Lake Oswego · Tigard Water Partnership
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Brown AND Caldwell

Technical Memorandum

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Subject: Treatment Technology Selection
Business Case Evaluation: Workshop #3

To: Joel Komarek, City of Lake Oswego
Dennis Koellermeier, City of Tigard

From: Bill Persich, Brown and Caldwell

Prepared by: Steffran Neff, Brown and Caldwell

Reviewed by: Jack Warburton, Brown and Caldwell
Jon Holland, Brown and Caldwell

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Introduction

This document provides an overview of the discussions and decisions from Workshop #3 conducted on June 10, 2010 of a three-workshop business case evaluation (BCE) process to determine the water quality objectives and select the treatment technologies for the upgrade and expansion of the Lake Oswego Water Treatment Plant (WTP). The Workshop #3 attendance list is presented in Appendix A.

Workshop #3 Preparation

The following describes steps taken in preparation for Workshop #3. Workshop #2 resulted in a list of six alternatives that were further analyzed for comparison. Table 1 contains the list from Workshop #2.

Table 1. Alternatives Retained From Workshop #2 for Additional Evaluation

Alternative	Description
1.0	Conventional treatment as per 2007 report
1.1	Add powdered activated carbon (PAC), enhanced coagulation, and ultraviolet (UV) disinfection to Alternative 1.0 baseline
1.2	Add ozone and granular activated carbon (GAC) biofiltration to the conventional treatment to Alternative 1.0 baseline
1.2.A	Add ozone and anthracite biofiltration to the conventional treatment to Alternative 1.0 baseline
2.1	Add PAC, enhanced coagulation, and UV disinfection to Alternative 2.0 Actiflo baseline
2.2	Add ozone and GAC biofiltration to the high-rate conventional treatment alternatives to Alternative 2.0 Actiflo baseline

For each of the above alternatives in Table 1 the following information was developed:

- Detailed design criteria
- Refined site layouts
- Refined process schematics
- Refined capital costs
- Refined operations and maintenance costs that included refurbishment and replacement
- Net present value (NPV) based on 6 percent discount rate and 3 percent escalation
- Power and chemical consumption, plus sludge generation quantities
- Carbon footprint
- Triple Bottom Line risk analysis.

Copies of this information were made available on the SharePoint site. The information will be compiled into a separate technical memorandum for future distribution. For the workshop preparation, the capital, operations, maintenance, and refurbishment costing information were incorporated into a 25-year NPV BCE. In addition, risk factors were developed and initially monetized for the evaluation parameters that were qualitatively compared in Workshop #2. Table 2 lists the risk factors and the basis for initial monetization. A full summary of the initial risk monetization is located in Appendix B. The full costing, design criteria, and risk information was uploaded to the SharePoint site for Expert Panel review prior to Workshop #3.

Table 2. Risk Factors and Basis for Initial Monetization	
Risk factor	Basis for Monetization
Particulate/bacterial removal	Cost of boil water order for a localized event
Seasonal taste and odor (T&O)	Differential PAC costs: week-long event
Enhanced disinfection byproduct (DBP) and trace organics removal	Need to modify existing for ozone or other technologies; likelihood of regulation in 10 years
Additional *Cryptosporidium* removal	Cost of boil water order: outbreak and legal fees
Distribution quality	Increased chlorine consumption of 1 part per million: potential consequence of T&O
Operability	Additional need beyond assumed operations staff: 1 full-time equivalent (FTE)
Maintainability	Additional need beyond maintenance staff: 1 FTE
Constructability	Temporary facilities, extended schedule: 10 percent of base cost - increase based on capital cost ratio
Reliability and resiliency	Reliability of existing systems: 1percent of base cost for emergency repairs - increase based on capital cost ratio
Site utilization	Need for late redesign: 3 percent of capital cost proportional to size of acreage–5 percent on smallest acreage
Proprietary technology	Locking into vendor: 1 percent of ozone and Actiflo capital costs
Energy	Sensitivity of power cost estimate: likelihood of 20 percent increase in cost ratio to power consumption
Carbon footprint	Carbon footprint
Chemical usage	Sensitivity of chemical cost estimate: likelihood of 20 percent increase in cost ratio to chemical usage
Plant safety	Increased risk of spills on-site: increased proportional to chemical usage
Residuals	Sensitivity of sludge hauling: likelihood of 20 percent increase–ratio to sludge disposal costs
Host and Lake Oswego/Tigard Community impacts	Increased truck traffic, transport of chemicals, and consumer confidence

Figure 1 provides a summary of the BCE results without risk, and Figure 2 provides a summary with risk considerations. Both analyses ranked the top three alternatives in the same order of least NPV, namely Alternative 1.0 Conventional Treatment, Alternative 2.0 Actiflo/Conventional Treatment followed by Alternative 1.2A Conventional Treatment with Ozone and Anthracite Biofiltration.

Alternative 2.0 Actiflo/Conventional was costed, but was not considered to be a viable alternative from Workshop #2. The reasons for not considering Actiflo were as follows:

- Actiflo is often used when proposed improvements cannot fit on the existing plant property, which it is not the case in this situation.
- Actiflo is more costly than conventional sedimentation.

- If raw water quality (e.g., turbidity) variation is high, use of Actiflo might be more warranted; however, Clackamas River raw water quality should not be a concern.
- PAC would need to be added ahead of Actiflo to treat for taste and odor compounds.
- Actiflo without ozonation has a potential polymer-induced clogging issue for the downstream filters.

Therefore, the key comparison was between Alternatives 1.0 and 1.2A for Workshop #3. A sensitivity analysis of the risk factors was conducted and it was noted that only two were significant enough to affect the relative difference between Alternative 1.0 Conventional Treatment and Alternative 1.2A Conventional Treatment with Ozone and Anthracite Biofiltration. The two risk factors were enhanced DBP and trace organic removal and additional *Cryptosporidium* removal.

Lake Oswego/Tigard Water Partnership
Treatment Technology Selection
Alternatives Net Present Value Analysis without Risk - 32 MGD

Agency: Lake Oswego/Tigard Water Partnership
Project/Problem: Treatment Technology Selection

		Sensitivity Adjustments (%)				Results		
		Risk Premium	Benefits	Capital Costs	Other Costs	Capital Cost	NPV	Difference
Alternative	Alt. 1.0 Conventional					$73,390,000	($101,803,963)	
Alternative	Alt. 1.1 Conventional Treatment with PAC, Enhanced Coagulation and UV Disinfection					$80,560,000	($123,405,184)	($21,601,221)
Alternative	Alt 1.2 Conventional Treatment with Ozone and GAC Biofiltration					$89,800,000	($121,811,037)	($20,007,074)
Alternative	Alt 1.2A Conventional Treatment with Ozone and Anthracite Biofiltration					$88,240,000	($119,326,815)	($17,522,852)
Alternative	Alt 2.0 Actiflo/Conventional					$86,100,000	($113,888,600)	($12,084,637)
Alternative	Alt 2.1 Actiflo/Conventional Treatment with PAC, Enhanced Coagulation and UV Disinfection					$92,260,000	($134,735,046)	($32,931,083)
Alternative	Alt 2.2 Actiflo/Conventional Treatment with Ozone and GAC Biofiltration					$102,090,000	($133,513,949)	($31,709,986)
Alternative								

Year of analysis: 2010
Escalation rate: 3.00%
Discount rate: 6.00%

Select one
All entries in dollars
All entries in thousands of dolla

Note: "Status quo" refers to None of the Alternatives

Figure 1. NPV of Alternatives without Risk Monetization (prior to Workshop #3)

Lake Oswego/Tigard Water Partnership
Treatment Technology Selection
Alternatives Net Present Value Analysis with Risk - 32 MGD

			Sensitivity Adjustments (%)			Results		
Agency:	Lake Oswego/Tigard Water Partnership	Risk Premium	Benefits	Capital Costs	Other Costs	Capital Cost	NPV	Difference
Project/Problem:	Treatment Technology Selection							
Alternative	Alt. 1.0 Conventional					$73,390,000	($107,123,485)	
Alternative	Alt. 1.1 Conventional Treatment with PAC, Enhanced Coagulation and UV Disinfection					$80,560,000	($127,696,044)	($20,572,559)
Alternative	Alt 1.2 Conventional Treatment with Ozone and GAC Biofiltration					$89,800,000	($126,129,915)	($19,006,430)
Alternative	Alt 1.2A Conventional Treatment with Ozone and Anthracite Biofiltration					$88,240,000	($123,602,781)	($16,479,296)
Alternative	Alt 2.0 Actiflo/Conventional					$86,100,000	($123,121,920)	($15,998,435)
Alternative	Alt 2.1 Actiflo/Conventional Treatment with PAC, Enhanced Coagulation and UV Disinfection					$92,260,000	($140,866,839)	($33,743,354)
Alternative	Alt 2.2 Actiflo/Conventional Treatment with Ozone and GAC Biofiltration					$102,090,000	($139,737,900)	($32,614,415)
Year of analysis:	2010							
Escalation rate:	3.00%							
Discount rate:	6.00%							

Select one
All entries in dollars
All entries in thousands of dolla

Note: "Status quo" refers to None of the Alternatives

Figure 2. NPV of Alternatives with Risk Monetization (prior to Workshop #3)

Workshop #3 Session

The main objective of Workshop #3 was to develop a preferred alternative for the WTP upgrade. The workshop started with a review of Workshop #2, followed by presentation of the BCE summary spreadsheets, both with and without initial risk considerations. Discussions on the benefits and risks of ozone as a treatment process were held, followed by an Expert Panel poll on the preferred alternative. The preferred alternative was selected and the afternoon session provided discussion on design criteria, site layout, and ozone justification.

BCE Results

The capital, operations, maintenance, and refurbishment costing information that were incorporated into the 25-year NPV BCE were reviewed at the workshop. Although six alternatives were presented for comparison, primarily two alternatives were discussed for subsequent evaluation and comparison: Alternative 1.0 Conventional Treatment, and Alternative 1.2A Conventional Treatment with Ozone and Anthracite Biofiltration.

During the initial discussion, the Expert Panel suggested that our capital and operations costs for the ozone system may be too high. Therefore, to look at the sensitivity, the capital cost for the ozone system was reduced by $8 million for Alternative 1.2A. In addition, the labor costs for the ozone system were set to be equal to conventional treatment at $800,000 per year. The other operations and maintenance costs were alternative specific. Figure 3 provides an updated summary of the BCE results without risk with the new capital and operations costs for Alternative 1.2A.

Lake Oswego/Tigard Water Partnership
Treatment Technology Selection
Alternatives Net Present Value Analysis without Risk - 32 MGD

			Sensitivity Adjustments (%)			Results		
Agency:	Lake Oswego/Tigard Water Partnership							
Project/Problem:	Treatment Technology Selection	Risk Premium	Benefits	Capital Costs	Other Costs	Capital Cost	NPV	Difference
Alternative	Alt. 1.0 Conventional					$73,390,000	($101,803,963)	
Alternative	Alt. 1.1 Conventional Treatment with PAC, Enhanced Coagulation and UV Disinfection					$80,560,000	($123,405,184)	($21,601,221)
Alternative	Alt 1.2 Conventional Treatment with Ozone and GAC Biofiltration					$89,800,000	($121,811,037)	($20,007,074)
Alternative	Alt 1.2A Conventional Treatment with Ozone and Anthracite Biofiltration					$80,240,000	($109,895,700)	($8,091,737)
Alternative	Alt 2.0 Actiflo/Conventional					$86,100,000	($113,888,600)	($12,084,637)
Alternative	Alt 2.1 Actiflo/Conventional Treatment with PAC, Enhanced Coagulation and UV Disinfection					$92,260,000	($134,735,046)	($32,931,083)
Alternative	Alt 2.2 Actiflo/Conventional Treatment with Ozone and GAC Biofiltration					$102,090,000	($133,513,949)	($31,709,986)
Alternative								
Year of analysis:	2010							
Escalation rate:	3.00%							
Discount rate:	6.00%							

Select one
All entries in dollars
All entries in thousands of dolla

Note: "Status quo" refers to None of the Alternatives

Figure 3. Updated NPV of Alternatives without Risk Monetization from Workshop #3

The Expert Panel discussed the monetized risk process and some members expressed concern with having assumptions rather than a fully justifiable rationale for determining the percent likelihood of a risk consequence occurring and determining the cost of that consequence as the base justification for moving to ozone over conventional treatment. The potential rate impacts were then reviewed and based on potential cost sensitivity presented as a range. The rate implication would be approximately $3 to $5 more per month to go from Alternative 1.0 to Alternative 1.2A. With the relatively low potential rate impact, the Expert Panel suggested using a "willingness to pay" justification for moving to ozone rather than the monetized risk approach. As a result, the Expert Panel dismissed further consideration of a numerical risk cost approach to evaluating the merits of ozone.

There was a short discussion on the potential negatives of ozone treatment, as summarized below.

Negatives of using ozone:

- Has risk of chemical transportation
- Costs more to build and operate
- Has added complexity and space requirements at plant
- Might increase taste and odor complaints by "raising the bar" on water quality
- May produce DBPs that become regulated in the future, although the risk is low due to the absence of bromide at significant levels in the source water.
- Occupies large space on site
- Has increased carbon footprint

- Creates need to invest in operators with skills in operating ozonation systems
- Will have increase in safety training

At this point in the discussion, Expert Panel members were polled to determine their opinions on whether to choose Alternative 1.0 or 1.2A as the preferred alternative.

Expert Panel Preferred Alternative Selection Poll

The following paraphrases each Expert Panel member's opinion on which alternative to recommend. The group overwhelmingly recommended Alternative 1.2A as the preferred alternative.

Lee Odell

If the cost is affordable to put in ozone, I would put it in now. It allows for multiple barriers, improved aesthetics, and reduced byproducts. It would help address regulatory uncertainty and provide flexibility to deal with more source water changes.

Eva Nieminski

Put ozone in now. You cannot go wrong with ozone as far as regulations are concerned, especially as bromide is not an issue with your source water. This is where industry is going. You have a choice to go with the leaders and go above and beyond regulations, or sit and wait. Your community is ready to be with the leaders and invest in increased health and customer satisfaction. There is also a difference between being happy and being happy and proud. Ozone will make you the latter.

Pete Kreft

I could support going to ozone now. It is about money and presentation to decision-makers. It would be easier with a more refined cost estimate. If you would put in ozone in 5 years, you might as well do it now. The plant will go beyond what is required by regulations. If you go above you will be prepared in the future.

Jeff Neemann

The benefits of going to ozone exceed the costs. As a utility you are looking around the corner rather than reacting. I would stress the importance of multiple barriers. You have a low-risk water source, but want to protect public health. You want to consider aesthetics. You want pleasing and palatable water. Tap water is more sustainable than bottled water. Therefore, you want to make water people want to drink. These are the messages I would put forward in supporting the case for moving to ozone.

Matthew Marshall

There are no current regulations or regulations in the pipeline to require you to put ozone in now. I believe it is a swamp to lead the public into a discussion on a health-based risk discussion prior to the regulation. If we are not required to do it, why are we going above and beyond regulations? I would not recommend ozone on health basis. If you want to put in ozone, I would suggest the driver be the taste and odor issue, not health. It will help ensure good water quality. You can give the public better tasting water with ozone.

Ozone Justification

Clark Worth then led a discussion on the choice to move to Alternative 1.2A with ozone treatment and the appropriate messaging. The following lists the ozone justification points developed at Workshop #3.

- Provides an additional disinfection barrier
- Consistently improves T&O
- Delivers higher quality water than is required by current regulations
- Reduces chlorine use
- Is capable of reducing emerging contaminants
- Represents proven technology
- Increases flexibility to handle source water quality changes
- Costs less than 20 cents per day per customer
- Supports Lake Oswego/Tigard stated values and principles

Design and Plant Layout Optimization

After the selection of Alternative 1.2A as the preferred alternative, the Expert Panel was asked to provide insight into optimizing the design and layout criteria.

Design Criteria Suggestions

- Ozone generation: Reduce the number of ozone generators—consider two larger units
- Flocculation/sedimentation basins size
    - Design basin geometry around plate settlers
    - Can have basins with differing geometry than existing
    - Could build large basins and demolish existing
    - Could not demolish the existing basins without having new basins in place
    - Having more basins can be beneficial from a maintenance perspective
    - Determine if the future winter demands allow for winter maintenance
- Ozone Contactors
    - Side stream injection is recommend for consideration
    - Operations and maintenance would be less with side stream injection than using submerged diffusers
    - Use of side stream injection would allow for a shallower contactor than the traditional submerged diffuser contactor
- Backwash system: Design plant with air scour
- Solids stream: Mechanize the wash water handling system

- Corrosion control
  - Has not been a focus of the design criteria to date
  - Requires about 16 hours per week of plant staff labor for the lime system
- UV disinfection: Keep space for UV in the design layout
- Hypochlorite: Consider onsite generation
- Lagoons
  - Need to keep two on-line for sequencing during construction
  - Cosider keeping them for future filter washwater handling
- Operations building: Need either new chemical facilities or office space—we cannot increase the chemical handling facilities and house the staff in the existing building

Sequencing/Construction Strategy

- Construction
  - Possibily use Mapleton/south side of property for construction mobilization and staging
  - Could use southern part of site for subterranean structures
  - Could look for an access road on Mapleton
  - Would be attractive to move the clearwell to the southern end of the property which could provide an option for two pipelines on two separate streets to maximize hydraulic redundancy
  - Provide an ideal layout using the entire site
  - Lay out of the flocculation and sedimentation facilities in an in-line hydraulic array with clearwell placed on the on the south end of the plant is ideal
- Sequencing
  - Keep two of the wash water lagoons in service at any given time until installation of new mechanized wash water handling processes is complete
  - Build new flocculation and sedimentation basins first

General Comments

- Piloting
  - There is a potential public interest in having a pilot test
  - Lake Oswego and Tigard might want to consider a pilot period in winter and summer
  - Ozonation system design criteria can be obtained from bench testing; it would be beneficial to pilot test ozone to see how ozone works with biofiltration
- State communication: There was a suggestion to meet with the State of Oregon and share information with the state engineer to help with the final design approval

Next Steps

The recommendation for Alternative 1.2A Conventional Treatment with Ozone and Anthracite Biofiltration from Workshop #3 will be presented to the Oversight Committee and to the City Councils for approval. In the interim, the design, cost estimation, and site layout for the preferred alternative will be refined.

APPENDIX A

WORKSHOP #3 ATTENDANCE LIST

The following people were in attendance at Workshop #3:

- City of Lake Oswego
  - Joel Komarek
  - Kari Duncan
  - Jane Heisler
  - Bob Burgeson
  - Dave Prock
- City of Tigard
  - Dennis Koellermeier
- Brown and Caldwell
  - Bill Persich
  - Steffran Neff
  - Jon Holland
  - Doug Wise
  - Jack Warburton
  - Lynn Williams
- Barney & Worth
  - Clark Worth
  - Libby Barg
- Carollo
  - Dave Kraska
- Citizen Sounding Board
  - Gretchen Buehner – Tigard
  - Gary Strealy – Tigard
  - David Brussman – Lake Oswego
- Expert Panel
  - Jeff Neemann – Black & Veatch
  - Matthew Marshall – Carollo
  - Lee Odell – CH2M Hill
  - Pete Kreft – MWH
  - Eva Nieminski – Utah Department of Environmental Quality