

Ross Island Lagoon HAB Solutions

Design Team 5

THE OBJECTIVE OF THIS ANALYSIS IS TO IDENTIFY PRACTICABLE SOLUTIONS TO REDUCE THE FREQUENCY & DURATION OF HABs AT ROSS ISLAND LAGOON.

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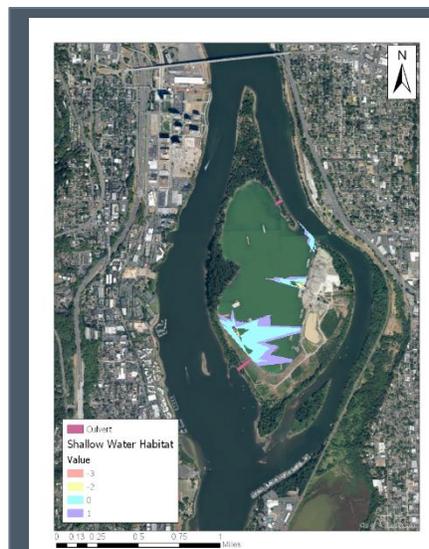
Alternatives analyzed

1. Construction of a south and north culvert to introduce flow into the lagoon
2. Injection of nanobubbles to destroy algae cysts
3. No action

KEY FINDINGS AND RECOMMENDATIONS

The HEC-RAS model indicated flow could be introduced into Ross Island lagoon with minimal disruption of stratification at very small depths. Richardson numbers, which indicate the ability to disrupt stratification, were large for Ross Island during August flows when the HAB would be occurring. Studies have shown nanobubbles to be an effective tool at removing HABs; however, the nanobubbles may damage diatoms.

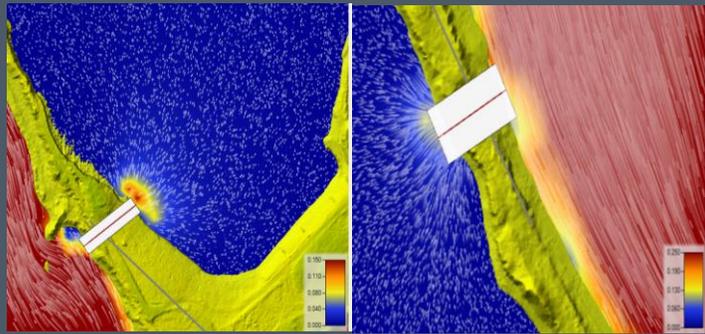
- > Research by Dr. Peter Moeller from the National Oceanic and Atmospheric Administration has shown that the use of nanobubble technology (NBOT) is effective at the prevention of the formation of harmful algal blooms for an entire summer and can easily be scaled up to meet the size needs of Ross Island.
- > Due to concerns over poor disruption of stratification by the culverts, the team recommends moving forward with the microbial solution of nanobubble injection to remove the HAB.



Placement of the South and North culverts (shown in pink) at Ross Island with the pre-existing shallow water habitat (+1 to -20 of the Ross Island Datum)

ALTERNATIVE 1

A two-dimensional unsteady model was made to understand the flow, depth, and stratification at Ross Island in Portland, OR using the US Army Corps of Engineers' Hydrologic Engineering Center's River Analysis System 5.0.6 (HEC-RAS) and raster data of Ross Island. Two box culverts (100'x 20') with an upstream invert elevation of -11ft with assumed manning's n values of 0.015 for concrete were inserted into the model. The model was run for all flow conditions. Richardson numbers, which indicated disruption of stratification, were found to be higher than 0.25 with the culvert additions at a 10m depth. This indicated stratification would likely not be disrupted.

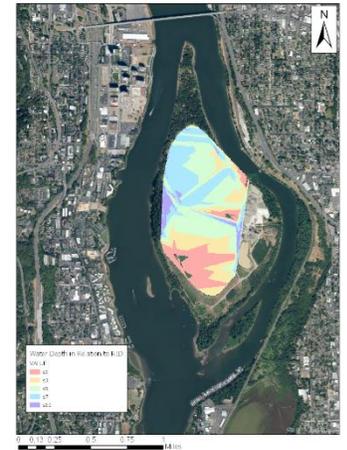


South culvert (left) and north culvert (right) shown with velocity contour from HEC-RAS model

ALTERNATIVE 2

Nanobubbles are air bubbles with high concentrations of ozone and oxygen free radicals that are formed into bubbles of five microns or less in size. Their small size means that instead of rising immediately to the surface, the bubbles implode in the water, releasing the gas to act as a disinfecting agent. As a strong reactant, free radicals and ozone can have a negative impact on local aquatic microorganisms (such as diatoms) but result in the death of nearly all harmful microbes (not just those listed by the EPA) and a temporarily increased dissolved oxygen. This alternative requires re-application but can easily be deployed and often requires less than 72 hours to be effective.

The non-hydraulic solution will not impact habitat loss but will instead be placed around the lagoon to dissuade stratification. This map shows the gradient in water depth with regards to the RID across the lagoon.



ALTERNATIVES ANALYSIS RESULTS

Evaluation criteria	1. Culvert	2. Nanobubbles	3. No action
Capital cost (\$)	\$13, 246,301.40	\$5,438,925.00	\$0.00
O&M (\$, frequency)	\$102,312/year	\$167,700.00	\$0.00
Loss and creation of shallow water habitats (acres)?	+0 (-0.02)	+0 (-0)	NA
Expected effectiveness at controlling HAB (unknown, low, med, high)?	LOW	MEDIUM	
Likelihood of failure during flood events (unknown, low, med, high)	LOW	LOW	
Risk to CAD cells (USACE likelihood scale)	MODERATE	REMOTE	
Likely benefit to widest range of aquatic taxa (Steelhead, chinook, lamprey, sturgeon, mussels)	Salmon Steelhead Lamprey	Salmon Steelhead Lamprey	
List any unintended impacts (List species, infrastructure, RISG operations, etc.)	Decreased navigability of the Lagoon	Adverse effects on Diatoms & microbial species	

References:

Contractors pricing guide 2019: Heavy Construction Costs with RSMeans data. (2019). Rockland MA,: R.S. Means Company

Moeller, P. (2019). Water Safety & Security Algae and Microbial Toxins Mitigation/Remediation. In *National Algae Association*. SC: Hollings Marine Laboratory