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DALHOUSIE UNIVERSITY
FACULTY OF ENGINEERING

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Department of Civil and Resource Engineering

Design of a Tailings Storage Facility

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Project Overview

Source: (Mining Magazine, 2019).

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Industry Contact: BGC Engineering

A mine in Sudbury, Ontario is depositing tailings into an existing lake and causing the water level to rise. DGS has been contacted to complete a total design of multiple earth fill embankments with the purpose of containing the rising water levels until the mine ceases operations in 2037.

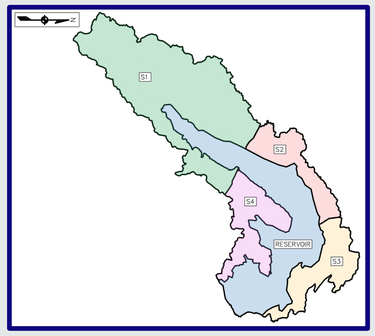
Site Investigations

Underlying Ground Properties			
Soil Type	**Dry Unit Weight (kN/m^3)**	**Friction Angle (°)**	**Cohesion(kPa)**
Silt	17	40	5
Sand	17	37.5	20
Clay	11	22.3	10
Bedrock	20	-	-

Specified Dam Properties			
Soil Type	**Dry Unit Weight (kN/m^3)**	**Friction Angle (°)**	**Cohesion (kPa)**
Clay Core	18	22.3	19
Filter	21	35	0
Rock Shell	38	38	0

Borehole data and tri-axial lab results were used to compile important soil properties for stability and seepage modelling. SPT results were used to correlate density values, friction angles, and cohesion values of each soil type.

Freeboard Calculations

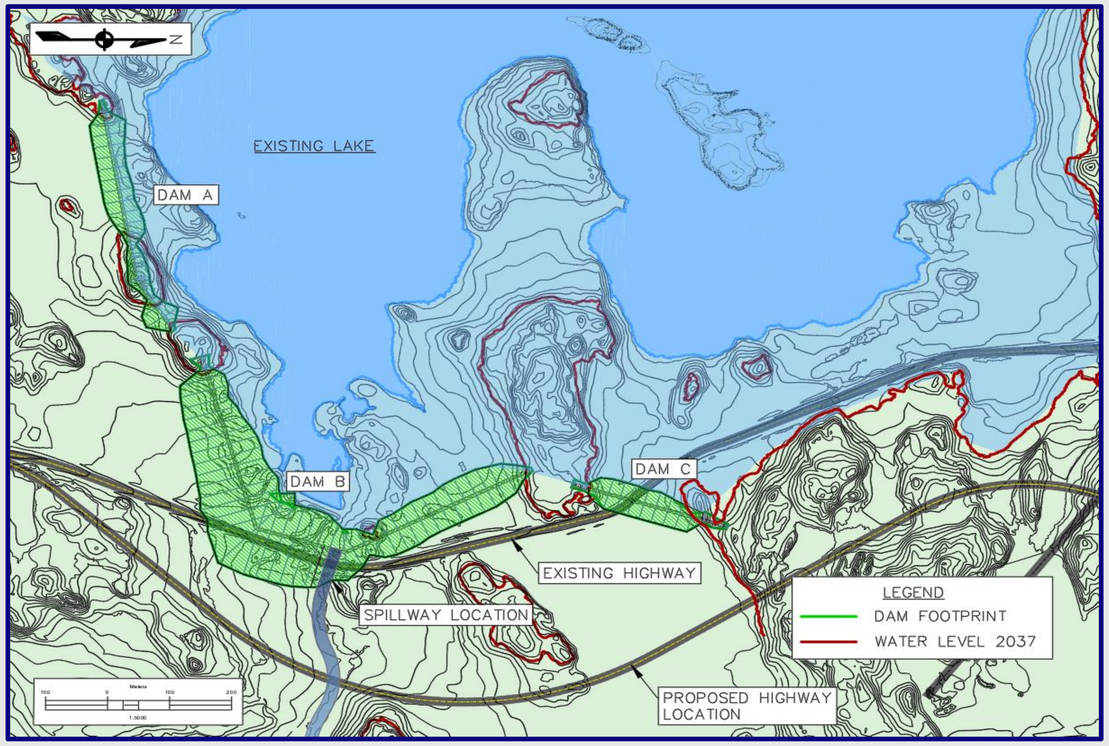


Catchment Properties:

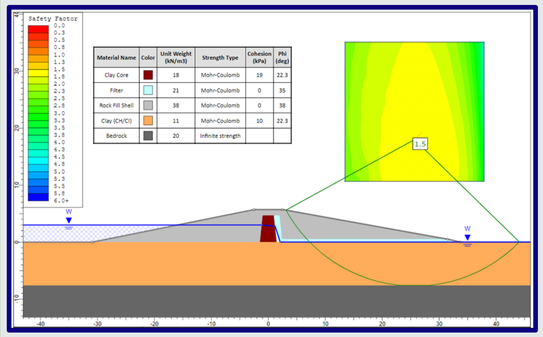
Sub-Catchment ID	Area (km^2)	Catchment Lag (Mins)
Reservoir Direct	5.8	0
S1	7.8	177
S2	1.7	42
S3	2.1	56
S4	2.1	25

The design storm used was one third of the way between the 1/1000 year storm and the Probable Maximum Precipitation.

Initial Reservoir Volume = 8.5 million m^3
Final Reservoir Volume = 36.5 million m^3
Total Resultant Increase in Water Level = 7.5m



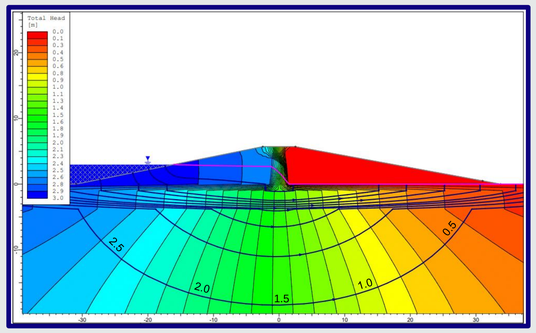
Slope Stability



Embankment	A	B	C
Height (m)	5.7	13.4	5.8
Top Width (m)	5	5	5
Height of Clay Core (m)	4.7	12.4	4.8
Width of Clay Core (m)	2	2	2
Width of Filter (m)	1	1	1
Upstream Slope Ratio	5:1	5:1	5:1
Downstream Slope Ratio	5.5:1	5:1	5:1

A slope stability analysis was conducted on each embankment using **Rocscience Slide.** A minimum **Factor of Safety of 1.5** was required as specified by the Canadian Dam Association for both the upstream and downstream slopes.

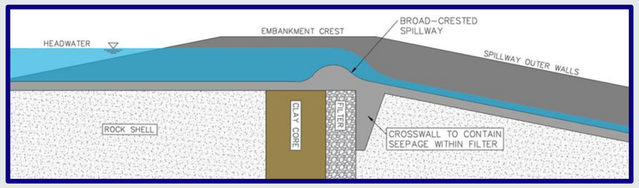
Seepage Analysis



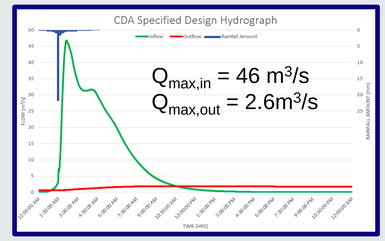
Embankment	A	B	C
Length (m)	380	710	210
Daily Discharge (m^3)	304	1243	69
Yearly Discharge (m^3)	111,000	453,500	25,300
Total Yearly Discharge (m^3)	589,800		

Rocscience Slide: Groundwater was used to compute a Steady-State Seepage Analysis. Seepage velocities were also modelled to ensure the filter functioned adequately, and that erosion of the downstream slope is mitigated.

Spillway Design



Shown above are the key upstream and downstream features of the designed spillway.



HEC-HMS was used in order to calculate peak flows in and out of the catchment area. Due to the large size of the reservoir it was noted that the outflow was greatly attenuated.

Spillway Dimensions			
Height [m]	**Width, L [m]**	**Stilling Basin Length, L_b [m]**	**Slope, So**
1.5	20	9	5:1

Conclusion & Recommendations

Three earth embankments are to be built in order to contain the total rising reservoir level of 7.5m. Each dam shall contain a 2m thick clay core as well as a 1m thick sand filter to control seepage volumes and varying slopes to control slope stability.

It is recommended by DGS that further site investigations are conducted in order to better evaluate the chosen locations of the embankments.

References & Acknowledgements

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