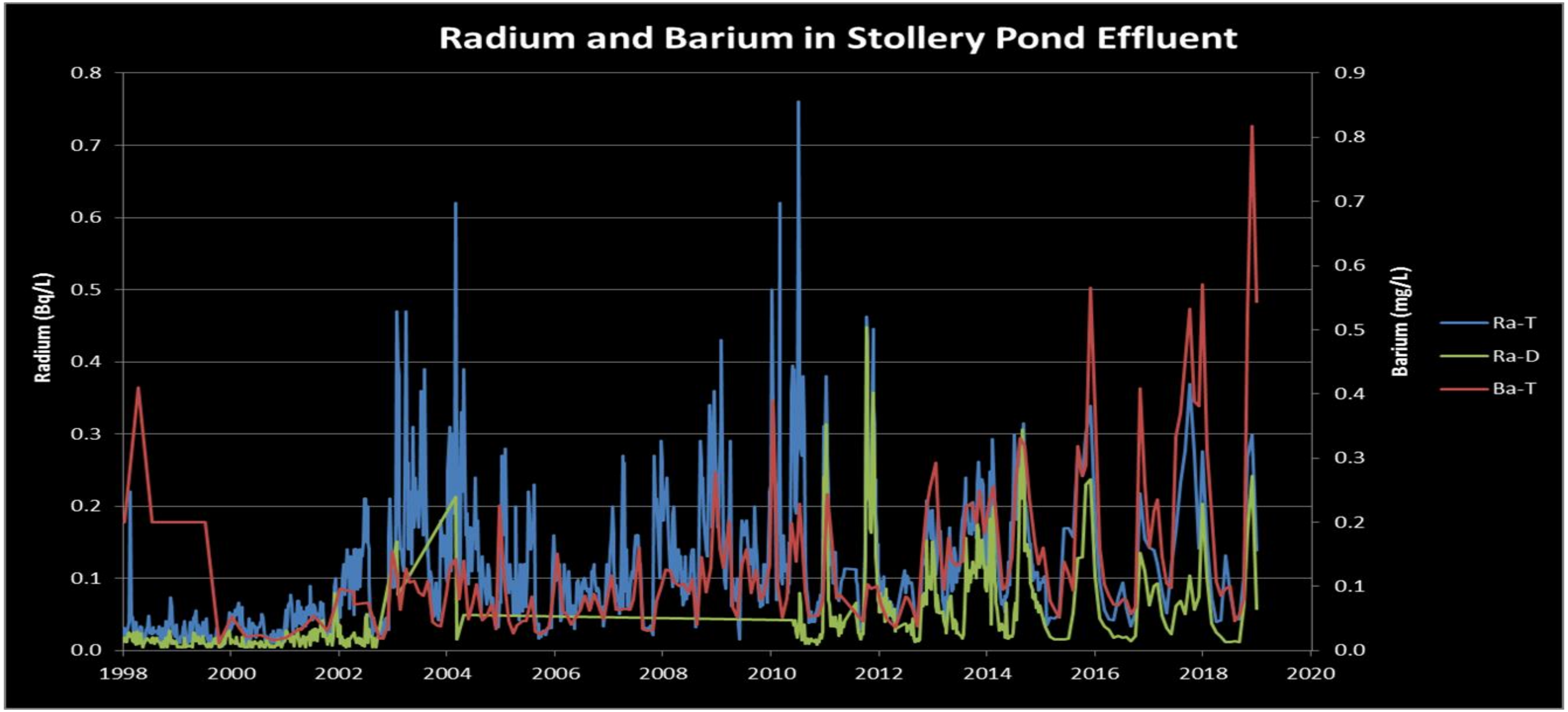
Denison TMA-1

- **TMA-1 Final Discharge** is monitored at the Stollery Settling Pond Outlet (**D-2**). Review of annual average concentrations for the last five years indicate generally decreasing sulphate concentrations while annual average radium concentrations consistently remain below the Ministry of the Environment, Conservation and Parks (MECP) Provincial Water Quality Objectives (PWQO) of 1.0 Bq/L.
- The increase in annual average barium concentrations is consistent with the increased barium chloride addition rates required for radium removal.
- Uranium concentrations appear to be gradually decreasing while cobalt, iron and manganese concentrations consistently meet criteria requirements
- There have been no compliance issues at TMA-1 final discharge D-2

Denison Site Water Quality 1998 - 2018



Effluent Water Quality 1998 - 2018



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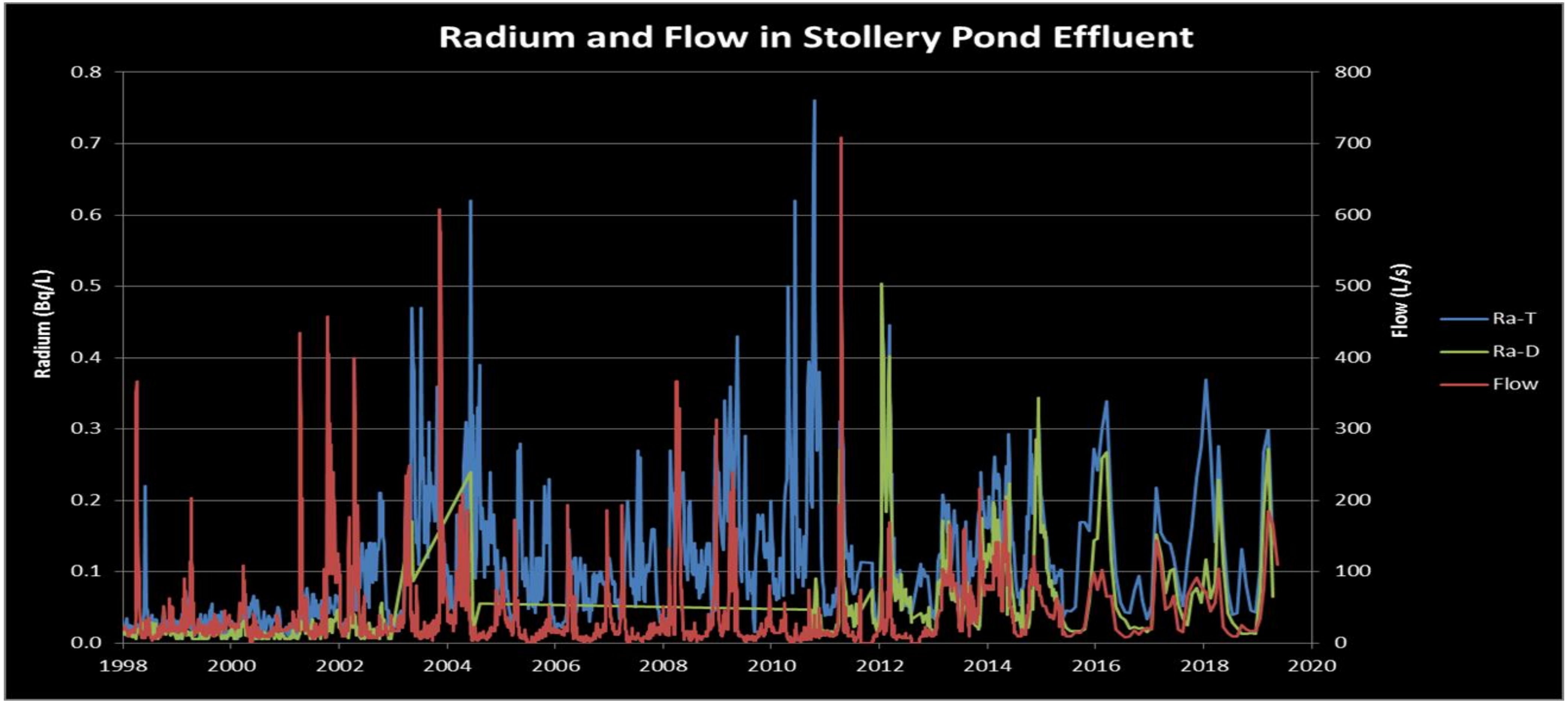
Effluent Water Quality 1998 - 2018



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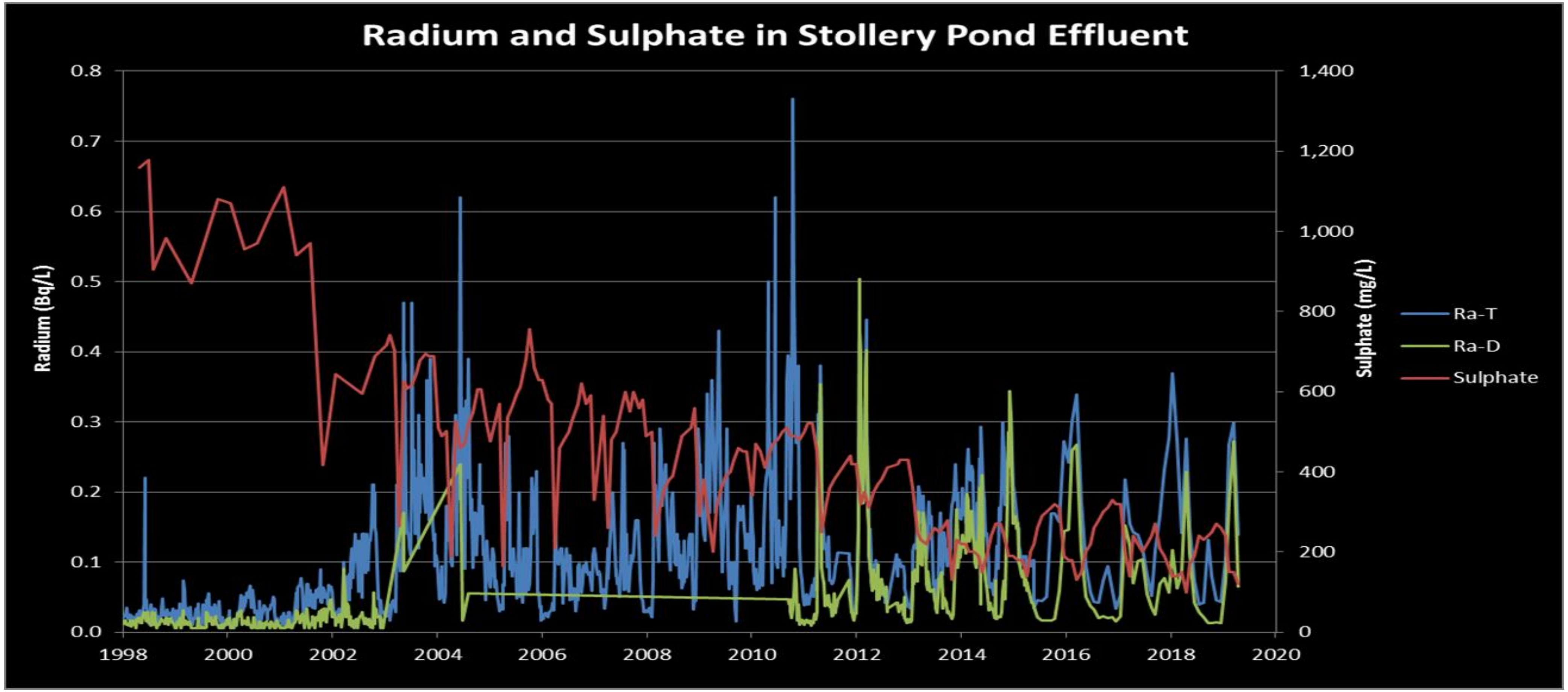
Effluent Water Quality 1998 - 2018



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Water Quality

Denison Lower Williams Lake

- Seepage from Dam 1 is monitored at the Lower Williams Influent (D-22). Review of annual average concentrations indicates relatively stable iron concentrations with near neutral pH and acidity below detection levels. Radium, uranium, barium, and cobalt concentrations consistently remain below the criteria requirements. The 2015 and 2016 annual average manganese concentrations appear to be influenced by seasonal spikes observed during July in both years when flow is generally very low. However, no impact was observed downstream at the final discharge (D-3) where concentrations remain well below criteria
- The discharge from Lower Williams is monitored at the Final Discharge Point (D-3). Review of annual average concentrations indicate that all parameters have consistently remained well below the criteria over the past five years with the exception of cobalt which remains at or below detection levels
- There have been no compliance issues at Lower Williams Lake discharge

Stanrock Mine Site Predictions

		10(1)	50(1)	100(1)	200(1)	300(1)	500(1)	600(1)	1000(1)
pH	Units	5.4	6.3	6.7			6.8		
SO4	mg/L	2,800	1,700	1,500	10	10	10		
Ra-226	Bq/L		0.9					3.7	2.7

Note: (1) Number of years after closure.

- Based on the results of the modelling, the *in-situ* plan predicted pH to recover to >6.0 by year 40 and that beyond 50 years, treatment for acidity will not be required.
- The sulphate levels were predicted to inversely track pH such that as pH levels increase sulphate levels will decline.
- Acid production is usually complete when sulphate levels decline to about <1,700 mg/L, which is expected to occur about year 50.
- Ra-226 levels are initially dependent upon sulphate levels. When acid production declines and sulphate levels drop, Ra-226 will start to climb, reaching peak conditions in pore water around year 600.
- Uranium levels appear to have peaked during decommissioning and are expected to decline thereafter.
- Thorium levels in the pore water were expected to be reduced to less than 1 Bq/L in 80 years.
- Lead-210 levels were expected to decline rapidly in the pore water but then increase again after that as they are dependent on ingrowth from Ra-226.

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Water Quality

Stanrock Mine Site

- Discharge and runoff from the TMA is monitored at the Stanrock Treatment Plant Influent (DS-2). Based on a review of the last five years of data, annual average radium concentrations appear to be relatively stable and remain consistently below the PWQO of 1.0 Bq/L while annual average barium concentrations remain well below the criteria of 1.0 mg/L
- Based on a review of water quality data at the Stanrock Final Point of Control at Orient Lake Outlet (DS-4) for the last five years, annual average sulphate concentrations are gradually decreasing and all metal concentrations consistently meet SRWMP receiving water quality objectives with cobalt approaching detections levels
- There have been no compliance issues at Stanrock Mine discharge

Results – Dose to Wildlife and Humans

- The concentrations of Ra-226 in riparian wildlife (muskrat, mink, mallard, scaup, merganser) were calculated using allometric food intake rates
  - Dose estimates received by aquatic biota and riparian wildlife in the six watershed lakes were less than the respective UNSCEAR (1996) benchmarks of 10 mGy/d and 1 mGy/d
- Site-specific criteria for Ra-226 were calculated for watershed lakes based on:
  - the highest dose among aquatic biota (which was the dose to aquatic plants),
  - the highest dose among riparian wildlife (which was the dose to muskrats), and
  - the dose to the generic human

$$Water\ Criterion\left(\frac{Bq}{L}\right) = \frac{Dose\ Benchmark}{Calculated\ Dose} \times C_{Ra-226\ water}$$

$$Sediment\ Criterion\left(\frac{Bq}{kg\ dw}\right) = \frac{Dose\ Benchmark}{Calculated\ Dose} \times C_{Ra-226\ sediment}$$

where,

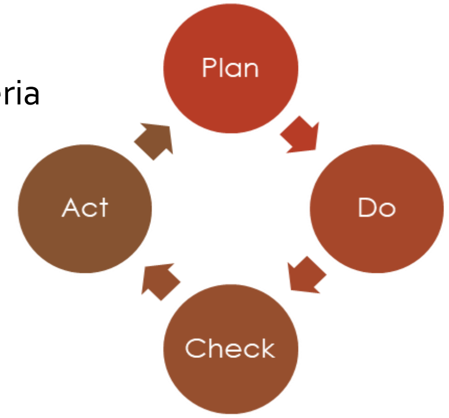
$C_{Ra\text{-}226\ water}$ = Concentration of Ra-226 in water in Bq/L

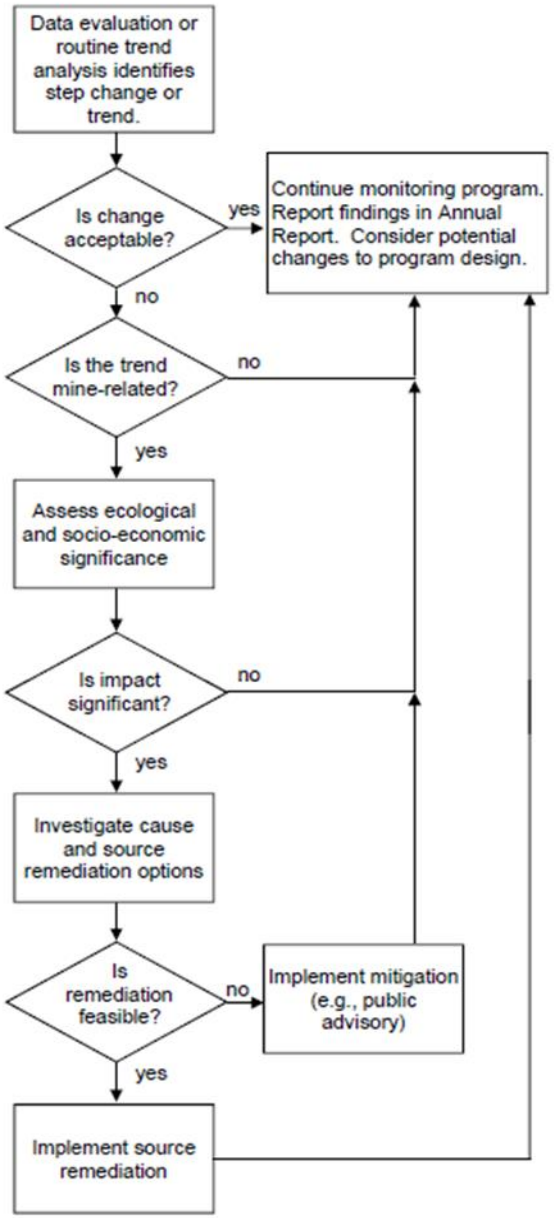
$C_{Ra\text{-}226\ sediment}$ = Concentration of Ra-226 in sediment in Bq/kg dw

Adaptive Management

- Data continually reviewed and changes to monitoring program are made accordingly
- Stakeholders review and approve study designs before next monitoring cycle
- An assessment of the results from three integrated monitoring programs is prepared every five years in a State of the Environment Report (SOE)

  Weight of evidence approach is used and includes:
  - Existing performance
  - Trend analysis
  - Loadings assessments
  - Down stream conditions relative to established criteria and expected conditions





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Reporting and Communication

- Annual presentations to community leaders
- Annual newsletter summarizing activities
- Annual water quality monitoring report available to the public
- Watershed monitoring reports available on website
- Members of the public invited for site tours

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Reporting and Communication (cont'd)

- Mine sites and TMAs decommissioned for 20+ years
- Members of the public are either generally informed and believe the site is safe and available for use or unaware of the history
- Company has found that members of the public are trespassing
  - Risks from physical activities as the sites are active industrial sites
  - Radiological risks are low but certain activities should be avoided
- Current communications push to inform the public about areas where access is restricted

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Thanks

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