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Managing a small volume of seepage (Reefton Restoration Project)

- **Diversion, Dilution, Treatment, or a little bit of everything?**
  Saddle Dam Seepage – from Optioneering to Construction

AusIMM Branch
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AusIMM New Zealand Branch Annual Conference - Enabling a Sustainable Future

20 - 22 August 2023
Rydges Latimer Christchurch

Overview

- Aim of Project
- Options Analysis
- Multi Criteria Analysis (MCA)
- Concept – Detailed Design
- Construction

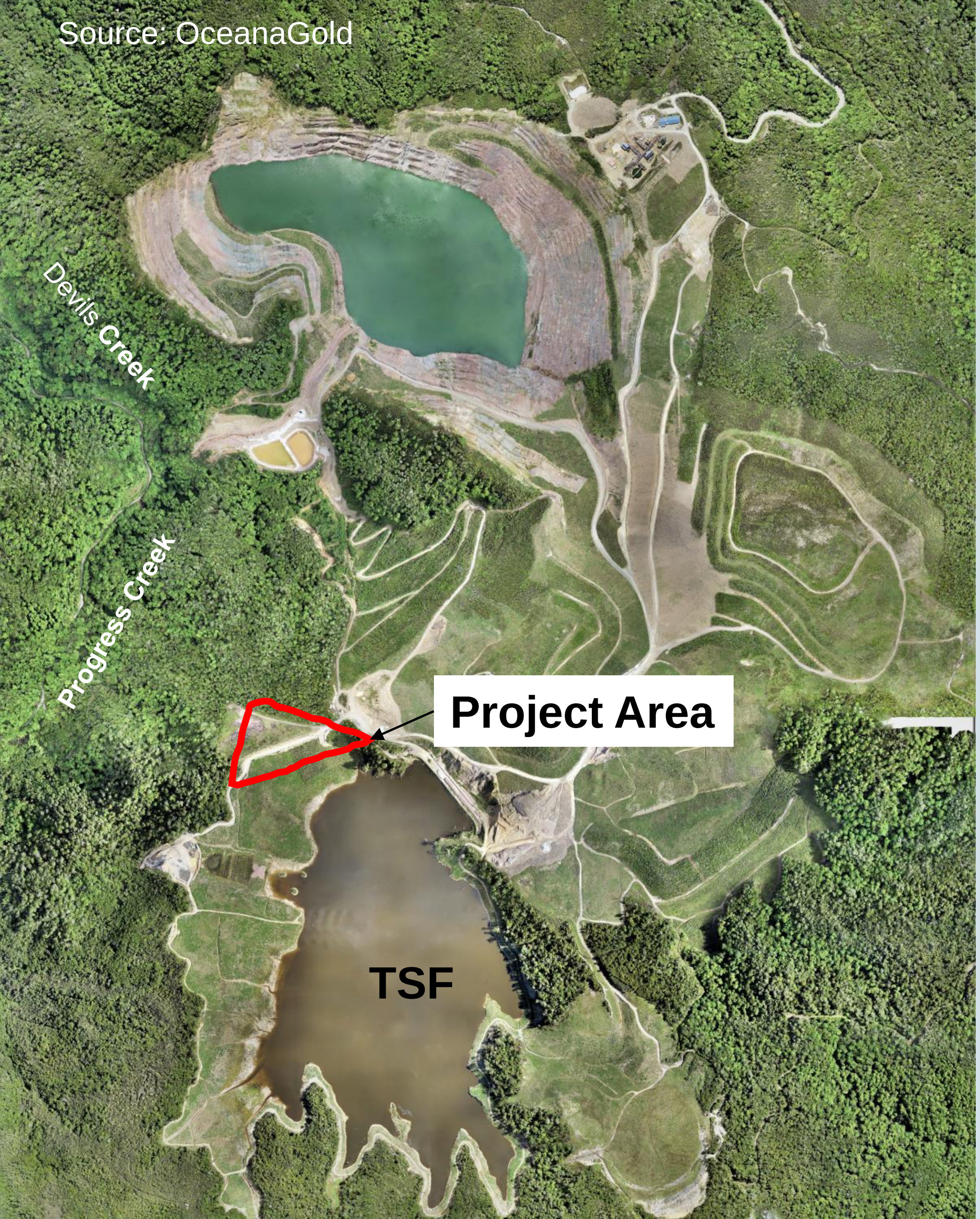
➔ Aim of Project

Globe Progress / Saddle Dam

Operational 2006 – 2016

Reefton Restoration Project 2016 - Current


Source: OceanaGold



Aim of project

↳ **Long-term solution for management of seepage water from Saddle Dam Embankment**

Table 1 Saddle PTS design dissolved contaminant concentration and load (Verum Group, November 2021)

Parameter	Quantity		Source
Flow Rate	118 m³/day (1.37 L/s)		GHD (2020)
	Concentration	**Load**	
	(g/m³)	(g/d)	
As	3.0	352	≈85th percentile of 2020/2021 dataset
Sb	0.005	0.61	Median 2020/21 dataset (Conc.)
Fe	12.2	1,444	Median 2020/21 dataset (Conc.)
Sulphate	148	17,413	Median 2020/21 dataset (Conc.)
pH	7.6	-	Median 2020/21 dataset (Conc.)
Alkalinity	319	37,684	Median 2020/21 dataset (Conc.)
Fe:As Ratio	4.1:1		

Potential visual / amenity risk

→ Option analysis, MCA and solution selection

Options analysis

Target :

Reduction in iron concentration to reduce risk of iron precipitation in receiving environment

Main challenges:

- **Site Access**
- **Low Maintenance / Operator input solution**
- **Limited footprint**
- **No access to reticulated power supply**


Source: OceanaGold

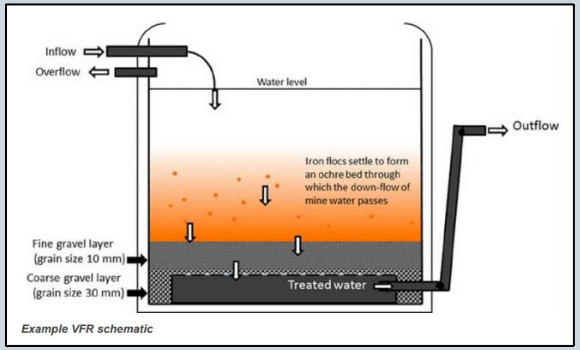
Options Analysis / Fatal Flaw

Oxidising / Reducing / Water Management Solutions

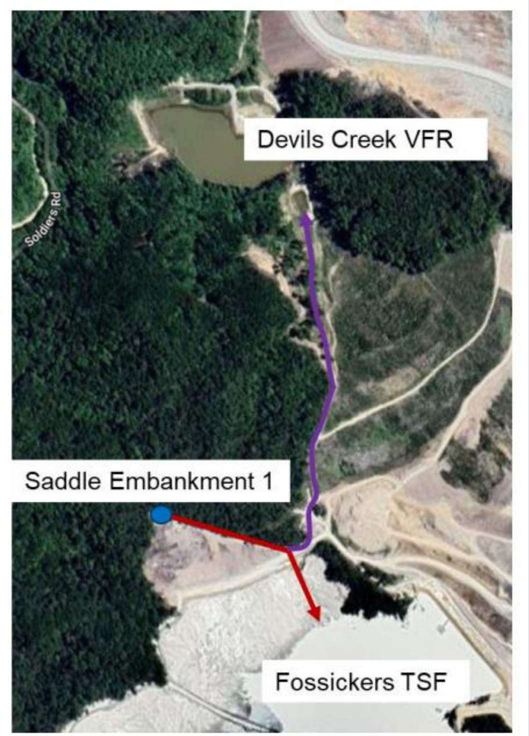
Table 4 ***Treatment Technology/Method Options – Fatal Flaws Assessment***

#	Source	Technology Category	Technology	Cost Fatal Flaw?	Footprint Fatal Flaw? (>200-300m^2)	Complexity (Process, O&M) Fatal Flaw?	Novel System Fatal Flaw	Treatabilty Fatal Flaw?	Fatal Flaws	Area/Size (m^2)	Pros	Cons
1	Verum Spreadsheet	Oxidising System	Cascade	No	No	No	No	Yes	Yes (Poor Treatment i.e. Staining)	20	• Inexpensive • Proven	• Fe will precipitate downstream • Minimal treatment
2	Verum Report	Oxidising System	Horizontal Flow Pond	Not Rated	Potential	No	No	Potential	Potential (Excessive Footprint & low Treatment)	354	• No piping • Proven	• Low Fe, As removal • Periodic sludge removal • Fe ppt density low
3	Verum	Oxidising System	Aerobic Wetland	Not Rated	Yes	No	No	No	Yes (Excessive Footprint)	787	• No piping • Proven • Aesthetic qualities • Potential for As uptake by plants	• Periodic and difficult sludge removal • Fe precipitate density low. • Replanting every 2 years (Verum) or up to 5 years (GHD) • Possible plant disposal issues.
4	Verum	Oxidising System	Cascade + VFR	No	No	No	No	No	None	265	• Proven • Fe ppt density high	• Periodic sludge removal at a difficult to reach site • Some staining may still occur • Expensive piping network and construction costs.
5	Verum Report	Oxidising System	Supplemental Iron Addition + VFR	Yes	No	Yes	No	No	Yes (High OPEX & requires frequent O&M at difficult site)	265	• High As removal • Proven • Possibly could use Devil's ppt	• More Fe to remove, may decrease Fe removal • Expensive • May increase sludge accumulation rates
6	Verum Report	Oxidising System	Steel Slag Leaching Bed	No	Unknown	Yes	Yes	Potential (As removal not used at full scale)	Yes (Too novel and complex)	N/A	• Small area required • Effective for Fe removal	• Experimental for As removal (Verum • Fe ppt can plug system • Slag from NI
7	Verum / GHD	Water Management	Pump back up to Fossickers (or discharge to existing VFR)	No	No	No	No	No	None	30	• Low maintenance • No discharge off site	• Minor additional Fe accumulation at large VFR.
8	GHD	Water Management	Gravity to existing VFR (HDD through hill)	No	No	No	No	No	None	30	• Very low maintenance • No discharge off site	• Expensive (CAPEX)
9	Verum	Reducing System	Bioreactor	Yes	Yes	Yes	No	No	Yes (Significant O&M,	590	• Proven • Good As and Fe removal	• Poor removal in cold

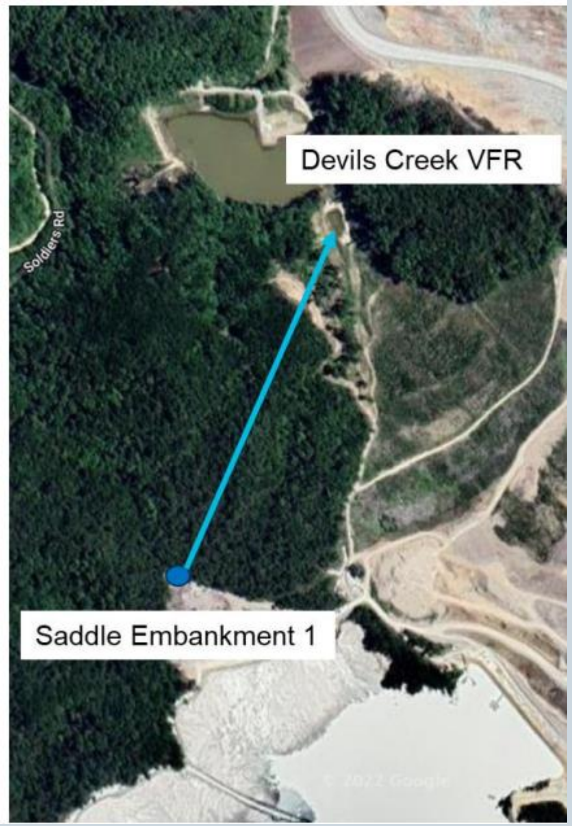
Options to Multi Criteria Analysis



Option 1. Cascade + VFR



Option 2. Pump to Fossikers / Devils Creek VFR



Option 3. Gravity to Devils Creek VFR

Option 4a. Dilution with Small Pond (Siphon)

Option 4b. Dilution with Small Pond (Gravity)

Multi-Criteria Analysis

- 4 options assessed
- CAPEX / OPEX / reliability / O&M inputs / performance
- Sensitivity Analysis on weighting parameters

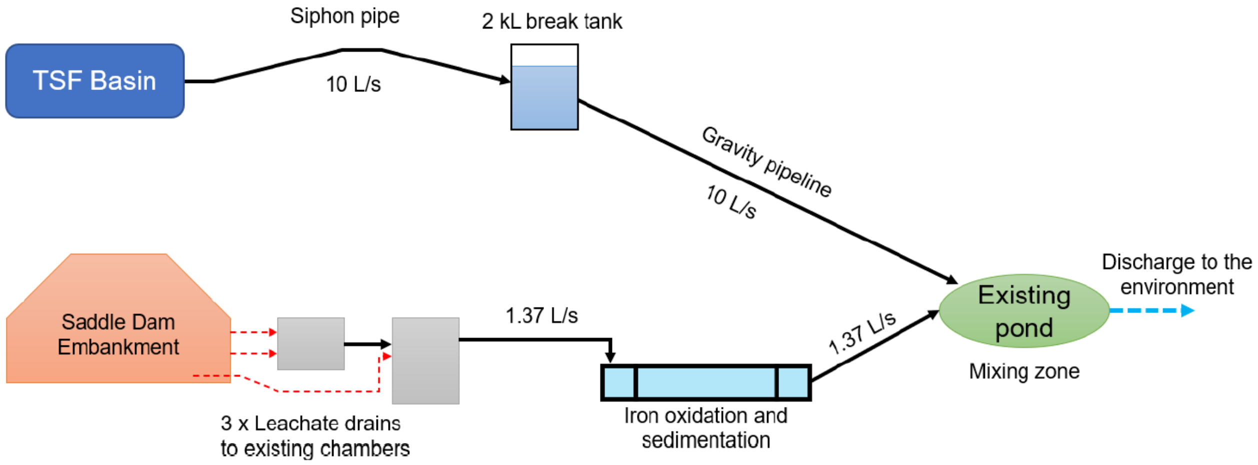
Table 8 *Sensitivity Analysis*

	Default Weighting + Default Scoring	Default Weighting + Low Option 4 CAPEX Score	Default Weighting + Low Option 3 OPEX Score	High-Cost Weighting + Default Scoring	High-Cost Weighting + Low Option 4 CAPEX Score
Weightings					
CAPEX	15%	15%	15%	40%	40%
OPEX and Maintenance Costs	25%	25%	25%	20%	20%
Treatability / Technical performance Risk / Certainty of Performance	20%	20%	20%	20%	20%
Operations & Maintenance complexity/frequency, H&S (No costs)	20%	20%	20%	10%	10%
Reliability	20%	20%	20%	10%	10%
Total	100%	100%	100%	100%	100%
Score Sensitivity					
Option 1 - Cascade + VFR	500	500	500	500	500
Option 2 - Pump back up to Fossickers (or discharge to existing VFR)	555	555	555	600	600
Option 3 - Gravity to existing VFR (HDD through hill)	625	625	550[2]	520	520
Option 4 - Dilution with Small Pond for Seepage Only	745	700[1]	745	730	610[3]

Solution to design

Two infrastructure streams:

- Leachate collection and oxidation / settlement
- Dilution water from basin to mixing zone



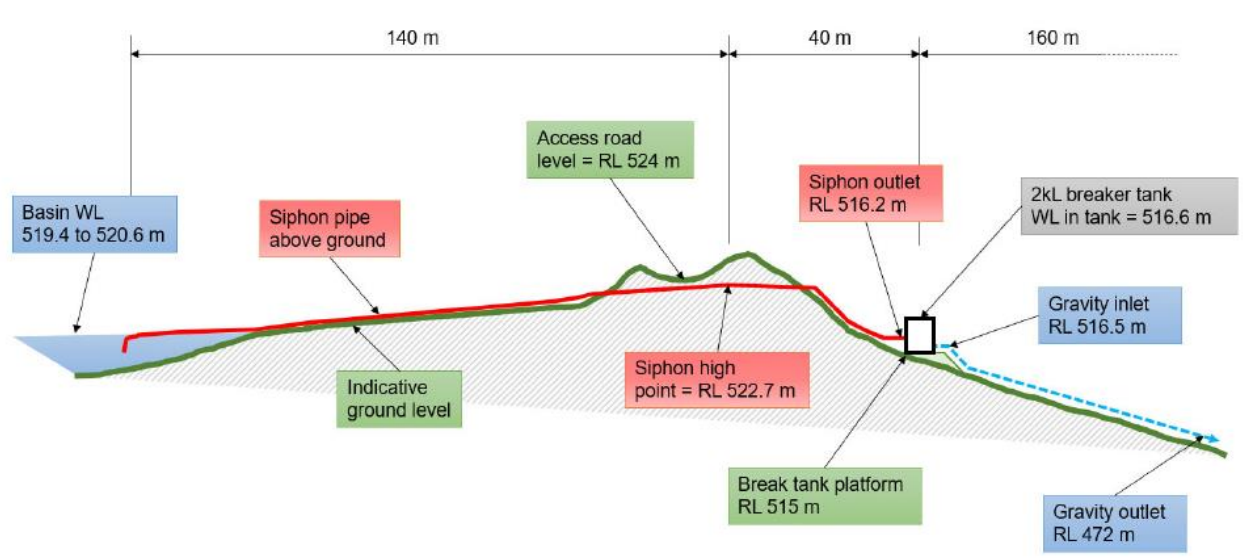
→ Design & Construction

Design to construction

Dilution water supply - siphon

- Supply 10 L/s
- Floating Inlet
- Low maintenance / operator input
- Basin water levels
- Geometrical constraints

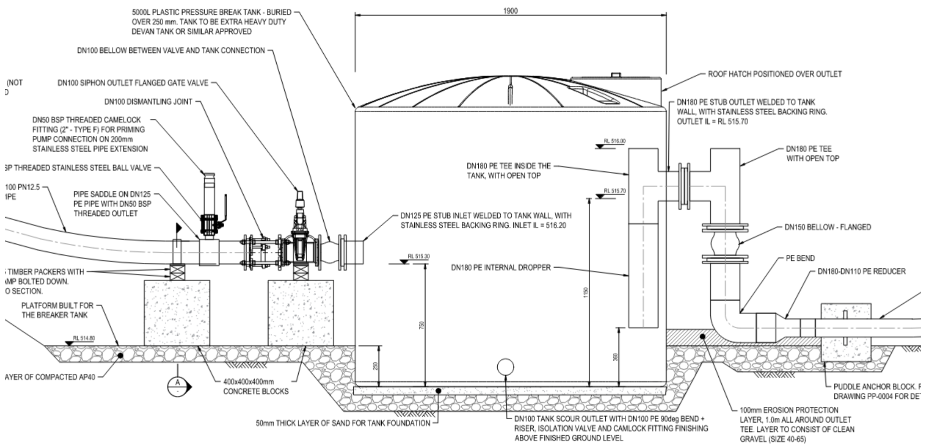
Source: OceanaGold

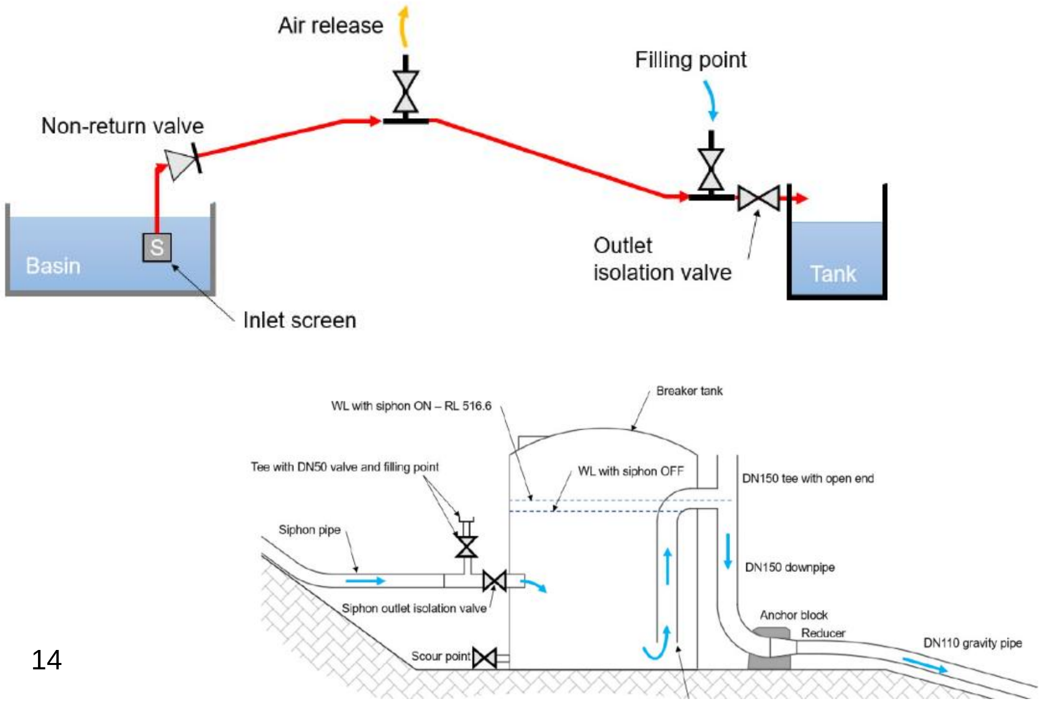


Design to Construction

Dilution water supply - Priming

- Pressure break tank at siphon outlet
- Water storage for siphon re-priming
- Easy access from top of embankment
- Alarm for siphon break



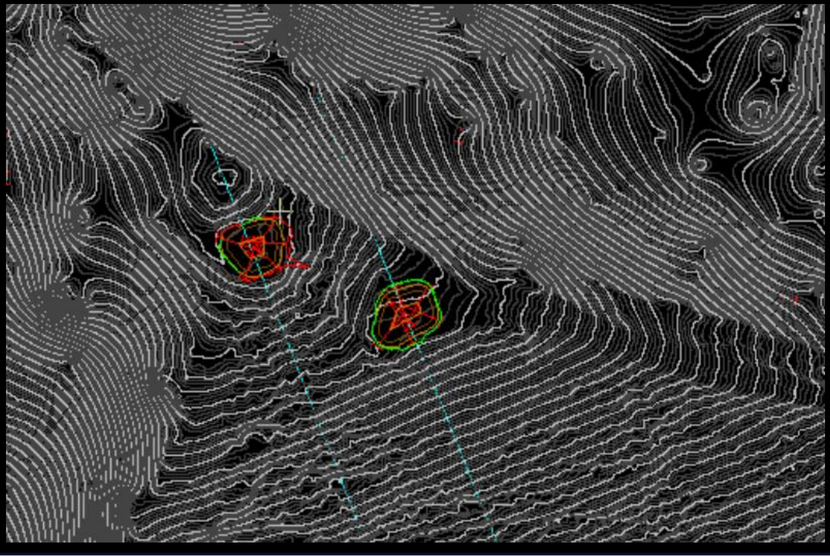


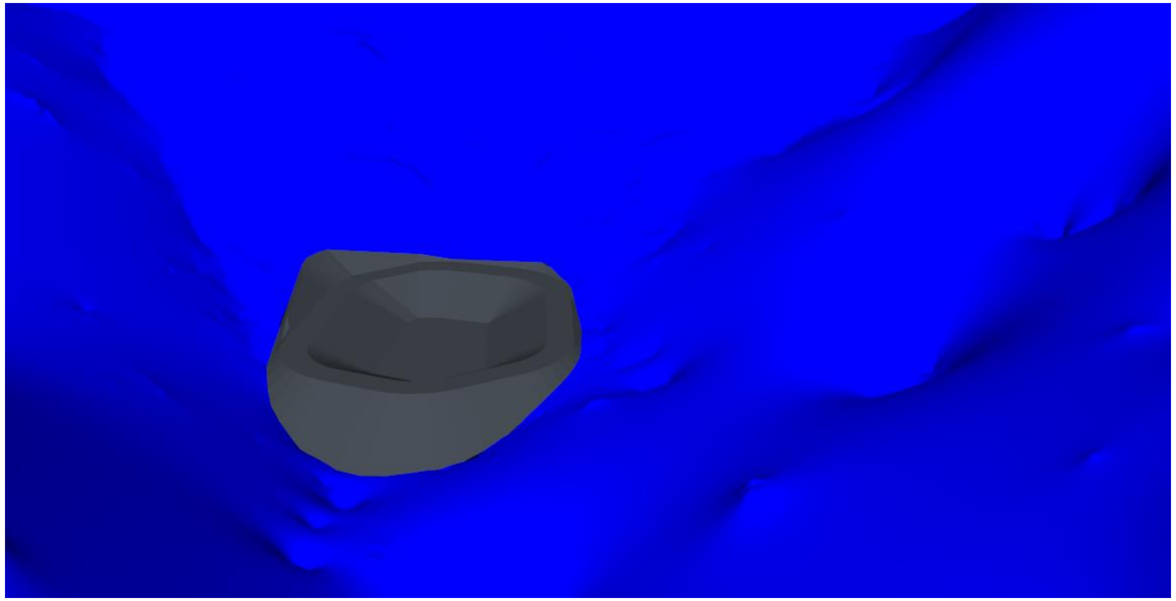
Source: OceanaGold

Design to Construction

Leachate Treatment

- Provide some aeration and settlement to reduce iron
- Maximise retention time
- Minimise footprint and earthworks requirements
- Safety in Design and geotechnical considerations





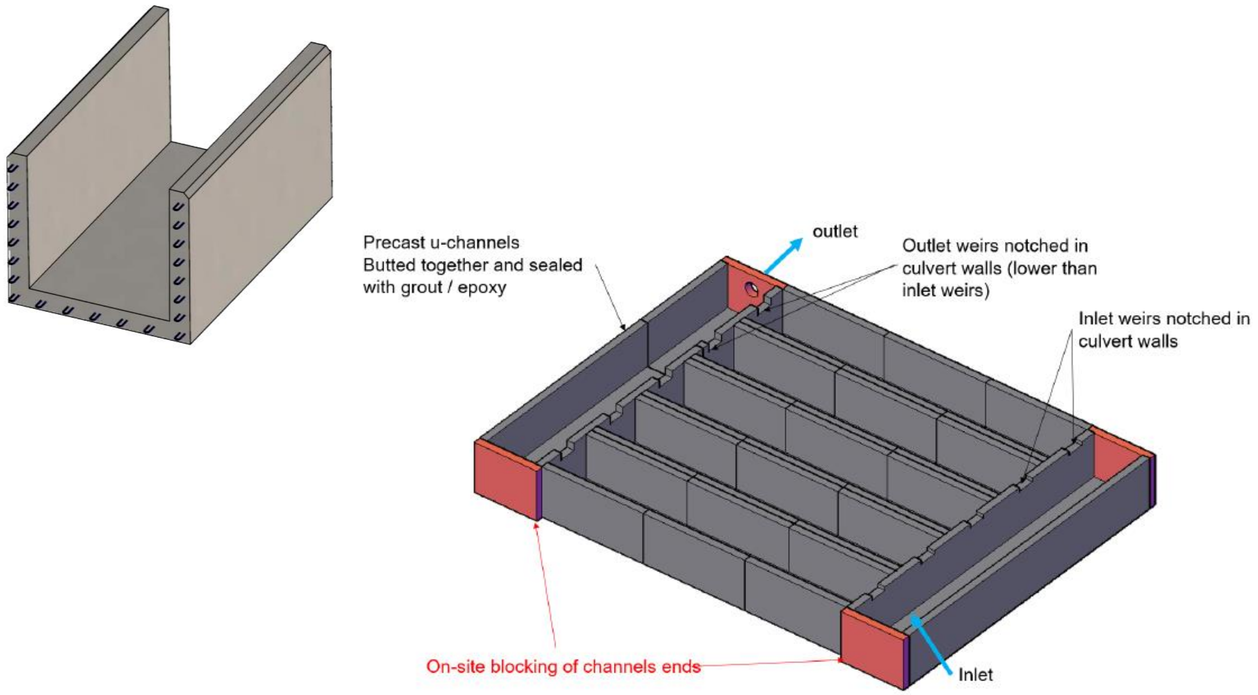
Design to Construction

Leachate treatment

Concrete pre-cast channels available on-site from previous project

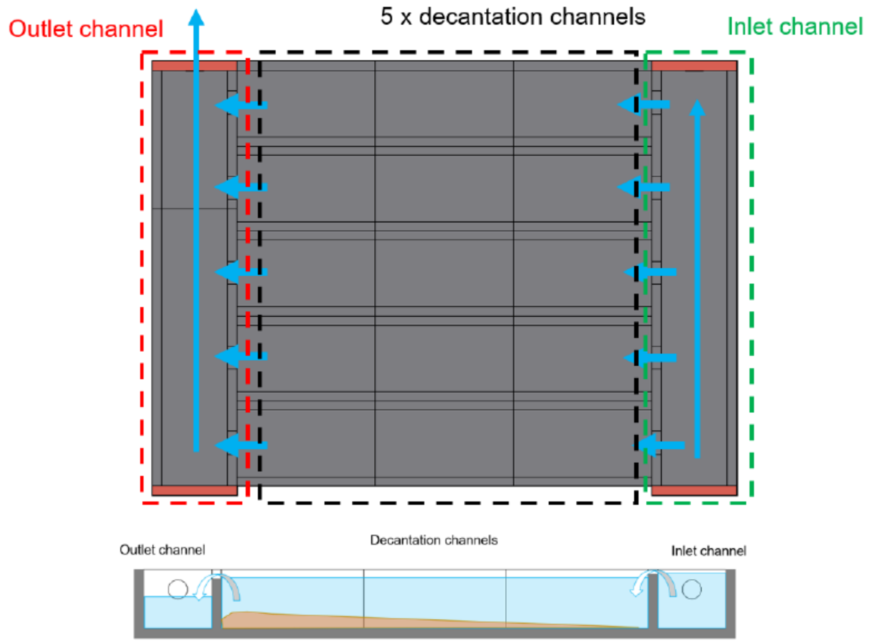
Re-purposing otherwise un-used assets

Lower CAPEX, good volume retention



Iterative process to identify:

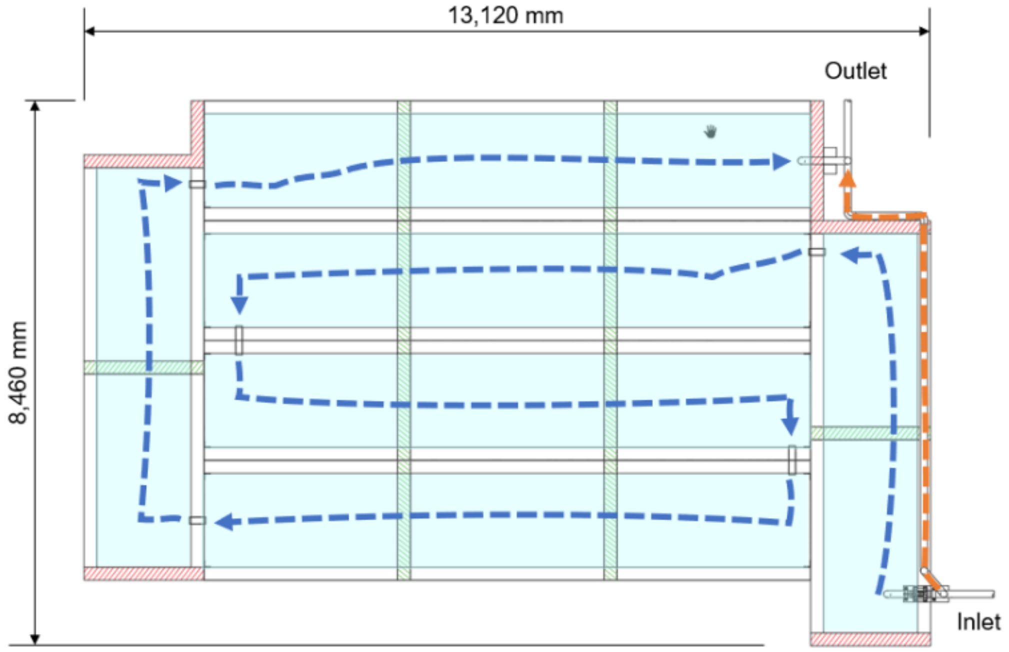
- Best volume retention
- Best hydraulic efficiency for sedimentation
- Best volume / footprint compromise

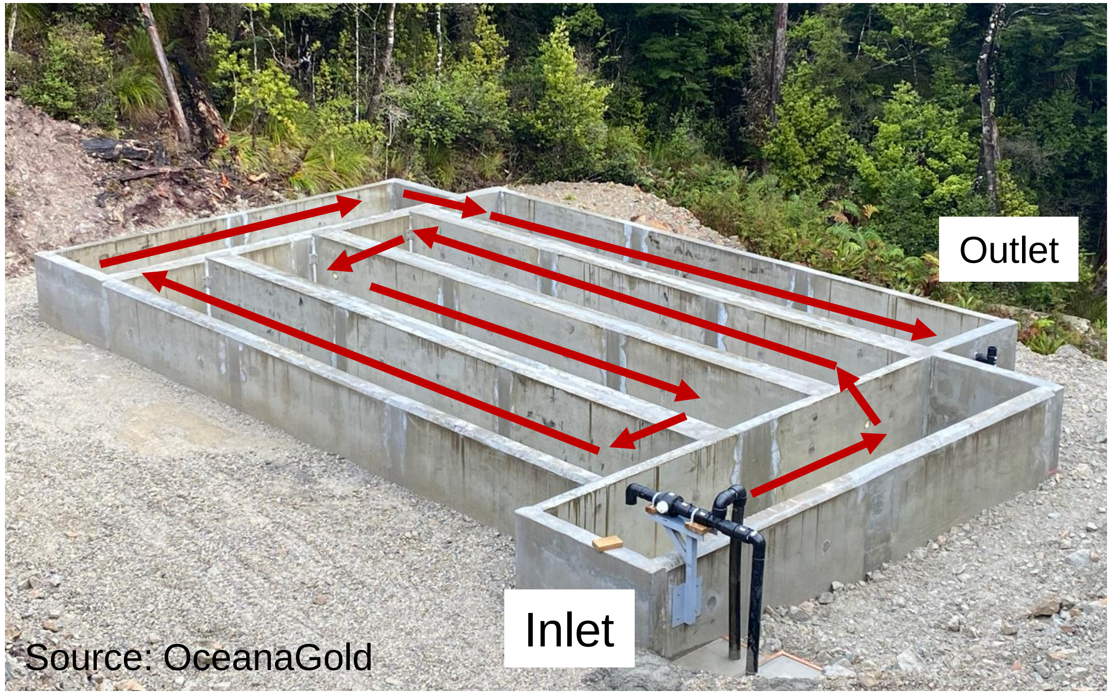


Design to Construction

Leachate Treatment

Retained solution





Current progress

- Consent granted
- Construction complete
- System commissioning underway
- Awaiting the first test results

Source: OceanaGold

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Acknowledgements

→ All parties involved

Managing a small volume of seepage

Questions?