Down-Valley Seepage Interception System, Rose Creek Valley, Faro Mine Remediation Project

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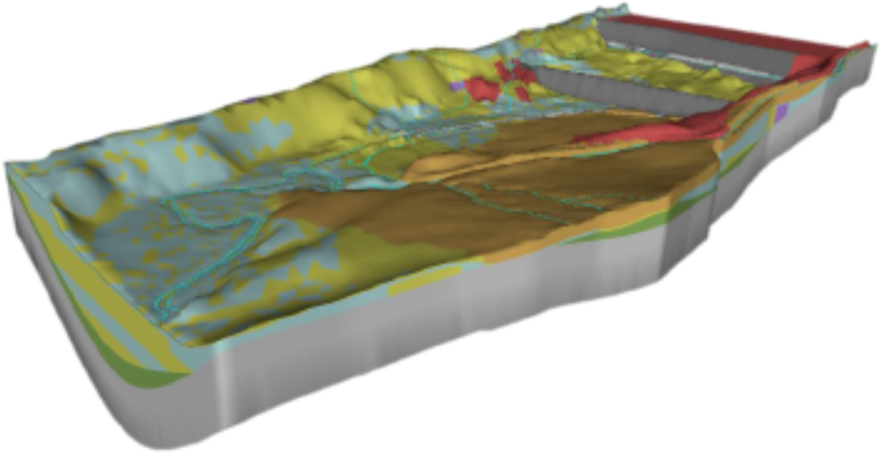


December 1st, 2020
27th MEND ML/ARD Workshop

Site Location and General Mine Arrangement

Background

Site History/Responsibilities

- The Faro Mine was once the largest open pit Pb-Zn mine in the world and was operated for 29 years from 1969 to 1998

- The site was abandoned in 1998 when the owner declared insolvency and has been under Care and Maintenance since 2003

- Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) is now responsible for Care and Maintenance (since 2018) and developing a remediation plan for the site

  See www.rcaanc-cirnac.gc.ca for further details

Remediation Plan

- The site will be remediated, in part, to achieve Water Quality Objectives (WQOs) for Rose Creek downstream of the site

- WQOs will be achieved by reducing metal loads in the creek by:
  - Capturing ARD-impacted groundwater before it reaches the creek; <u>and</u>
  - Raising and/or diverting some reaches of Rose Creek

- The Down-Valley Seepage Interception System (DV-SIS) is the largest and most downstream component of the site-wide SIS and will be operated in perpetuity

Presentation Objectives and Outline

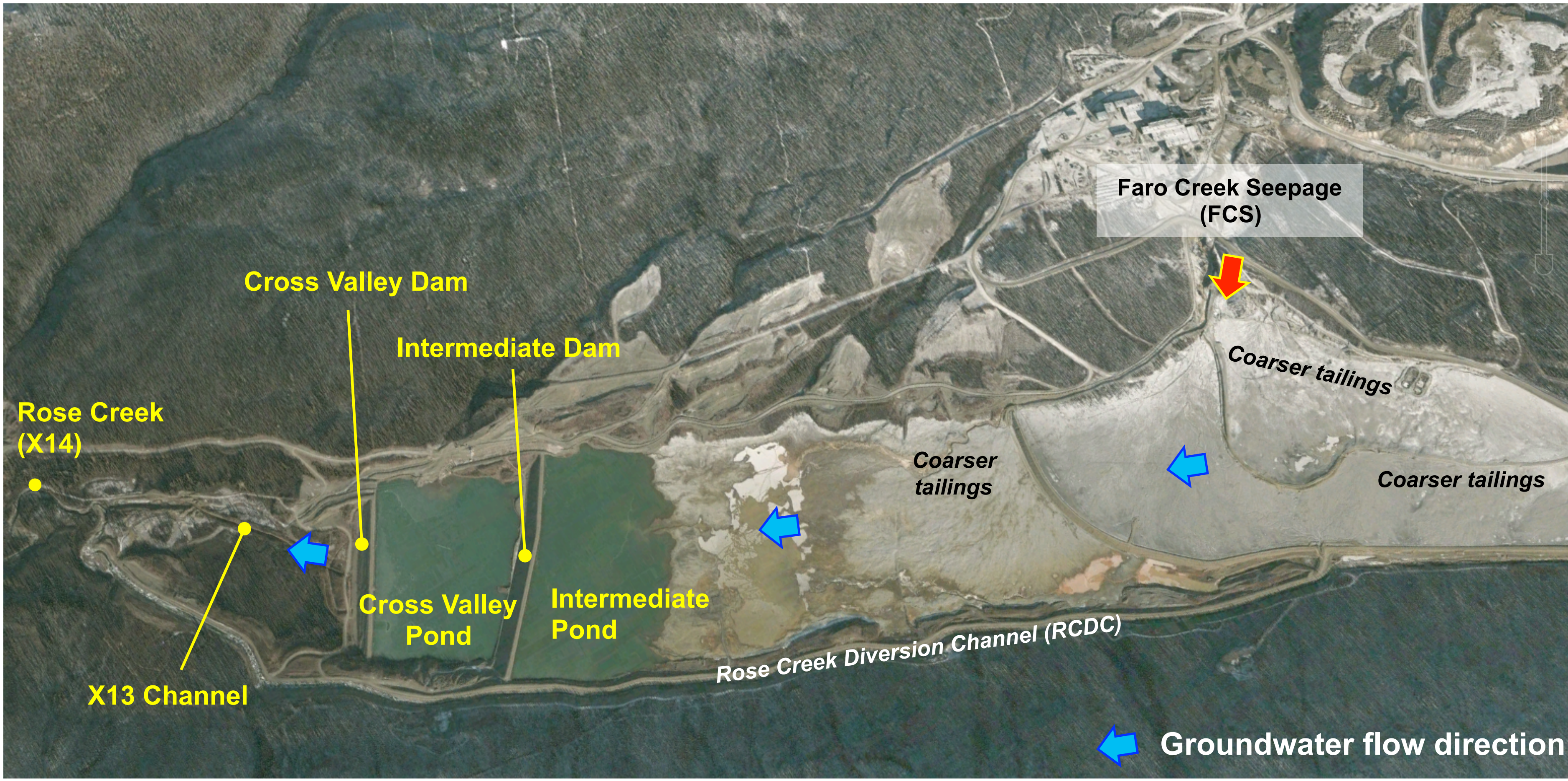
Presentation Objectives

- Summarize key aspects of the conceptual hydrogeological model for the Down-Valley Area (downgradient of the Cross Valley Dam)
- Discuss the development and calibration of a numerical groundwater flow model developed for the DV area
- Summarize the design of the DV-SIS and its predicted performance in terms of capture efficiency and load reduction in Rose Creek

Presentation Outline

- Water Quality in the DV-Area
- Groundwater Flow Model – Down-Valley Area
- DV-SIS Design and Predicted Performance
- Recent Advances in DV-SIS Design and Implementation

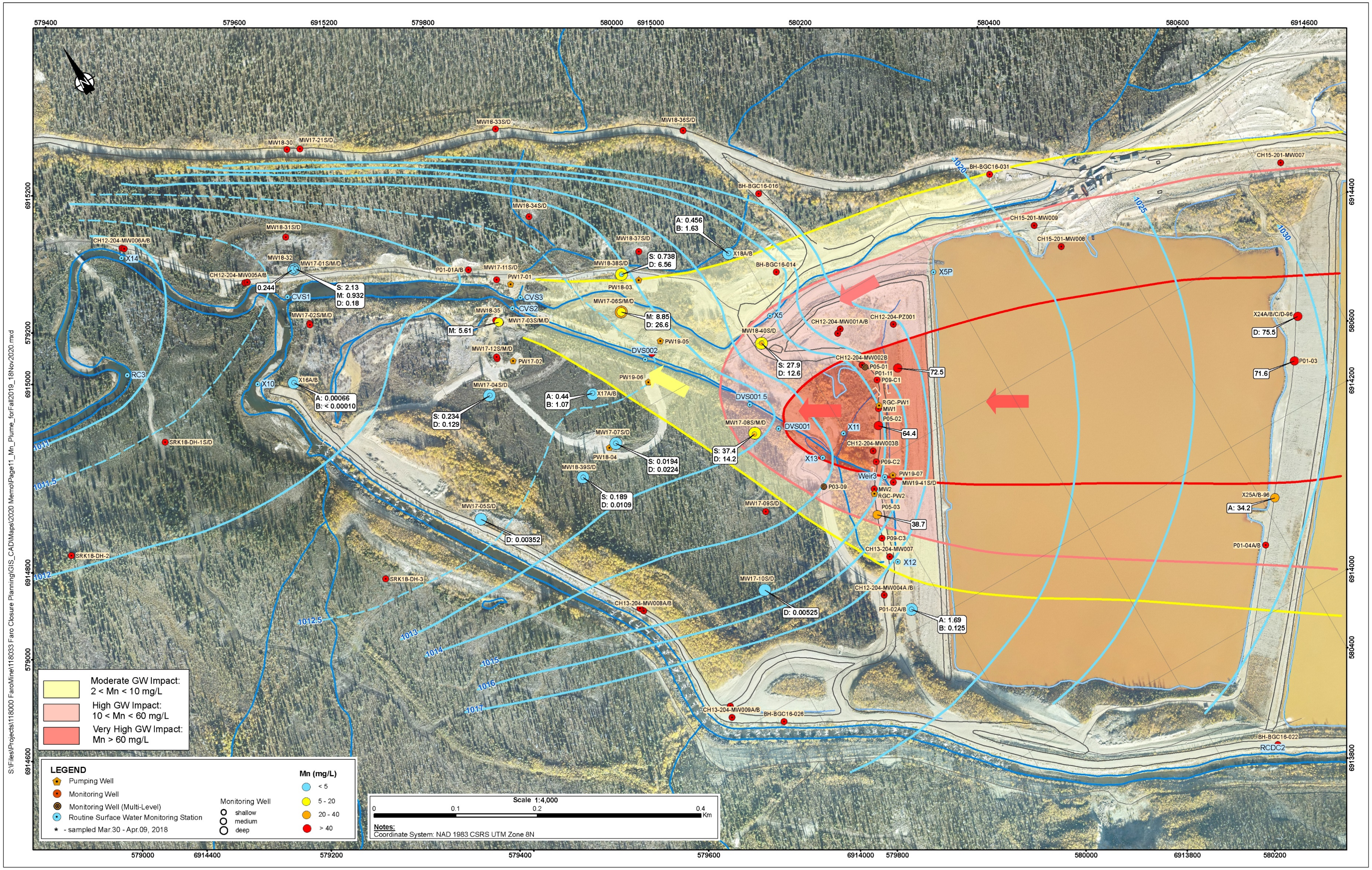
Major ARD Sources in Rose Creek valley



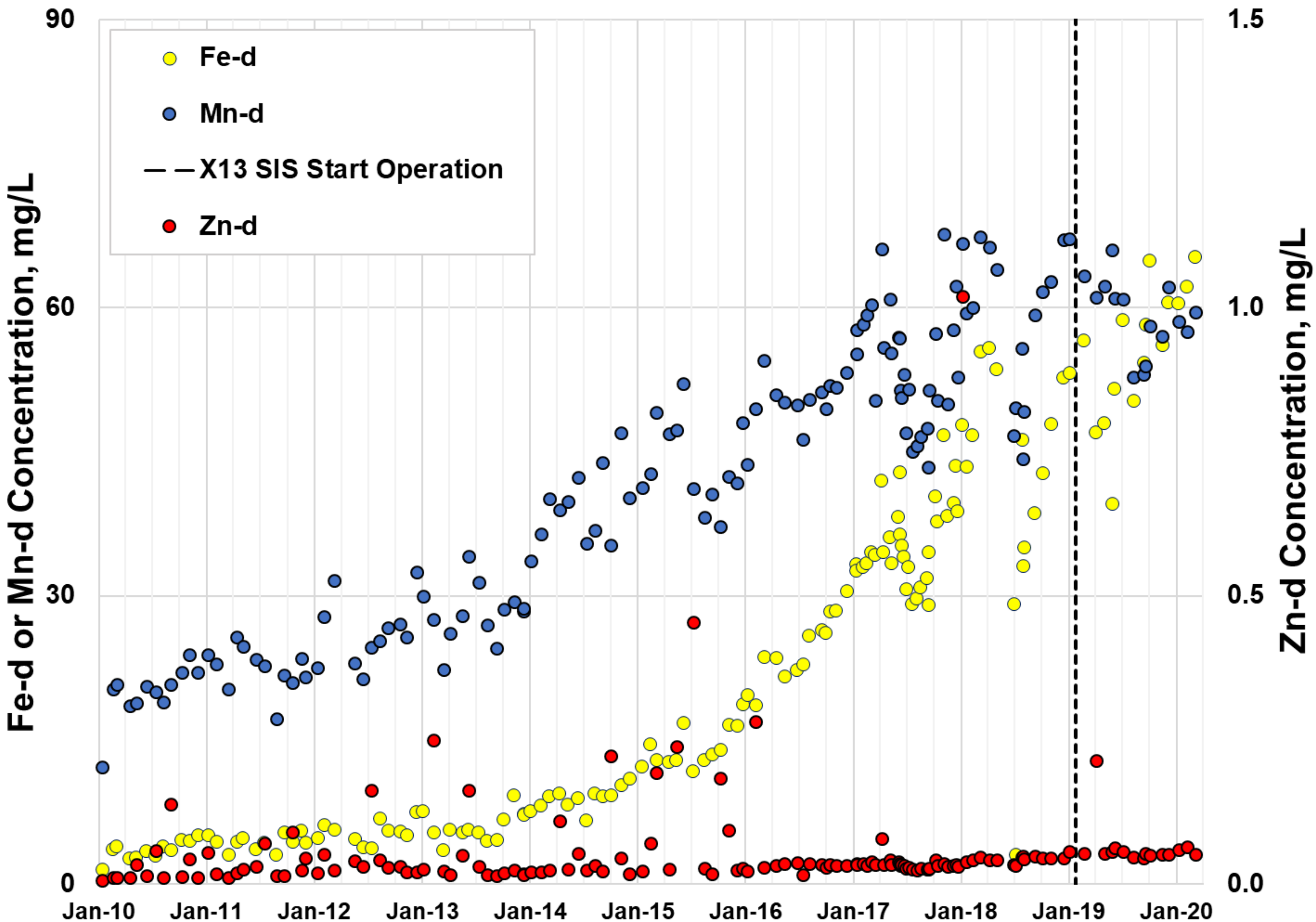
"The Faro Mine Legacy", 2018 Northern Latitudes Mine Reclamation Workshop
http://bc-mlard.ca/files/presentations/2018NL-15-MCGREGOR-the-Faro-Mine-Legacy.pdf

Down-Valley (DV) Area

Inferred Manganese Plume – Shallow Aquifer

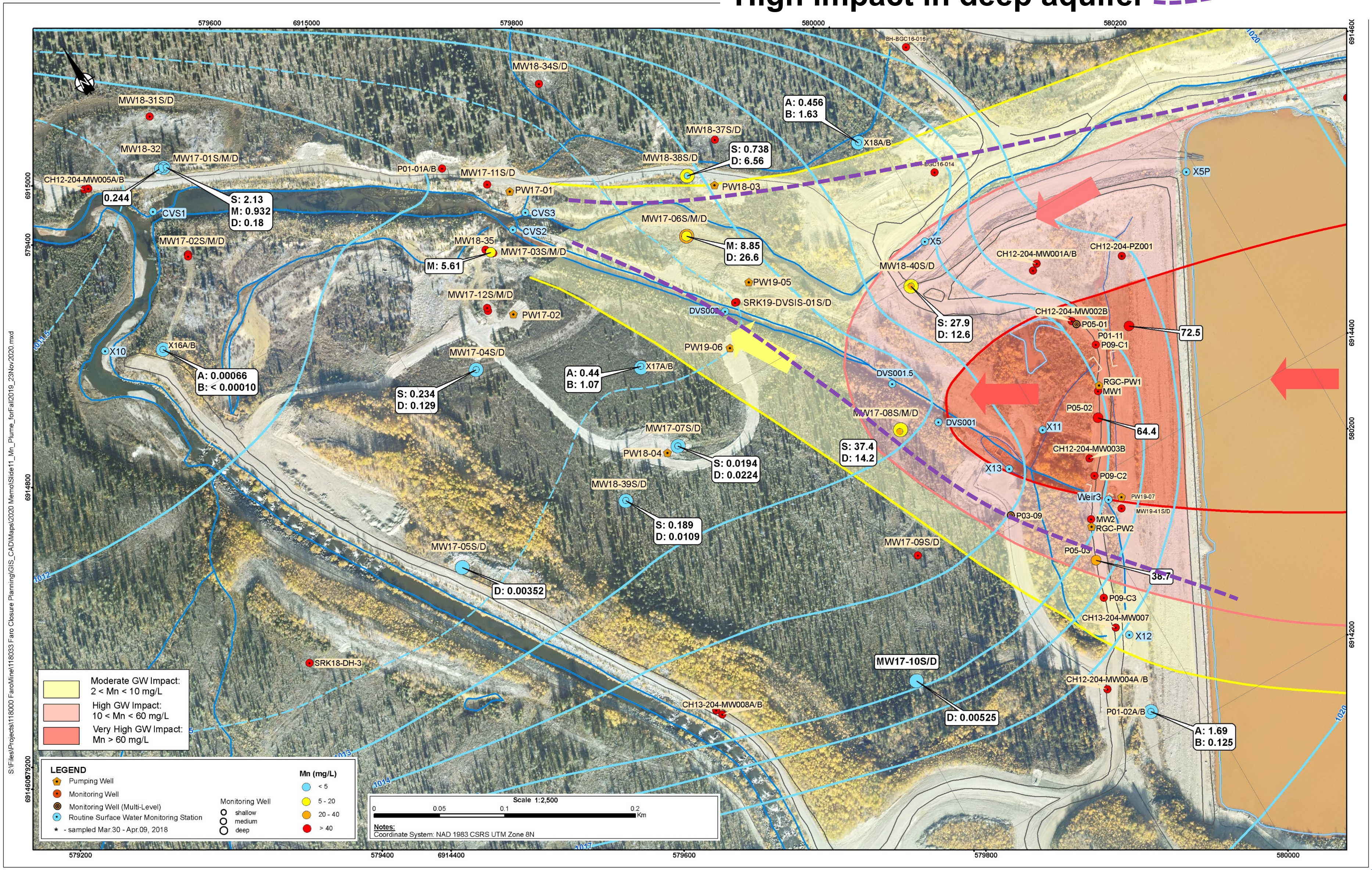


Water Quality Trends – Station X13



Inferred Manganese Plume – Deep Aquifer

High impact in deep aquifer



DV-SIS Performance Objectives & Design Criteria

DV-SIS Performance Objectives

- ***Meet site-specific water quality objectives for Rose Creek established by Yukon Water Board during water licensing***
- Operate reliably and continuously over the long term (>100 years)
- Provide adequate emergency storage to prevent discharge to Rose Creek during planned or unplanned shutdowns
- Provide adequate redundancy to allow maintenance and replacement of selected components without full shut down of the system

Design Criteria

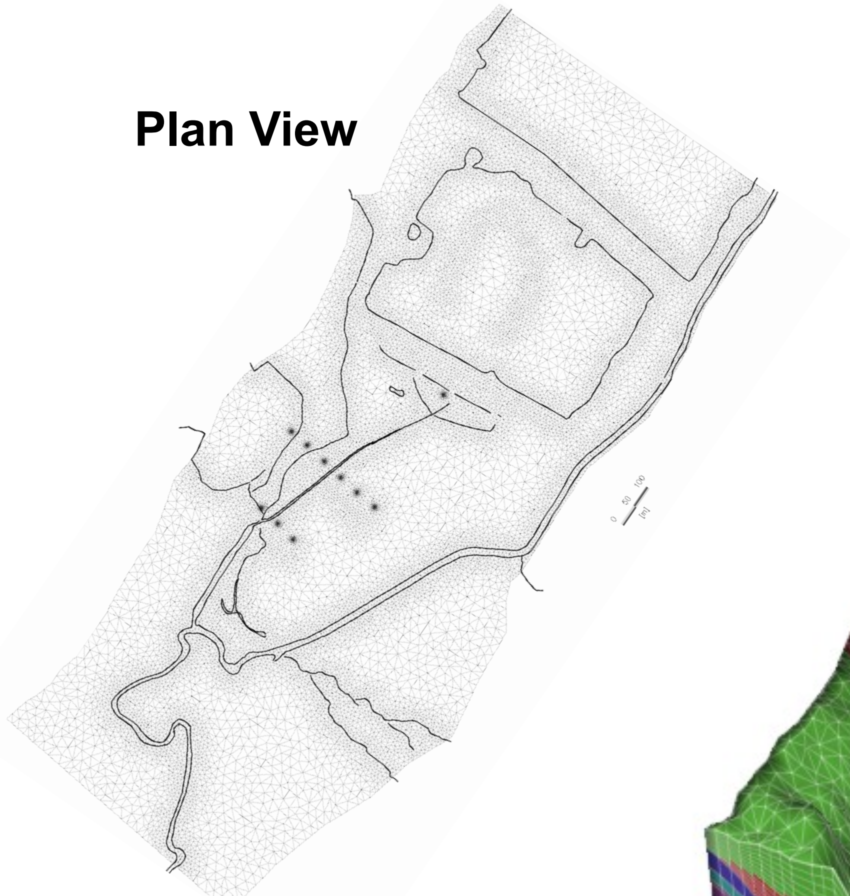
- Provide 100% hydraulic capture of impacted groundwater in Rose Creek aquifer and shallow bedrock downstream of the CVD (i.e. reverse hydraulic gradients)
- Capture at least 98% of contaminant loads in Rose Creek aquifer reaching the DV-SIS

⇒ Groundwater flow model developed to predict SIS performance and support the design of DV-SIS components, including:

- Drain alignment and pumping well spacing
- Pumping level (to reverse hydraulic gradients)
- Construction de-watering plans

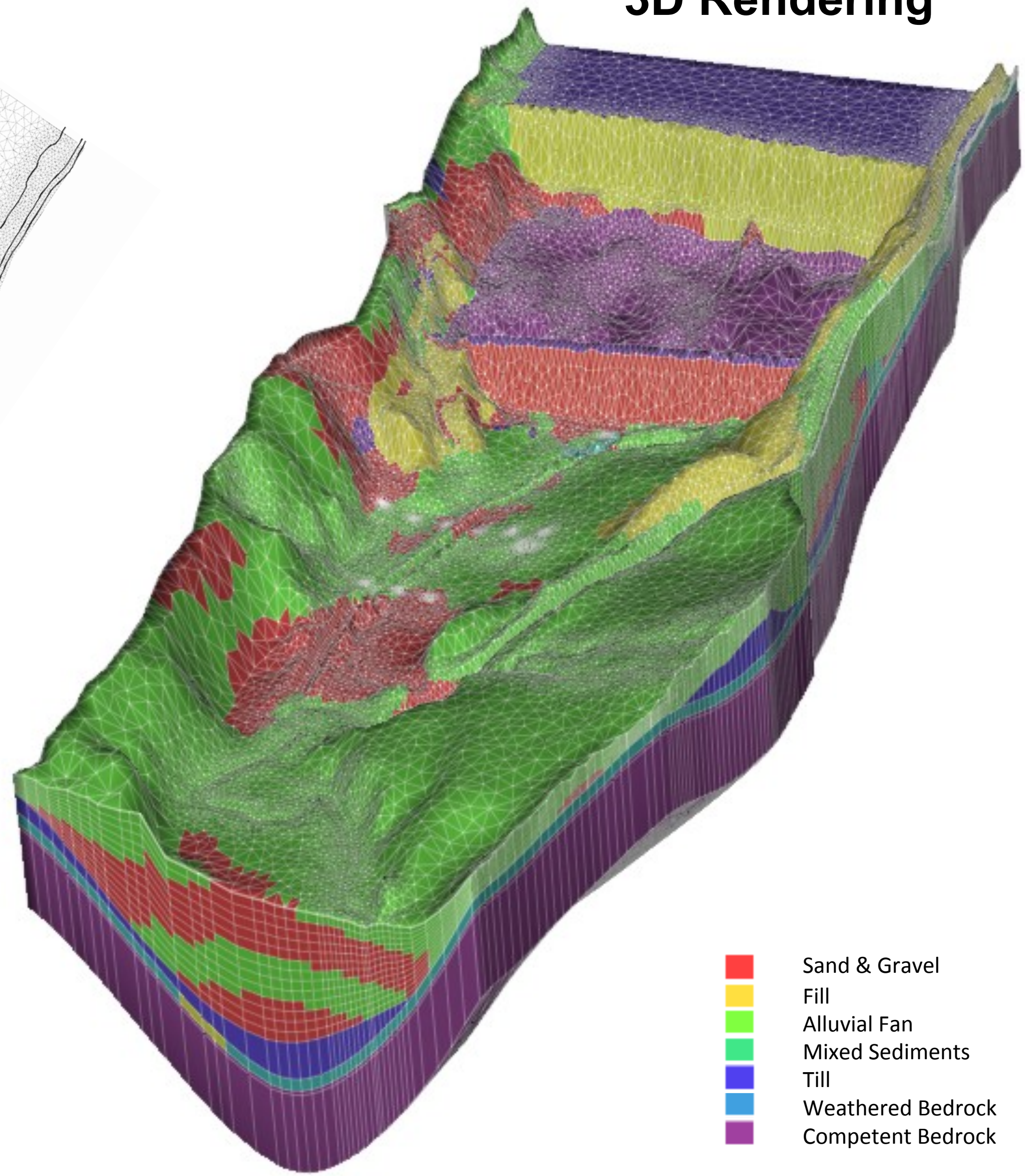
3D Groundwater Model (FEFLOW)

Plan View

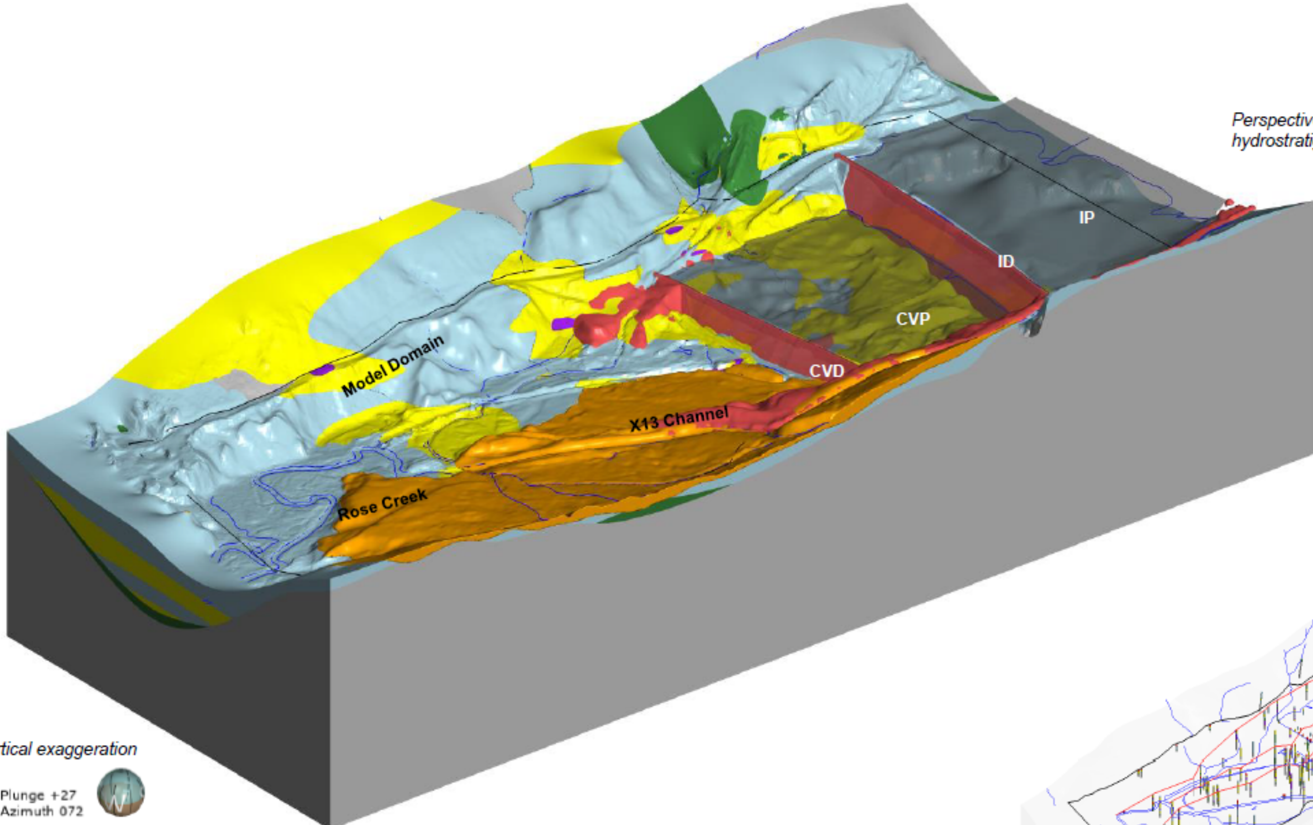


Model Domain and Mesh Design	
Area	1.4 km^2
Number of Layers	19
Total Nodes	333,860
Min Node Spacing	1 m
Max Node Spacing	25 m

3D Rendering



Hydrostratigraphic Model

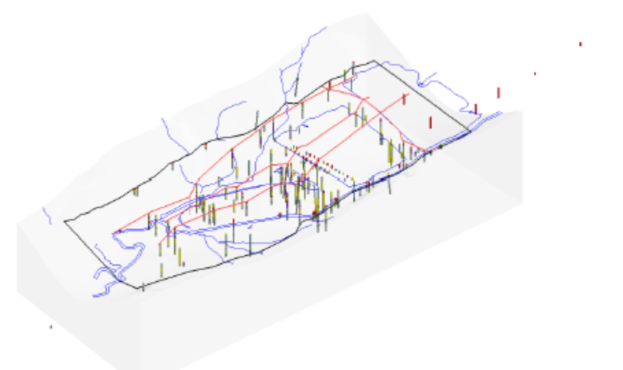


Perspective view of Leapfrog Geo hydrostratigraphic model

3x vertical exaggeration

Plunge +27
Azimuth 072

0 100 200 300

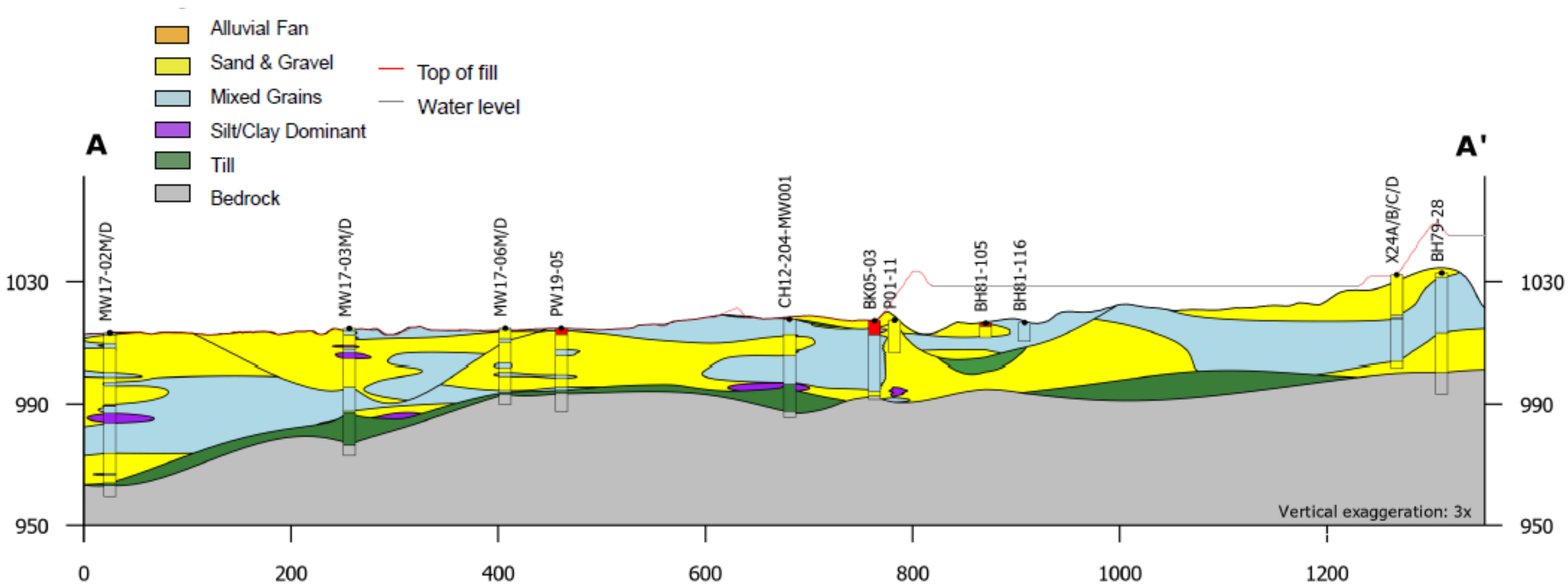


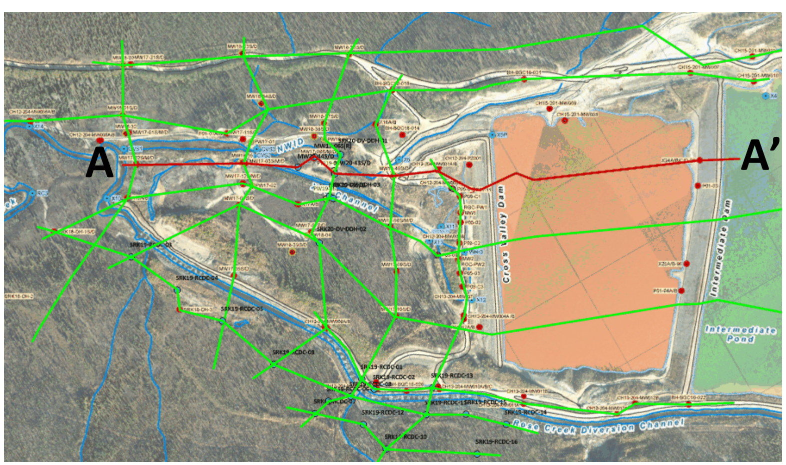
Perspective view of the available boreholes

Legend

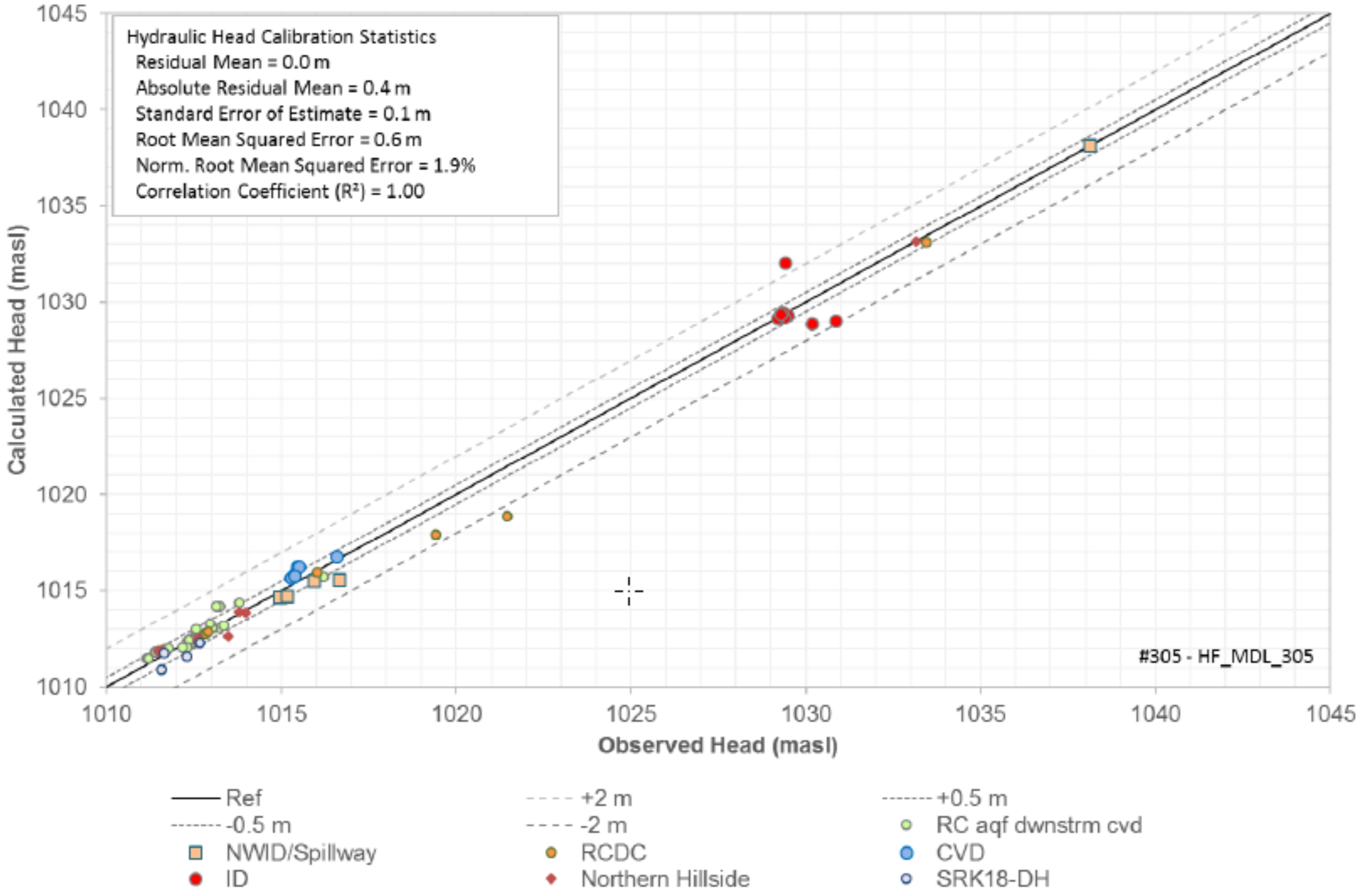
- Alluvial Fan
- Sand & Gravel
- Mixed Grains
- Silt/Clay Dominant
- Till
- Bedrock
- Anthropogenic Fill

Cross-Sections (Longitudinal)

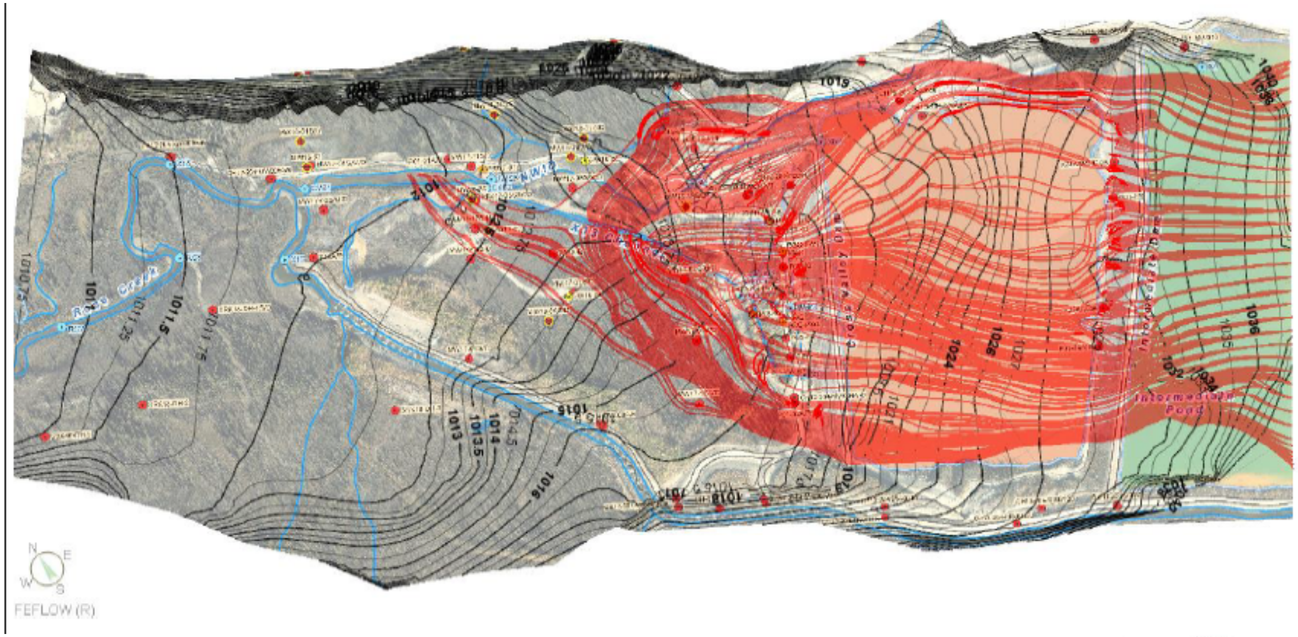




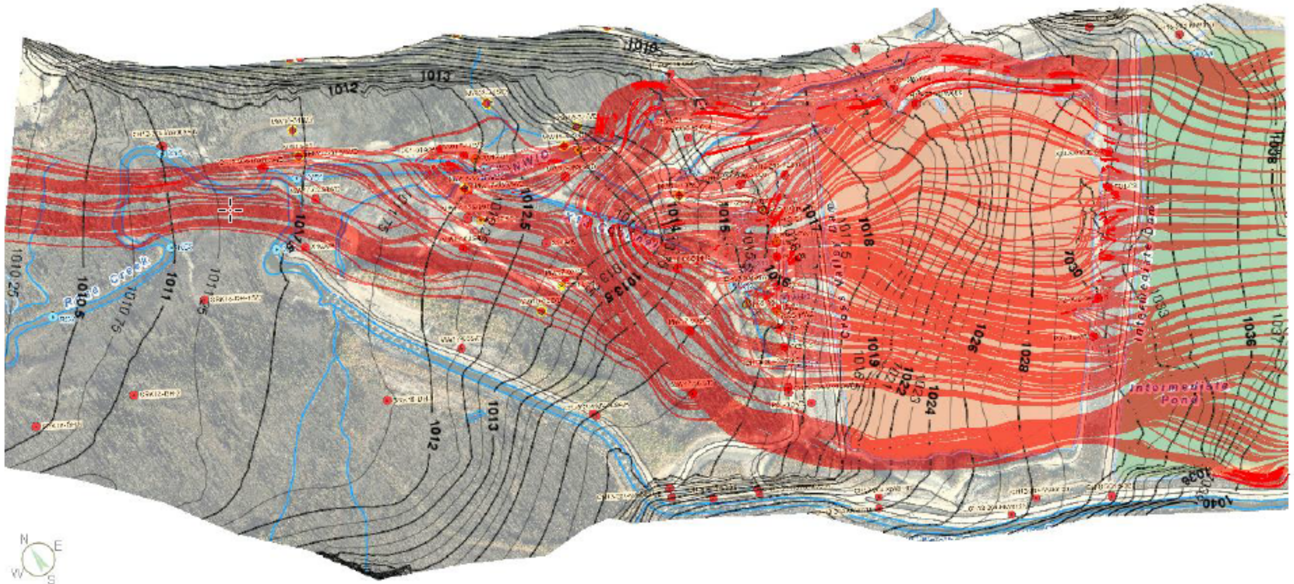
Simulated and Observed Heads – High Flow Conditions



Simulated Flow Field & Particle Tracks – Current Conditions (No SIS)



High Flow



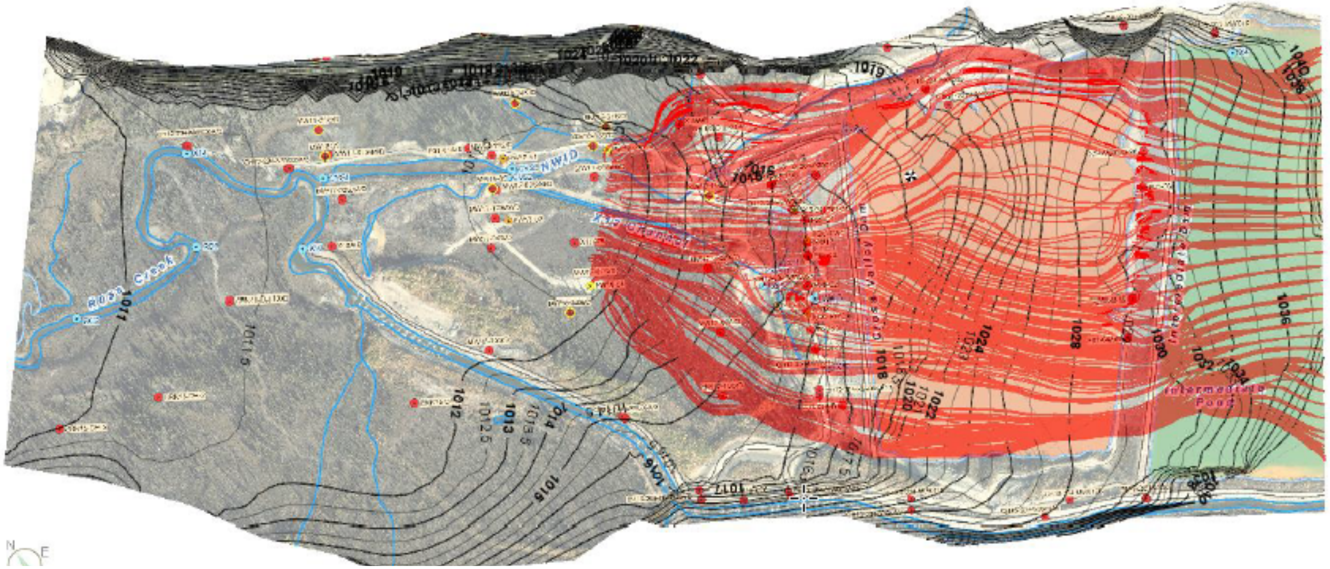
Low Flow

DV-SIS Design Concept

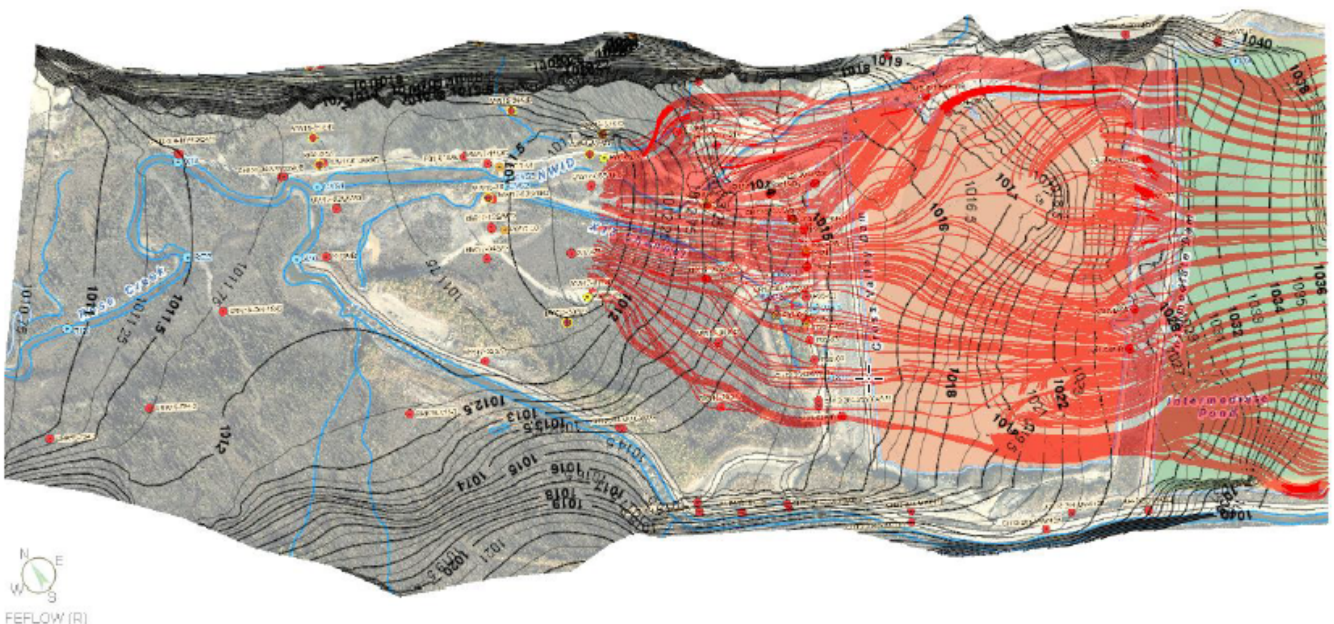
4 Design Elements

- DV-SIS1
  - Toe Drain
  - Sump in CV Pond
- DV-SIS2
  - X13 Sump
- DV-SIS3
  - X13 channel
  - Interceptor Drain
  - Fence of Pumping Wells
- DV-SIS4 (Back-up)
  - Interceptor Drain
  - Fence of Pumping Wells

Simulated Particle Trajectories – DV-SIS

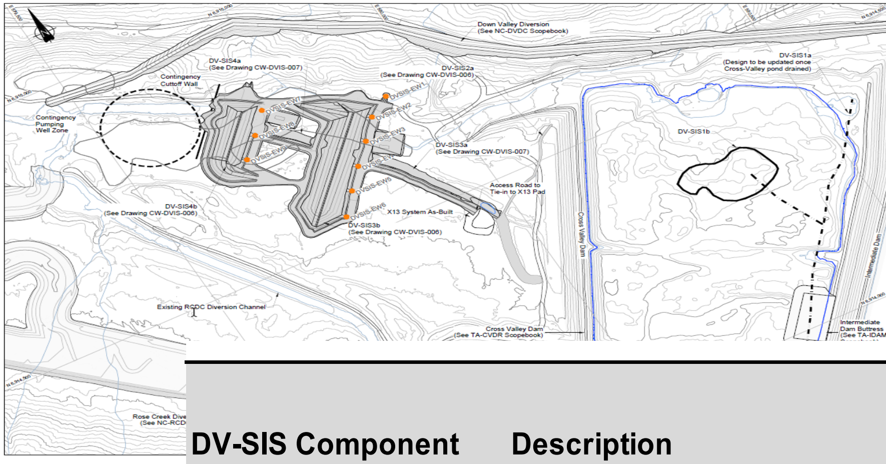


Early DV-SIS
- CV Pond full



Long-term DV-SIS
- CV Pond drained

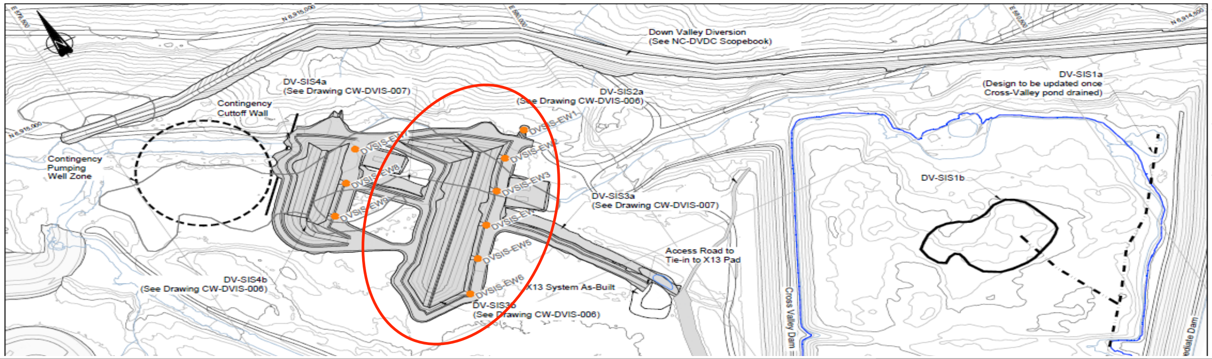
Predicted Inflows to DV-SIS – High Flow Conditions

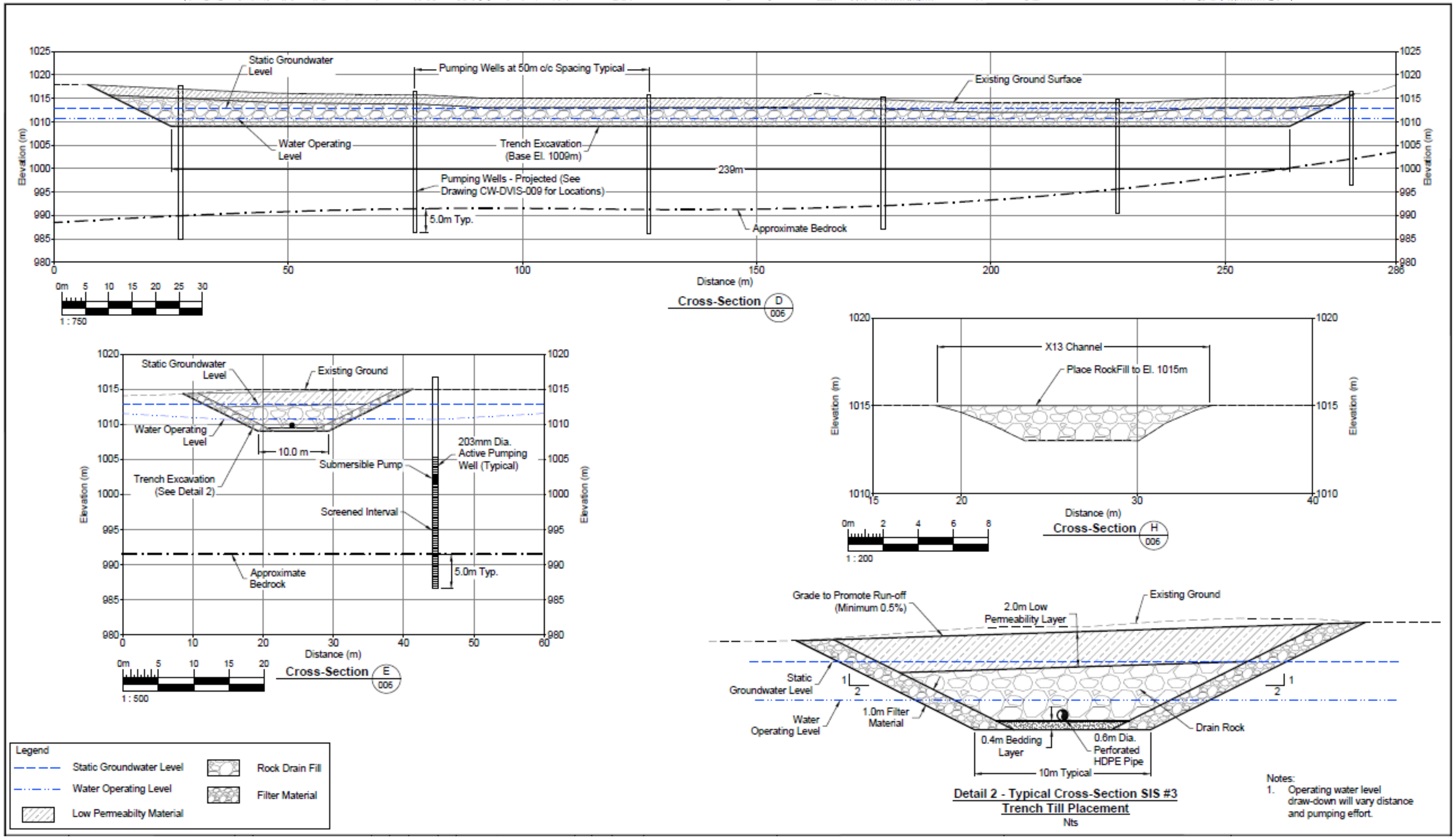


DV-SIS Component	Description	Predicted Inflows (Early DV-SIS)		Predicted Inflows (Long-Term DV-SIS)	
		L/s	**ML/year**	**L/s**	**ML/year**
Cross Valley Pond	Cross Valley Pond "full" (operated at 1029.19 m asl)	34.2	1,079	n/a	n/a
DV-SIS1	- Intermediate Dam toe drain - Cross Valley Pond footprint sump	n/a	n/a	101.2	3,191
DV-SIS2	X13 SIS - CVD toe drains - X13 sump	26.3	829	4.1	129
DV-SIS3	- Upper X13 channel - Submerged and encapsulated drain - Fence of six pumping wells	74.2	2,340	53.7	1,693
DV-SIS4	- Submerged and encapsulated drain - Fence of three pumping wells	Backup system (not routinely operated)			
	TOTAL:	**134.7**	**4,248**	**159.0**	**5,014**

Note: Predicted flows are 30 to 50% lower during winter baseflow conditions

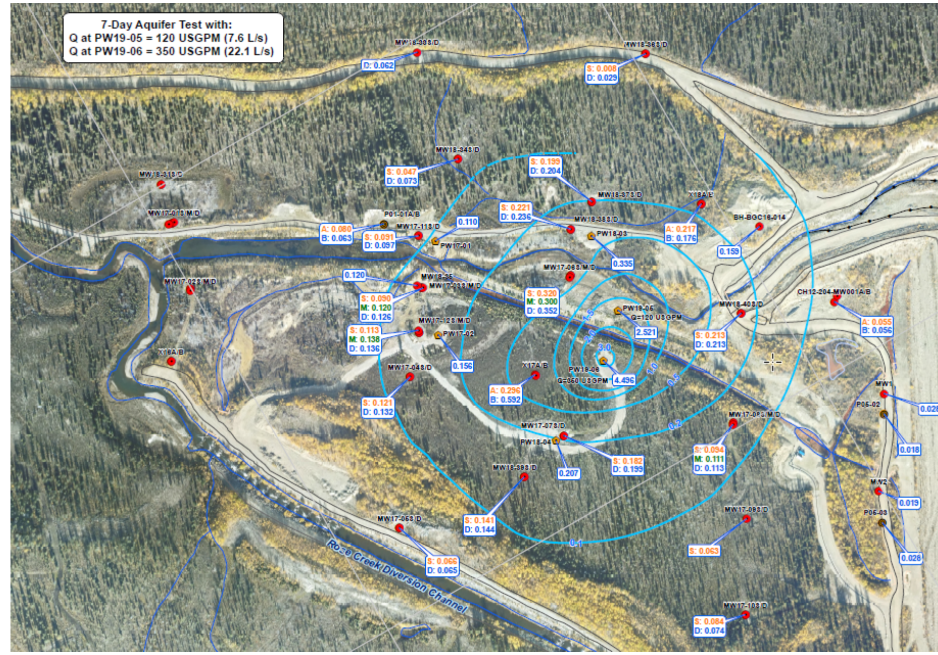
DV-SIS3 – "Submerged and Encapsulated Drain"





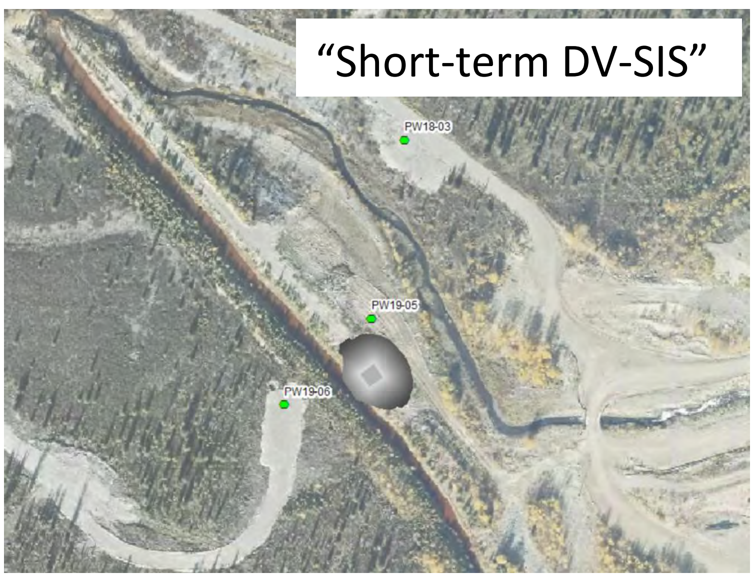
Recent Advances in DV-SIS Model

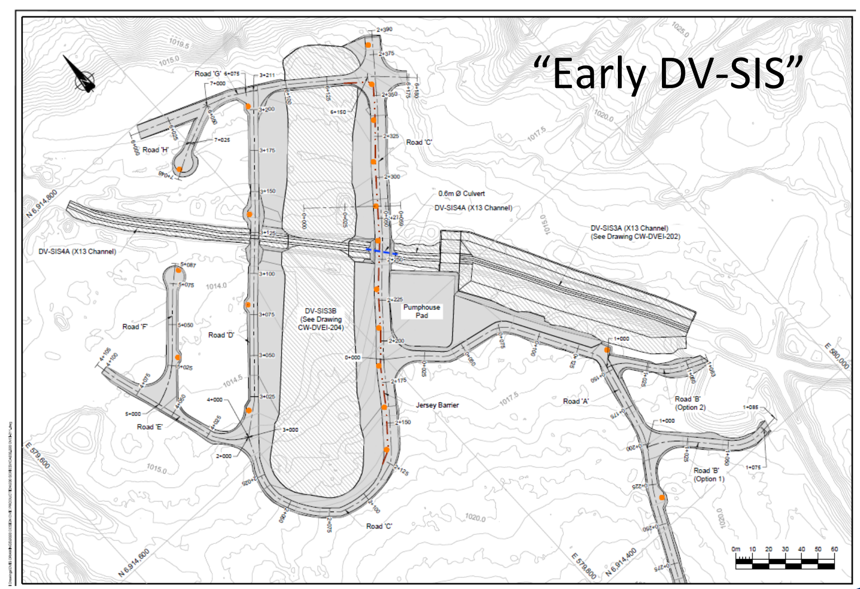
- Installation of Pumping Wells & Completion of pumping tests
- Bedrock characterization program
- Conceptual model update
- Development of transient flow model



Recent Advances in Design & Implementation

- DV-SIS2 (X13 SIS) commissioned in February 2019 and operating
- SRK/RGC is advancing design of DV-SIS
  - Short-term DV-SIS
  - Early DV-SIS
  - Long-Term DV-SIS
- Short-Term DV-SIS to be constructed in early 2021
- Performance monitoring for short-term DV-SIS to determine timing of the Early DV-SIS construction





Acknowledgements

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