Lake Elsinore Aeration and Mixing System (LEAMS) Alternatives Ranking

Presentation to LECL TMDL Task Force

January 15, 2025

Presentation by Steve Wolosoff, GEI Consultants

Agenda

- List of alternatives considered
- Preliminary screening of alternatives
- Description of short-listed oxygenation alternatives
- Ranking of oxygenation alternatives

List of Alternatives

- Screening
  - Blue = not viable for long-term whole lake treatment, at this time
  - Red = viable, detailed evaluation completed
  - Yellow = baseline (already underway)

Alternatives
1. Dredging top 2 feet of lake bottom sediment
2. Lake level stabilization
3. Destratification / Aeration (e.g., LEAMS)
4. Macrophyte harvesting
5. Wetland treatment
6. Algae harvesting
7. Hypolimnetic withdrawal
8. Dilution with reverse osmosis water
9. Sediment sealing (liners, barriers, etc.)
10. Herbicides
11. Oxygenation
12. Shading
13. Sediment sealing (chemical)
14. Bacteria addition
15. Fishery management
16. Biomanipulation
17. Sonication

Key Components of Oxygenation Alternatives

- On-site generation or delivery by O2 supplier
- Dissolution
- Distribution in lake

Generation vs Delivery

- Trucked liquid oxygen (LOX)
- 2 tanks ~ 6' diameter, 15' tall

- On-site generation ~30 Pressure Swing Absorption (PSA) units needed to meet demand
- Each ~5' tall

Oxygen Dissolution Systems

- Multiple technologies available to add oxygen to water
- Target dose of 15,000 lbs/day to lake bottom

Speece Cone

Oxygen Saturation Technology (OST)

Blue-in-Green High Pressure System

Moleaer Nanobubble Diffuser

Dissolution System Configurations (Five methods)

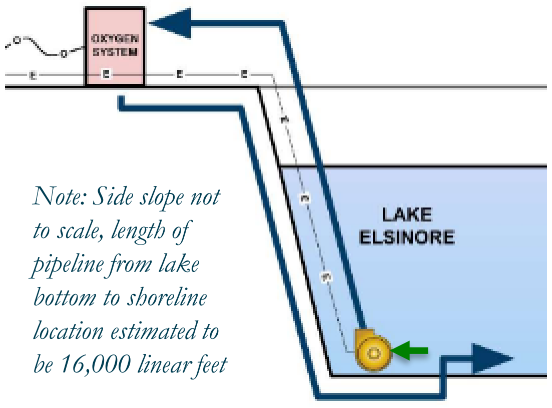
Delivered LOX in configurations 1-4

E = Energy

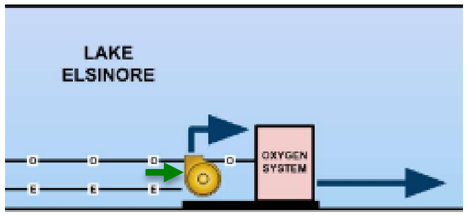
O = Oxygen

→ = Suction or delivery pipe

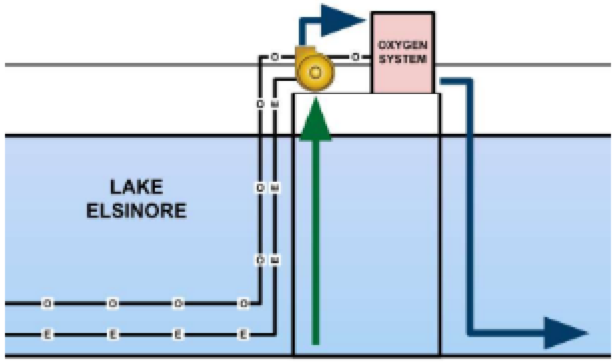
1. Shoreline



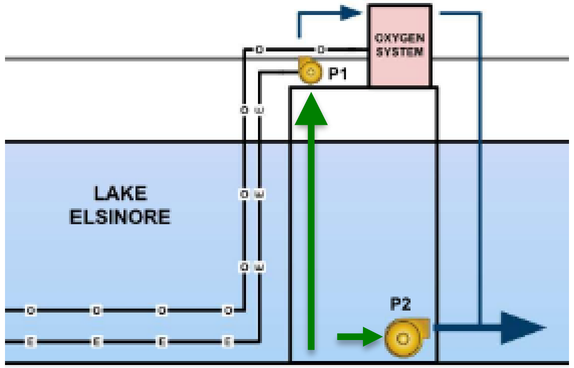
2. Submerged



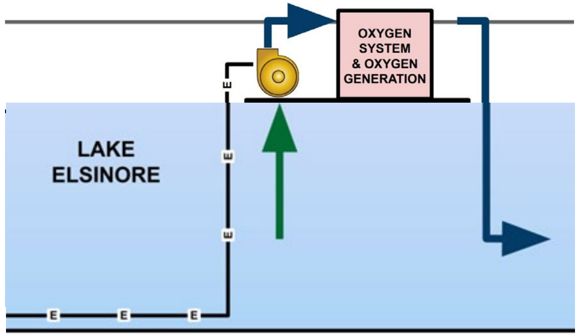
3. Crib (Flow in single stream)



4. Crib (Flow in two-streams)



5. Floating Barge

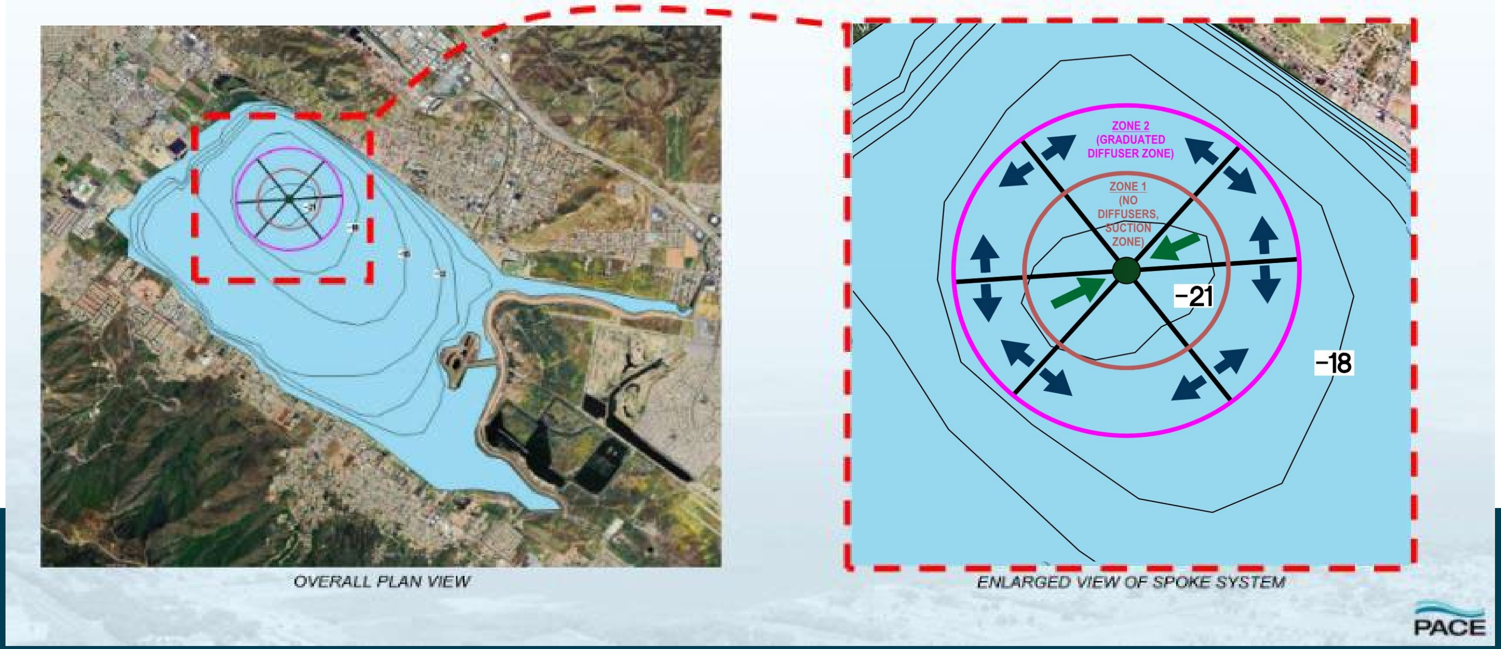


Distribution of Oxygenated Water

- Jet under floating barge mid-water column (configuration 5 only)
- Suction inflow of low DO water near bottom of deep hole (pump at black point in center of spoke)
- Distribution through spoke system with graduated diffusers designed for equalized distribution of oxygenated water near the lake bottom

Jet delivery

Spoke distribution



Summary of Options

1. Shoreline - LOX, 60 MGD pumped to shoreline oxygenation system, spoke distribution *(Moleaer, Speece, OST, Blue in Green)*

2. Submerged – LOX, submerged system with 60 MGD, spoke distribution *(Speece, OST)*

3. Crib, single stream - LOX, concrete crib, 60 MGD, spoke distribution *(Moleaer, Speece, OST)*

4. Crib, 2-stream – LOX, concrete crib, 9 MGD through high-pressure system on concrete crib, 90 MGD mixing water at lake bottom, spoke distribution *(Speece, OST, Blue in Green)*

5. Floating barge – onsite generation, floating barge, 60 MGD, jet distribution mid depth *(Moleaer)*

Expert Reviewers

- Dr. Alex Horne
- Dr. Michael Anderson
- GEI Team: Steve Wolosoff, Chris Stransky, John Rudolph, Craig Wolf, AJ Reyes, Luke Gervase
- Pace Team: Andy Komor, Evan Chen, Pace

Key Notes from Expert Review

Oxygenation Option	Life Cycle Cost (@ 3% rate, 25 years)	Pros	Cons
1. LOX, shoreline, spoke ***(Speece, OST, Blue-In-Green, Moleaer)***	$82,769,000	Easy to access for O&M, proven approach in other lakes	Requires lengthy large diameter pipes along lake bottom, temperature increase along flowpath, costly
2. LOX, submerged, spoke ***(Speece, OST)***	$50,338,000	Less pumping head, hidden, minimize temperature increase	Concerns with anchoring to lake bottom, obstruction to boats
3. LOX, crib, single stream, spoke ***(Moleaer, Speece, OST)***	$66,912,000	Easy to access for O&M	Complex construction, Energy inefficient
4. LOX, crib, 2-stream, spoke ***(Blue-In-Green, OST, Speece)***	$53,760,000	Easy to access for O&M, most energy efficient	Complex construction, Innovative but unproven method
5. PSA, floating barge, jet ***(Moleaer)***	$50,546,000	Current deployment, simple to construct	Hydrodynamics limit high DO water at bottom, many components

Average of Alternatives Ranking (by four experts)

Scale: 1 (Worst) to 5 (Best)
Criteria and weights used in multi-factor score

Oxygenation Option	Capital Cost	Annual O&M Cost (assumes full time operation)	Life Cycle Cost (@ 3% rate, 25 years)	Cost	Reliability	Ease of Construction and O&M	Regulatory Compliance / Environmental Impacts	Social, Political, Recreational Constraints	Sustainability/ Other Benefits	**Multi-Factor Weighted Score**
				30%	20%	10%	25%	10%	5%	
1. LOX, shoreline, spoke *(Speece, OST, Blue-In-Green, Moleaer)*	$19,730,000	$2,550,000	$82,769,000	1.0	4.3	3.4	4.3	4.4	2.9	**3.1**
2. LOX, submerged, spoke *(Speece, OST)*	$9,550,000	$1,650,000	$50,338,000	5.0	4.1	3.6	4.0	3.6	3.5	**4.2**
3. LOX, crib, single stream, spoke *(Moleaer, Speece, OST)*	$15,000,000	$2,100,000	$66,912,000	3.0	3.1	2.7	2.8	2.9	2.8	**2.9**
4. LOX, crib, 2-stream, spoke *(Blue-In-Green, OST, Speece)*	$10,500,000	$1,750,000	$53,760,000	4.6	3.9	3.1	4.0	3.4	3.3	**4.0**
5. PSA, floating barge, jet *(Moleaer)*	$10,500,000	$1,620,000	$50,546,000	5.0	1.9	3.6	2.1	2.8	2.6	**3.2**

Dissolution Vendor Comparisons

- Preliminary design phase to determine most cost-effective sub-option and dissolution technology

Oxygenation Option	Vendor	Life Cycle Cost (@ 3% rate, 25 years)	Cost	Reliability	Ease of Construction and O&M	Regulatory Compliance / Environmental Impacts	Social, Political, Recreational Constraints	Sustainability/ Other Benefits	**Multi-Factor Weighted Score**
			30%	20%	10%	25%	10%	5%	
2. LOX, submerged, spoke	Speece	$50,788,000	4.9	5.0	4.0	3.0	4.0	3.0	**4.2**
	OST	$49,888,000	5.0	2.0	3.0	4.0	4.0	4.0	**3.8**
4. LOX, crib, 2-stream, spoke	Speece	$55,760,000	4.3	5.0	4.0	4.0	3.0	3.0	**4.1**
	OST	$54,960,000	4.4	2.0	3.0	4.0	4.0	4.0	**3.6**
	Blue in Green	$53,760,000	4.6	4.0	4.0	4.0	3.0	3.0	**4.0**

Compliance Outlook

Summary of Offsets	TP (kg/yr)	TN (kg/yr)
EVMWD's Load Reduction Target [1]	2,183	40,365
Other's Load Reduction Target [1]	1,354	8,914
Total Load Reduction Target [1]	3,538	49,278
Oxygenation Nutrient Reduction Capacity	11,107	51,922
% of Target Met	314%	105%

[1] Reductions based on interim milestone (20 years from effective date) in the proposed TMDL revision

- To achieve final TMDL, a supplemental project to remove nitrogen may be needed in a future phase

Next Steps

- Draft comprehensive report (February 2025)
- Slideshow providing details of sediment study (February 2025)
  - Scientific basis for estimated annual nutrient load reduction (TN and TP)
  - Scientific basis for oxygen delivery rate to achieve oxic conditions at sediment-water interface
- Final comprehensive report (March 2025)
- Procurement for design engineering