DALHOUSIE UNIVERSITY
FACULTY OF ENGINEERING

DGC

Dam Good Consulting

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BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Department of Civil and Resource Engineering

Geotechnical Design of a Tailings Storage Facility In Central America

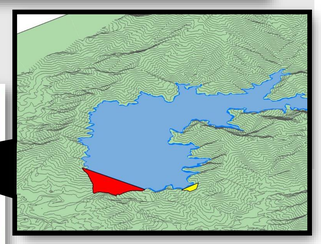
Project Overview

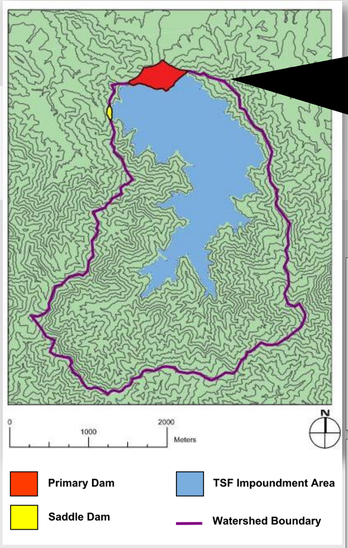
BGC Engineering Inc. issued a request for proposal to design a tailings storage facility (TSF), at the pre-feasibility level, that can hold approximately 100,000,000 tonnes of tailings. The TSF is located at a gold mine in Puerto Rico.

What are Tailings?

Tailings are the waste byproduct that come from the mineral extraction process.

Project Site





Design Process

Site Investigation

- Site Material Properties
- Created Soil Profile
- Catchment Area

Dam Design

- Dam Classification
- Freeboard and Storage Requirements
- Alignment Options
- Stability and Seepage Analysis
- Optimize Slopes
- Core and Filter Sizing
- Material Volumes and Cost Estimate

Completion

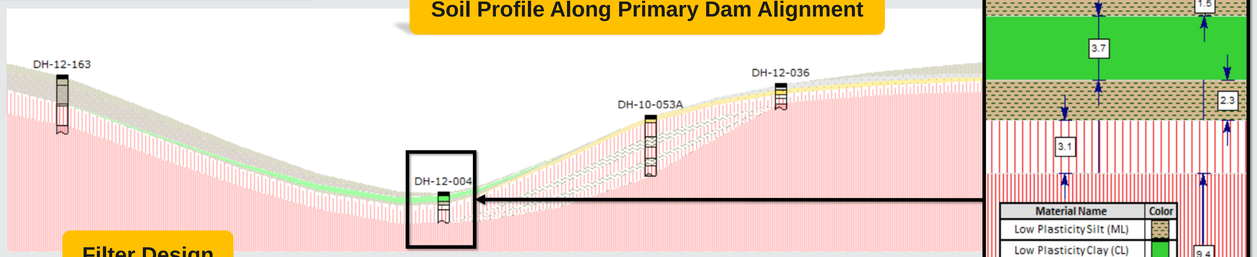
- Dam Staging Schedule
- Recommendations for Closure

Freeboard Analysis

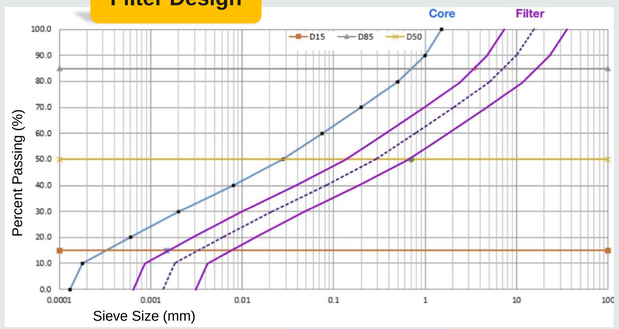
Total Impoundment Area: **8.8km²**
Freeboard Based on 1000 Year Rainfall Event: **2.5m**
Freeboard Based on Wind Event: **7m**
Total Freeboard: **9.5m**

Details of Design

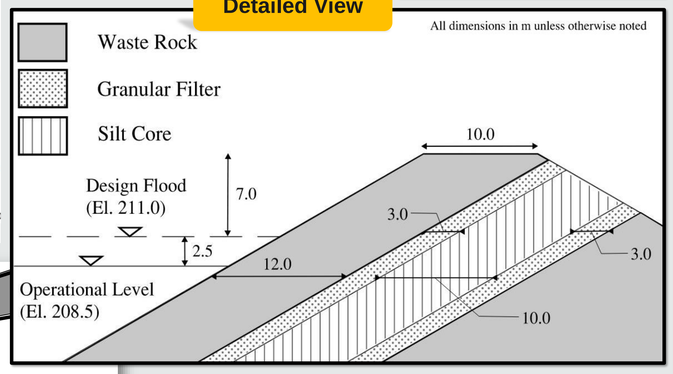
Soil Profile Along Primary Dam Alignment



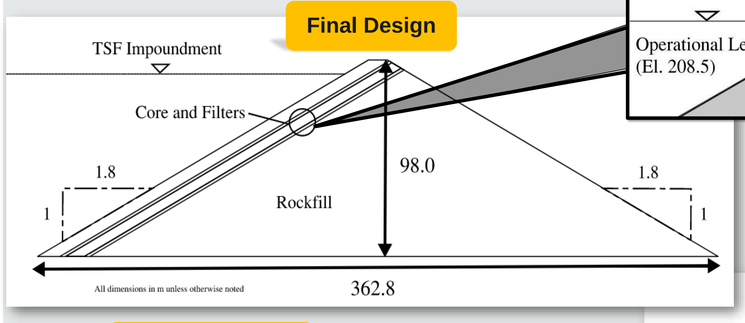
Filter Design



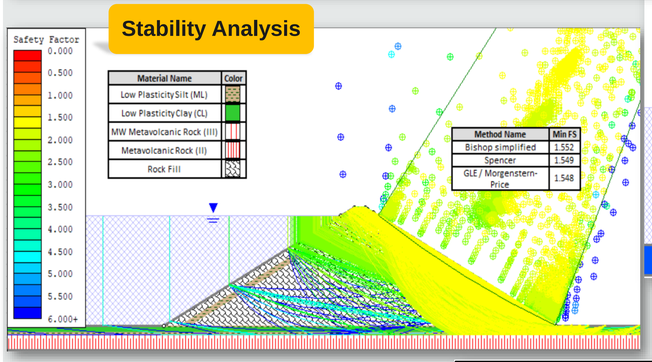
Detailed View



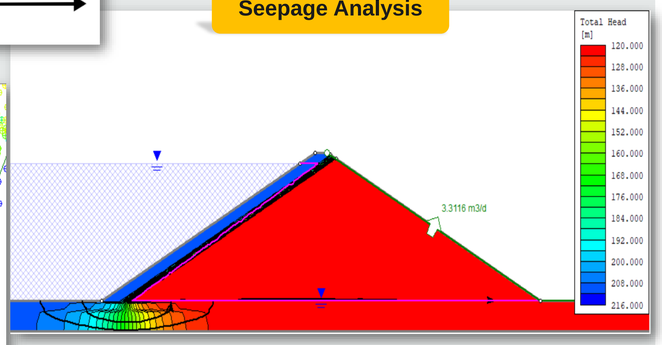
Final Design



Stability Analysis



Seepage Analysis



Seepage Results

Rate	m³/day	L/s
Total Discharge from Impoundment	2317	26.8

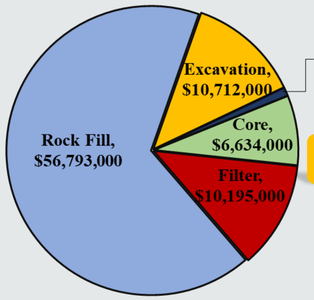
Stability Results

Slope	Min. Static FS	Ky for FS of 1.1
Upstream	1.54	0.085
Downstream	1.55	0.16

Material Property Table

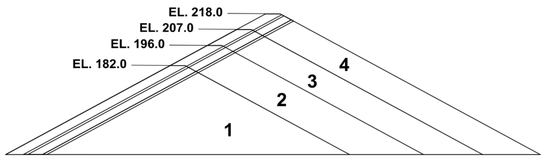
Type	Description	Symbol	γ (kN/m3)	γ sat (kN/m3)	φ' (°)	c' (kPa)	s_u (kPa)	K (cm/s)
Coarse Grained Soils	Mined rockfill	-	22.0	-	40.0	0	-	10
	Poorly graded gravel	GP	19.0	20.8	33.0	0	110	10
	Silty gravel	GM	18.3	20.8	41.2	0	31.5	1.05x10-5 (FHT)
	Poorly graded sand	SP	17.3	20.0	36.3	0	150.0	1
	Silty sand	SM	16.8	19.8	28 (DS)	34 (DS)	No data	0.1
Fine Grained Soils	Low plasticity silt	ML	14.5	17.0 (CU)	24.0 (CU)	30 (CU)	105.0	8.4x10-7 (CHT)
	Low plasticity clay	CL	15.0	16.0	33.5	0	180.0	1x10-6

Cost Estimates



Total: $85.2 million

Construction Schedule



Stage	Operation Life (years)	TSF Volume (10^6 m³)	Dam Height (m)
1	5	24.26	62
2	10	43.36	76
3	15	62.47	87
4	21	86.4	98

Conclusion & Recommendations

- The final dam design has a tailings storage capacity of 86,400,000 m³.
- The dam will be constructed in 4 stages, with a final dam height of 98m.
- The dam is constructed using a 10m silt core to control seepage, and a 3m granular filter on each side to mitigate internal erosion.
- The dam will have a 10m crest for heavy equipment traffic.
- It is recommended that after a period of 21 years the tailings are capped to avoid erosion.
- The cap may be designed as a dry cover that can accommodate vegetation to reclaim the land.
- The dam was designed with material borrowed on-site to reduce costs and environmental impacts.

References

- Fell, R., MacGregor, P., Stapledon, D., Bell, G., & Foster, M. (2018). *Geotechnical Engineering of Dams* (2nd ed.). CRC Press.
- BCG (2021). Kickoff Presentation 2021. Presented by Greg Horne, September 22, 2021
- CDA (2007). *CDA Dam Safety Guidelines* (2013 Edition). Provided by Jana Purmalis of BGC Engineering Library