Oswego Lake Interceptor Sewer Upgrade Project
Phase 2 Predesign Report

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Figures
1. In-Lake Alternative
2. Around-the-Lake Alternative
3. Buoyant Interceptor System
4. Alternatives Present Worth Cost Comparison

Tables
1. Alternatives Evaluation Matrix
2. OLIS Upgrade Recommended Improvements Summary
3. Consultant Team for OLIS Upgrade Predesign Phase 2

1 SEISMIC EVALUATION OF EXISTING INTERCEPTOR

Figures
1. Pipeline Segments and Stiffness Transitions
2. Elevated Pile Segment at Transition
3. Pipe Support 30A33
4. Transition Failures
5. Support Failures
6. Pile Leg Instability
7. Liquefaction Failures
8. Flow Slide Failures
9. Total Failures, Instability, and Breaks

Tables
1. Pipeline Conditions
2. Embedment Depths of Analyzed Pile Bents
3. Uncertain Model Parameters
4. Pile Bent Failure Mechanisms
5. Geotechnical Condition Failures

Appendices
A. Lake Oswego Interceptor Sewer Workshop Memorandum, Brown and Caldwell
B. Seismic Vulnerability of Existing Pipeline – Shannon & Wilson, Inc.
C. Summary Analysis Results for Support Bents
D. Segment-by-Segment Summary of Failures Expected and their Mechanisms
2 PUMPING ALTERNATIVES EVALUATION

Figures
1 Peak Flow Diversion to Durham WWTP
2 In-Lake Capacity Relief Pumping
3 Around-the-Lake Alternative

Tables
1 Summary of Existing Interceptor Deficiencies
2 Around-the-Lake Alternative Description
3 Around-the-Lake Alternative Pump Station Overview
4 Around-the-Lake Alternative Force Main System Overview

Appendices
A Pump Station Sites
B System Hydraulics
C Workshop Minutes – Pump Station Siting and Force Main Routing
D Cost Estimates

3 IN-LAKE BUOYANT GRAVITY SYSTEM

Figures
1 Buoyant Interceptor System
2 Pipe Bracket
3 Tether Connection to Bracket
4 Bar to Wire Rope Transition at Mudline
5 Rock Anchor at Bedrock

Appendices
A Analytical Modeling: Submerged Buoyant Sewer Pipeline for Lake Oswego – Makai Ocean Engineering
B Oswego Lake Interceptor Sewer Buoyant Pipeline Anchorage – Shannon & Wilson

4 MODELED FLOW PROJECTIONS

Figures
1 Meter Locations and Modeled Sewers
2 2007 Meter Locations and Lake Oswego Sewer System
3 Calibration Check of Total Flows from Lake Oswego at TCWTP
4 Five-Year Event, Existing System, Maximum Depth above MH Rim
5 Twenty-Five Year Event, Existing System, Maximum Depth above MH Rim
6 Proposed In-Lake Gravity Upgrade Alternative from Phase 1 Predesign Report
7 Proposed Facilities, Existing Flows 5-Year Event, Depth above MH Rim
8 Proposed Facilities, Existing Flows 25-Year Event, Depth above MH Rim
9 Modified Facilities (24-inch Blue Heron Connection), 2015 Flows 5-Year Event, Depth above MH Rim
4 MODELED FLOW PROJECTIONS (CONTINUED)

10 Modified Facilities (24-inch Blue Heron Connection), 2015 Flows 25-Year Event, Depth above MH Rim
11 Modified Facilities (24-inch Blue Heron and East Mountain Park Connections), 2025 Flows 25-Year Event, Depth above MH Rim
12 Modified Facilities (24-inch Blue Heron and East Mountain Park Connections), 2035 Flows, 5-Year Event, Depth above MH Rim
13 Modified Facilities (24-inch Blue Heron and East Mountain Park Connections), 2035 Flows, 25-Year Event, Depth above MH Rim
14 Modified Facilities (24-inch Blue Heron and East Mountain Park Connections, 21-inch Main Canal, 36-inch from MH 10 to MH D), 2035 Flows, 25-Year Event, Depth above MH Rim
15 Modified Facilities (24-inch Blue Heron and East Mountain Park Connections, 21-inch Main Canal, 36-inch from MH 10 to MH D), 2045 Flows, 25-Year Event, Depth above MH Rim
16 Modified Facilities (24-inch Blue Heron and East Mountain Park Connections, 21-inch Main Canal, 36-inch from MH 11 to MH D), 2045 Flows, 25-Year Event, HGL Profile from MH 10 up West Bay Trunk
17 Modified Facilities (24-inch Blue Heron and East Mountain Park Connections, 21-inch Main Canal, 36-inch from MH 11 to MH D), 2045 Flows, 25-Year Event, HGL Profile from MH 11 up the Blue Heron Trunk
18 In-Lake Gravity Alternative Proposed Upgrades from Phase 2 Predesign

Tables
1 Flow Monitoring Site Characteristics
2 Estimated I/I Statistics – 2007 Data
3 1996-1997 Model Calibrations
4 Existing and Future Sewered Area
5 Modeled Flow Projections – Summary for Capacity Evaluation
6 Around-the-Lake Alternative Pump Station Flows

Appendices
A Sanitary Sewer Flow Monitoring 2007 – SFE Global NW
B Hydrologic Model Calibration Assumptions and Procedures
C Calibration Plots
D L4, South Lake, and Canal Wastewater Collection Basins
E Tryon Creek WWTP Capacity Summary from 1999 Facilities Plan, IGA with Portland
F City of Lake Oswego Wastewater Overflow Emergency Response Plan

5 ENVIRONMENTAL PERMITTING

Appendix
A Environmental Analysis of Oswego Lake Interceptor Sewer Upgrade Project – Anchor Environmental, LLC
## 6 FINAL ALTERNATIVE SELECTION

### Table

1. Alternatives Evaluation Matrix

### Appendices

- A. Mutual Agreement and Order between City of Lake Oswego and DEQ
- B. City Engineer’s Council Report – Presentation of Staff Recommended Replacement Alternative
Executive Summary

This summary provides an overview of Phase 2 of the Oswego Lake Interceptor Sewer (OLIS) Upgrade Project Predesign. The Phase 1 Predesign Report, initially submitted to the City by Brown and Caldwell in draft form in December 2005 and then finalized in February 2007, focuses primarily on in-lake gravity replacement options. An around-the-lake pumping option is also examined briefly in Phase 1, though in much less detail than the in-lake options, to determine whether it merits further consideration. As the Phase 1 cost estimates and other evaluation criteria do not clearly favor the in-lake gravity option over around-the-lake pumping, a second phase predesign effort was undertaken in April 2006 to evaluate several pumping alternatives, including an in-depth look at the preferred around-the-lake pumping alternative initially developed in Phase 1. Further evaluation of the buoyant system is also provided to increase understanding of and confidence in its expected performance.

Updated summaries of the proposed improvements for the in-lake buoyant system and the around-the-lake pumping alternative are shown in Figures 1 and 2, respectively.

The result of Phase 2 was selection by the City Council on July 10, 2007 of the in-lake gravity buoyant pipe alternative for the main lake reach. Further analysis in detailed design will determine the precise extents of where direct burial, pile support, and buoyant system methods are applied for in-water tributary trunks.

Phase 2 Predesign Objectives

The major objectives of the Phase 2 effort are as follows:

- Quantify the seismic risk the existing interceptor faces from a relatively moderate level of ground shaking that would be reasonably likely to occur in the foreseeable future
- Determine if the around-the-lake pumping option is competitive with in-lake gravity options
- Investigate an in-lake pumping alignment to gauge viability and potential advantages
- Evaluate two short-term capacity relief pumping scenarios to help the City Council determine whether the long-term replacement project should be deferred
- Analyze further the in-lake buoyant alternative and present findings to the public and Council to enable an informed decision on whether this option can be relied on with confidence
- Develop updated peak wet weather flow projections at future buildout conditions and revise project limits and pipe sizing accordingly
- Establish future infiltration/inflow (I/I) goals to ensure capacity is preserved
- Conduct a more in-depth review of permitting requirements and get key regulatory agency feedback on likely requirements
- Evaluate remaining alternatives in sufficient depth that City staff and Council can make their final preferred alternative selection with confidence
Conclusions and Recommendations

The primary conclusions and recommendations from each of the investigations undertaken in Phase 2 are presented in the balance of this Executive Summary. More in-depth information on each topic can be found in the technical memoranda and appendices that comprise this report. These topics and the respective locations in the report are as follows:

- Tab 1 – Seismic Evaluation of Existing OLIS
- Tab 2 – Pumping Alternatives Evaluation
- Tab 3 – In-Lake Buoyant Gravity System
- Tab 4 – Modeled Flow Projections
- Tab 5 – Environmental Permitting
- Tab 6 – Final Alternative Selection

Tab 1 – Seismic Evaluation of Existing OLIS

This study is intended to provide a better understanding of the existing, in-lake interceptor sewer performance under low-level but highly probable seismic ground motions. Events with peak ground acceleration of 10 percent of the force of gravity (0.10 g) and 0.15 g were studied, corresponding to exceedance probabilities of 50 percent and 25 percent respectively in a 100-year time horizon. A 50 percent, 100-year event generates substantially similar base rock motion as a 15 percent, 25-year event. The pipeline’s performance is characterized by the expected number of failures along the study length during and immediately after the seismic event. Failure is defined as a pipe length pulling out of the adjoining section’s bell, or sufficient long-term soil displacement to achieve a similar discontinuance of flow.

Analysis of the in-lake, elevated pipeline on pile-supported bents reveals three primary failure modes:

- Excessive displacement longitudinally where elevated pipeline transitions into buried supports
- Pryout of the pile from the unreinforced receiving socket causing loss of support
- Pile instability due to greatly different pile lengths in the same bent

Geotechnical analysis of the buried pipeline segments confirms both liquefaction and flow-slide type failures will occur, both of which fail multiple pipe lengths.

An estimated 170 elevated pipe lengths and 50 buried pipe lengths will fail under the 0.1 g ground motion studied for a total of 220 pipe lengths. Geotechnical condition failures were not expected to increase substantially at 0.15 g given the analysis results. Structural failures were determined at 0.1 g motion, thus additional analysis at 0.15 g was not conducted. Failures are expected along the entire study length without significant clustering. Timely repair of this system after an earthquake does not appear feasible due to the number and dispersion of failures, as well as the considerable difficulty in accessing buried segments.

Given the variable lake bottom conditions, differing structural systems, and age of the pipeline, there are uncertainties in the expected performance. The most likely significant unknowns are the true physical condition of structural elements, particularly the effects of corrosion on steel pile supports and hardware and whether previous ground motion (Scotts Mill earthquake, for example) has pre-displaced pipe lengths making them susceptible to pullout at smaller displacements than analysis predicts. Both of these uncertainties have been addressed by analyzing the pipeline assuming “like-new” condition, which results in bias toward fewer predicted failures. A structural retrofit to strengthen the existing OLIS such that it could survive design level ground motions is not feasible for a variety of reasons.
Tab 2 – Pumping Alternatives

This investigation provides a detailed look at pumping alternatives with both in-lake and upland conveyance system options. Two new permanent upgrade (long-term) options are considered: an around-the-lake pumping system and an in-lake pumping system. In addition, two temporary capacity relief (short-term) options are evaluated: diversion of peak flows to Clean Water Services’ Durham Advanced Wastewater Treatment Facility and an in-lake peak flow pumping system.

The short-term options defer the replacement of the interceptor but would still rely on the existing interceptor for the foreseeable future (10 to 20 years). No structural integrity improvements are included in the short-term options. The long-term options replace the deficient segments of the OLIS and thus address structural issues as well.

Short-Term Pumping Alternatives

- The construction costs of both short-term alternatives are on the order of $25 million. They both involve very long force mains with challenging alignments and pumping stations sized to handle peak flows in excess of 2,200 gallons per minute.
- Wet weather pumping systems have several operation and maintenance (O&M) drawbacks related to intermittent usage. These include having to drain the pipeline after each use to avoid odors, and refilling with clean water to prevent pump damage upon startup. Reliability is also a concern for any infrequently operated electro-mechanical system.
- Neither of the short-term alternatives has the potential to be fully integrated into a long term replacement alternative. Therefore their substantial construction costs will make the eventual long-term replacement of the OLIS even less affordable.
- Deferral of the long-term OLIS replacement may prove to be more expensive if the recent trend of construction industry cost escalation continues.

Based on these preliminary findings and the outcome of the seismic evaluation of the existing OLIS, which were presented to the City Council at the December 19, 2006 meeting, the Council agreed with the staff and consultant team recommendation to stop further development of short-term alternatives and focus only on long-term replacement options.

Long-Term Pumping Alternatives

- Much of the OLIS could be replaced by an around-the-lake pumped alternative that includes two large pump stations, 4 small-to-medium-sized pump stations, and 37,000 feet of new force mains and gravity sewers (includes 7,000 feet in the west end of the lake and in the Main Canal). Dual force mains are required in several locations to handle the range of flows and to maintain velocities within an acceptable range.
- The net present value of the around-the-lake alternative is estimated at $121 million. This includes costs for construction, O&M, future replacements, escalation to the mid-point of construction at 10 percent per year, a 30 percent contingency, and a 25 percent allowance for engineering, construction management, easements, and administration. Future costs are discounted at 3 percent per year.
- The around-the-lake pumping option still requires significant in-water buried gravity sewer replacement at the west end of the lake, specifically in the Main Canal and from OLIS Manhole (MH) 12 to MH 9 to the West End Pump Station (PS) site. This work requires lake drawdown of 16 feet to enable the excavation and installation to be done by conventional means.
Siting of the West End PS has not been resolved. Siting of the other five stations would be as follows: two in residential driveways; two in waterfront recreational easements; and one on City-owned vacant property.

This system could be designed and permitted by summer 2009 to allow construction to start by October 1, 2009, as required by the City’s Mutual Agreement and Order (MAO) with the Oregon Department of Environmental Quality (DEQ).

In-lake pumping has several challenges that are difficult to overcome. At this preliminary stage, in-lake pumping is judged as not able to meet the project feasibility and reliability criteria.

Tab 3 – In-Lake Buoyant Gravity System

The Phase 1 Predesign Report concludes that an in-lake buoyant gravity sewer system is a viable alternative for replacing the main lake reach of the OLIS. The system evaluated in Phase 1 relies on a buoyancy pipe fastened by polyester webbing to an interceptor pipe—both made of tough high-density polyethylene (HDPE)—with the entire assembly anchored by flexible HDPE-impregnated wire rope installed through the deep lakebed sediments and grouted into the underlying bedrock.

The key to performance of the system is grade control to keep solids moving given the flat profile of the existing OLIS that also constrains the replacement system—7 feet of fall in 9,000 feet, an overall average of roughly 0.08 percent. Two factors affect the pipe grade: upward deflection of the pipe mid-span between anchors and thermal expansion/contraction of the HDPE over the typical 35-degree lake water temperature range at the installed depth that causes lateral and therefore downward deflection at anchor points.

The solution to upward deflection is to keep anchors closely spaced such that the pipe’s stiffness can make the span with very little deflection, less than ½-inch. The solution to the thermally induced lateral and downward deflection is to install the pipe on a sinuous alignment, essentially with built-in expansion loops. Fastening the pipe to each tether at a turnbuckle allows fine-tuning of the pipe grade.

A preliminary geometry was established in Phase 1 that addressed both of these issues to ensure that the pipe would stay on grade within tight tolerances. Brown and Caldwell, together with its subconsultant, Makai Ocean Engineering (Makai), evaluated the system requirements and determined with a high degree of confidence that the system would perform as intended and that there were no insurmountable installation challenges.

Despite the fact that all of the elements of the proposed system have a well-established track record in more demanding environments, there are no known existing buoyant sewer pipelines to serve as examples to assure decision-makers that the proposed OLIS system, the City’s largest-ever infrastructure project, will perform as expected. For this reason, the Phase 2 work includes a more detailed evaluation of the buoyant system and each of its components to provide a higher level of assurance to the public, City staff, and the City Council.

The Phase 2 investigation proceeded on several fronts, all previously part of Phase 1 but in greater detail:

- Discussions with five marine contractors to gauge interest in the project and identify any constructability concerns over pipe fusion, connection to tethers, and grade adjustment
- Finite element modeling of a majority of the proposed OLIS to determine stresses and movements
- Discussion with three rock anchor installers and Shannon & Wilson to understand the available technologies and their capabilities and challenges
- Examination of tether material and connection options

Outcomes of each of these activities are briefly explained below.
Marine Contractor Interest

Brown and Caldwell contacted marine contractors in Oregon and Washington that were thought to potentially have the capability to perform this work. Several companies contacted were not interested because they have other specialties and felt they could not be competitive. One was not interested because it could not access the lake with its large equipment and did not want to assemble modular barges.

However, meetings were held with five other interested firms to present the scope of the project. All expressed a high level of interest in pursuing the opportunity to construct it. Collectively, there were no concerns expressed with the concept of installing rock anchors and tethers and connecting a buoyant HDPE pipe to the tethers. The contractors could not, of course, speak to the issue of how closely final grade could be controlled other than confirming that divers and surveyors working together could adjust tether lengths with turnbuckles to achieve the target grade at each tether at the time of installation.

Finite Element Modeling

Makai undertook a more detailed modeling effort in Phase 2 primarily to refine grade control predictions made in Phase 1. Makai’s overall conclusions are:

- The pipeline can be practically and safely constructed to meet the project requirements
- The pipeline is very flexible and thus forgiving of construction errors, thermal expansion and contraction, installation handling, and earthquakes
- In the one dimension that is critical—vertical grade—it is tightly and reliably constrained by tethers; this grade can be easily measured and modified by adjusting tether length with turnbuckles in a single pass

Makai representatives made a presentation to City staff and three City Councilors at a workshop on the buoyant system on May 30, 2007. In addition to presenting the results of their modeling work, they showed photos of a variety of marine HDPE pipeline installations, including some buoyant, from around the world. These reference projects convincingly illustrate the demanding and dynamic ocean conditions in which these pipelines are installed and in which they have performed well for many years.

Rock Anchors

Several rock anchor installers either met with or had phone conferences with the consultant team to discuss the issues surrounding this technology. They described the approach that would be used to advance a small-diameter steel drill string (casing pipe) through the sediment to bedrock without drilling, thereby eliminating the issue of handling sediment spoils. Other issues discussed included anchor/tether materials, construction sequence, installation tolerances, uplift capacities, pull-test procedures, production rates, and updated pricing. The results of these discussions confirmed that rock anchors are a highly reliable means of anchoring the pipe to bedrock. At the May 30, 2007 buoyant system workshop, Shannon & Wilson made a presentation on rock anchors that strongly supports this conclusion.

Tethers and Connections

Brown and Caldwell simultaneously investigated in further detail how best to make connections of the tether to the pipe and to the rock anchors. Discussions and meetings were held with wire rope manufacturers and riggers to refine materials and sizing and to confirm that the desired connections could be reliably made.

Further discussions were also held with Corrosion Probe in which Type 316 stainless steel was identified as the preferred material for steel submerged in the lake. Corrosion Probe determined there is no risk of corrosion of this material in Oswego Lake due to the relatively low chloride levels and favorable temperature.
As a result of these discussions, several preliminary design improvements over the initial selections made in Phase 1 resulted:

- Stainless steel brackets will be used instead of polyester webbing to fasten the buoyancy pipe to the interceptor and the interceptor to the tether; this eliminates the need for future replacement of the webbing which had been estimated to be needed every 25 years
- "Multiple corrosion protected" steel bars will be used instead of wire rope from bedrock through the sediment
- Stainless steel wire rope will be used in lieu of HDPE impregnated galvanized wire rope to eliminate corrosion potential and to reduce costs of materials and rigging
- Hardware connection details to transition from the steel bars to the tethers and to the pipe brackets were refined

The results of these refinements are depicted in Figure 3, which show a revised proposal for the buoyant system.

![Buoyant Interceptor System](image)

**Figure 3. Buoyant interceptor system**

**Buoyant Pipe Issues to Resolve in Final Design**

Though the buoyant pipe concept has been refined, improved, and further proven to be a viable replacement option that meets the City’s project objectives of feasibility and reliability, there are a number of issues to be resolved in final design. These include:

- Finalizing buoyancy pipe location relative to the interceptor to avoid raising the profile of the system such that less clearance below the water surface is provided than by the existing OLIS (i.e., though the buoyancy pipe is shown on top, it could be relocated to beneath the interceptor)
Executive Summary

- Determining whether to induce the sinuous pattern via mitered pipe joints (as shown in Figure 3) or by bending straight pipe into place and holding it there with an inter-nodal cable (as described in Makai’s Phase 1 report)
- Optimizing wavelength and amplitude to achieve desired grade control while easing installation
- Determining whether the buoyancy pipe should be filled with air or foam
- Optimizing the bracket design for economy, longevity, and ease of assembly/disassembly
- Confirming the pipe sizing with updated flow projections as recommended in Technical Memorandum No. 4 – Modeled Flow Projections
- Deciding whether and when to pre-purchase stainless steel components to reduce risk of further price escalation
- Finalizing diameters of anchor bars and tethers as a function of length to ensure potential for differential elongation between adjacent anchor locations is minimized
- Developing a reliable design for submerged manholes
- Developing connection details to rigid manhole structures from tributary trunk lines as well to new pile-supported segments at either end of the main lake
- Obtaining approval for site(s) for pipe delivery, staging, assembly, and storage
- Determining whether a stiffening truss or catenary cable should be used to increase spans between rock anchors

Tab 4 – Modeled Flow Projections

A city-wide sanitary sewer flow monitoring and modeling effort was undertaken in January 2007 as part of the Phase 2 Predesign for the OLIS Upgrade Project.

Identification of capacity-deficient pipe segments and sizing of replacement lines were done previously by Crawford Engineering Associates (CEA) as part of modeling work for another consulting team to help prepare the report entitled, Overflow Mitigation (Tetra-Tech/KCM, Inc., October 2000). These results were the basis for the improvements identified in the OLIS Phase 1 Predesign Report. Also, CEA has done modeling work for many years while directly contracted with the City. CEA was added to the Brown and Caldwell team for the Phase 2 Predesign in 2006 so its prior work could be reviewed, updated, and confirmed to ensure proper extents and sizing of the proposed replacement alternatives were identified, both for in-lake gravity as well as for around-the-lake pumping.

In December 2006, as part of that review, the City and consultant team determined that a more intensive and updated flow monitoring effort was required. The previous monitoring, completed in 1996-1997, while adequate for conceptual planning, was not sufficiently detailed for design, particularly for many of the six proposed pumping stations in the around-the-lake alternative for which there were no nearby monitoring sites. Further, more monitors to cover the system would increase confidence in predictions of design-event flows from the City arriving at the City of Portland’s Tryon Creek Wastewater Treatment Plant (TCWTP) so that plant capacity and city-wide I/I reduction goals could be aligned.

Because Brown and Caldwell has the professional responsibility that goes with being the designer of the OLIS upgrade, and as a further reliability check on prior work, Brown and Caldwell used its own proprietary approach to calibrate the sewer system’s I/I response to rainfall. These flows were then input to the hydraulic model prepared by CEA to evaluate system capacity needs under various scenarios.
The following conclusions and recommendations are drawn from this work:

1. Buildout conditions are projected to occur in the year 2045 and include a 21 percent increase in the City’s overall sewer service area to nearly 4,500 acres, and a 50 percent overall service area population increase to 58,500. These totals do not include the Stafford Urban Reserve which is projected to have a buildout population of nearly 7,000 and will require a separate trunk line to the TCWTP. Final sizing of the proposed replacement Foothills Road segment of the OLIS should consider incremental costs of providing future capacity for Stafford.

2. New service area is presumed to have 25-year recurrence, peak-hour I/I rates of 1,500 gallons per acre per day. This will require the City to employ best practices for sewer design, inspection, and maintenance.

3. Rainfall events during the 2007 monitoring period were very light (the highest rain total on any one calendar day was 0.69 inch). This means that flow/rainfall calibrations are uncertain and the following results, conclusions, and recommendations should be viewed as preliminary until follow-up monitoring with adequate rainfall can be performed. Meters should be re-deployed from October 2007 through March 2008, and the calibrations and capacity evaluations updated.

4. The current and future buildout, 5-year recurrence, peak-hour flows projected from the City at the TCWTP are 20 and 23 million gallons per day (mgd), respectively. The available TCWTP capacity for Oswego Lake is about 22 to 23 mgd. Current base flows average about 3.6 mgd so the overall city-wide peaking factor for the 5-year event relative to base flows is about 5.6. This degree of I/I is typical for sewer systems in western Oregon and Washington; some are better and some are worse.

5. With 10 percent I/I reduction in the Southwood and South Lake Basins and leaving all of the Southwood Basin to be served by Clean Water Services, the extents of the OLIS upgrades identified by CEA were confirmed (on a preliminary basis until 2007-2008 monitoring results are obtained). Upgrades are needed to the Blue Heron Trunk from South Shore Boulevard to the north, in the Main Canal Trunk from Bryant Road to OLIS MH 10, in the West End from OLIS MH 9 to MH 11, and in the Main Lake from OLIS MH 11 to MH 22. In addition, the Bryant Road diversion from Cardinal Drive to the Main Canal Trunk was confirmed. With no I/I reduction, upgrades must be extended south of South Shore Boulevard in Blue Heron Canal and through West Bay.

6. Several of the previously sized OLIS segment upgrades should be further upsized to pass the future buildout 25-year, peak-hour flow. The Blue Heron Trunk from MH 12 to MH 11 should be increased to 24-inch-diameter. The Main Canal Trunk from MH 10 to Bryant Road should be increased to 21-inch-diameter. The OLIS from MH 11 to new MH D should be increased to 36-inch-diameter. The connection from OLIS MH 14 to the new MH D should be increased to 24-inch-diameter.

7. Another measure needed to pass the future buildout, 25-year, peak-hour flow includes shifting 86 acres of future service area from the South Lake Basin to the Main Canal Basin via a new line flowing east on Childs Road.

8. Three small diameter upland segments in the South Shore and McVey Basins are in need of upsizing to pass the 25-year recurrence, peak-hour flow under current population and I/I conditions; a fourth segment in the McVey Basin must be upsized sometime between 2015 and 2025.

9. Results for the highest I/I rates in the city are summarized below. A program of TV inspection, condition assessment, smoke-testing, and ongoing metering and modeling should be implemented to reduce I/I.
a. Site #12, which monitored flow from the L3 Basin at Twin Points, had the highest I/I rate per inch-diameter-mile of upstream sewer, however it produced only 2 percent of the peak-hour I/I in the city-wide sewer system.

b. Site #18, which measured flow from the Downtown Basin at 3rd Street just upstream of OLIS Manhole No. 25, ranked second in I/I rate and contributed 8 percent of the I/I. Much of the work on an upstream sewer rehabilitation project in the First Addition Neighborhood had been completed by the time of the peak flows in late February to early March of 2007.

c. Site #2 measured flow from the Westridge area in the Blue Heron Basin, ranked third in I/I rate, and produced 4 percent of the I/I. This area is tributary to the capacity-limited west end of the OLIS, and should be a priority for further field investigation and rehabilitation.

d. Site #20 measured flow from the McVey Basin, ranked fourth in I/I rate, and produced 14 percent of the I/I in the system. In terms of potential for reducing flow at the TCWTP, this basin should be a priority for field investigation to determine if there are sources that can be cost-effectively eliminated. However, this basin does not contribute to the OLIS until just upstream of the TCWTP and is therefore not a conveyance capacity priority.

e. Site #15 measured flow from the South Shore Basin at Lost Dog Creek, ranked fifth in I/I rate, and produced 7 percent of the I/I in the system.

**Tab 5 – Environmental Permitting**

Anchor Environmental was retained in Phase 2 to provide an environmental review and evaluation of permitting requirements for the final alternatives under consideration. Anchor Environmental’s major conclusions are:

1. The City should begin the permitting process as soon as possible in summer of 2007 in anticipation of a possible construction start date of September 2008. This would allow time to address any issues that arise during the review of permit applications.

2. A variance from work windows for fish species in Oswego Lake (July 1 through October 15) and bald eagle nesting (August 16 through December 31) will be needed from the Oregon Department of Fish and Wildlife to accommodate the construction schedule. Consideration of the work window for the Willamette River, which is July 1 through October 31, may also be required.

3. Specific construction practices should be used to the extent practicable to minimize environmental impacts. Many of these practices will become part of the permit requirements and are listed below:

   - Maximize work “in the dry”
   - Perform low-impact pile installation
   - Use erosion control measures
   - Provide dredging control measures
   - Manage construction process water
   - Provide site restoration

4. Past copper sulfate applications to control aquatic plants represent the copper source with the highest potential to contaminate Oswego Lake sediments. Studies of similar lakes have shown that copper becomes tightly bound to sediments and organic matter and is generally not available at toxic levels to aquatic life. Other sources of contamination, including stormwater runoff and Tualatin
River inflows, are considered relatively low risk for sediment quality issues, although these sources need to be managed for water quality issues.

5. The proposed OLIS replacement project will leave the lake bed in a similar condition if the trenches for buried pipe are backfilled with excavated sediment. If backfilled with imported material, the lake bed will be left in a better condition. Either way, the net impact of the project on sediment quality in the lake is likely to be neutral at worst.

6. Monitoring of bacteria and temperature near the outlet of the lake during drawdown is recommended to identify and limit any potential water quality excursions related to Willamette River total maximum daily load limits.

**Tab 6 – Final Alternative Selection**

The City and DEQ executed an MAO in February 2007 requiring the City to upgrade the OLIS. The MAO prescribes a series of milestones that must be met in the course of the upgrade project. One of these is:

By no later than August 7, 2007, the Lake Oswego City Council will select either the In-Lake Option or the Around-the-Lake Option for the Lake Interceptor replacement project. The City will notify the Department of the City Council’s decision within three business days thereafter.

The result of the staff and consultant team evaluation process was a recommendation by the City Engineer to the City Council at their meeting on June 12, 2007 that they select the in-lake buoyant gravity system for final design and construction to complete the upgrade of the OLIS. As the final step in an ambitious public outreach effort, the City Council held a public hearing on July 10, 2007 prior to making its final determination. At the conclusion of public testimony overwhelmingly in favor of the in-lake buoyant system, the City Council voted unanimously to accept the City Engineer’s recommendation. The Lake Oswego Corporation (LOC) also expressed their preference for the in-lake buoyant system.

Table 1 presents a summary of the more detailed evaluation conducted by City staff and the consultant team and which formed the basis for the City Engineer’s recommendation and the City Council’s selection. The in-lake buoyant system is favored in five of the seven key differentiating criteria (capital, O&M, and future replacement costs counted as one). While the around-the-lake pumping option is favored in the consequence of failure and emergency response criteria, the significance of these is reduced by some of the strengths of the buoyant system that make failures and emergencies unlikely: robust materials, proven quality assurance and testing procedures during manufacture and assembly, and modular components which could be replaced with spares kept on hand.

Figure 4 summarizes the updated present worth cost estimates for the alternatives. The most notable differences are the $10 million higher capital cost for the pile-supported option and the $23 million differential in O&M and future replacements between the around-the-lake pumping and the buoyant HDPE options.

The alternative names are derived from how the main lake reach of the project would be addressed. Two clarifications related to these names are important: around-the-lake pumping includes in-lake gravity trunk and interceptor piping—both buried and pile-supported—in the west end of the lake and Main Canal; and in-lake buoyant likely includes new pile-supported pipe to be constructed at the west and east ends of the lake where shallow water could limit application of the buoyant system.
## TABLE 1. OSWEGO LAKE INTERCEPTOR SEWER–ALTERNATIVES EVALUATION MATRIX

<table>
<thead>
<tr>
<th>OBJECTIVE</th>
<th>FEASIBILITY – CAN WE BUILD IT?</th>
<th>RELIABILITY– WILL IT WORK?</th>
<th>Longevity–Will it last?</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL CATEGORY</td>
<td>Cost–Can we pay for it?</td>
<td>Technical–Can it be done?</td>
<td>Public Acceptance– Preference of stakeholders and public?</td>
</tr>
<tr>
<td>CRITERIA</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>In-Lake Buoyant</td>
<td>✓ $69M</td>
<td>✓ $4M</td>
<td>+ $0</td>
</tr>
<tr>
<td>In-Lake Piles</td>
<td>- $78M</td>
<td>✓ $4M</td>
<td>✓ $11M</td>
</tr>
<tr>
<td>Around-Lake Pumping</td>
<td>✓ $65M</td>
<td>- $8M</td>
<td>- $20M</td>
</tr>
</tbody>
</table>

**Legend**

- **Strength** - High importance differentiator between alternatives
- **Neutral** - Medium importance differentiator
- **Weakness** - Low importance differentiator

### Criteria No. Criteria Description
1. Capital cost in 2006 dollars, includes 30 percent contingency and 25 percent for engineering, construction management, easements, and admin. Does NOT include escalation.
2. 75-year present worth of ongoing routine O&M including labor, materials, and energy costs.
3. 75-year present worth for future replacement cost of components that don't last 75 years.
4. Risk of cost increases for items such as construction claims for differing site conditions or variable discount rate for future O&M and replacement.
5. Availability of required methods and materials to construct each alternative to established tolerances.
6. Adequacy of construction access points to work site(s) and staging areas for contractor to stockpile materials and store equipment.
7. Necessity for using highly qualified contractor and subcontractors; interest level of likely contenders
8. Ability to site facilities and obtain easements from multiple parties.
9. Impacts to traffic, business, local access, and other disruption including noise and dust from construction activities.
10. Impacts, primarily noise and odor, from ongoing operation and maintenance activities.
11. Drawdown depth and duration to construct work at west end of lake.
12. Quantity of underwater excavation required to construct work at east end of lake or Springbrook Creek may impact permit schedule.
13. Likelihood of sediment testing requirement by regulators.
15. Risk of catastrophic failure of some critical component of system. Examples: for around-the-lake, break in a force main or a mechanical/electrical pumping system malfunction; for in-lake, break in pipeline or support.
16. Consequence of a system failure. Examples: for around-the-lake, overflows to lake or private property until crew responds and completes repairs; for in-lake, more difficult repairs = longer overflow to lake and lake partially drains to TCWTP; ongoing cleaning of buoyant system if dam fails.
17. Accessibility of system components for routine maintenance to detect and prevent impending problems; also, accessibility for major replacements and emergency maintenance activities.
18. Requirement to use outside contractor for maintenance activities.
19. Ability to quickly implement emergency response measures to address a system failure and minimize consequences. Designing system with replaceable components and extras on-hand is recommended.
20. Long-term corrosion resistance of system.
21. Ability of overall system to survive design-level seismic forces.
22. Potential for system components to wear out or become obsolete (e.g., spare parts not available).
Figure 4. Alternatives present worth cost comparison

Note: Capital Cost includes construction cost, 30% contingency, and 25% for engineering, construction, management, easements and administration.
Recommended Improvements

Table 2 is a reach-by-reach summary of the recommended improvements for the OLIS replacement project.

<table>
<thead>
<tr>
<th>MH nos.</th>
<th>Reach description</th>
<th>Recommended improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>56 to 10</td>
<td>Main Canal Trunk</td>
<td>Replace by direct burial on existing alignment the existing 12-inch pipe (and laterals and manholes) with 21-inch pipe. If lake drawdown is not permitted, existing pipe would remain in service, a new pump station at Bryant Road and a force main to connect with the interceptor at MH 10 are required, along with rehabilitation of the existing line and installation of rock anchors to prevent manholes overturning in a seismic event.</td>
</tr>
<tr>
<td>1 to 9</td>
<td>West Bay</td>
<td>Continued O&amp;M. Clean pipe to remove debris, and anchor manholes to prevent overturning in a seismic event. Consider when to undertake rehabilitation.</td>
</tr>
<tr>
<td>9 to 11</td>
<td>West End</td>
<td>Replace existing 16-inch line with 24-inch pipe between MHs 9 and 10 and with 30-inch pipe between MHs 10 and 11; use pile supported system but consider how to make use of HDPE pipe. Renovate or replace existing MHs depending on lake drawdown. Lake drawdown would significantly simplify construction.</td>
</tr>
<tr>
<td>12 to 11</td>
<td>Blue Heron Canal</td>
<td>Replace existing 16-inch and 18-inch pipe by installing 24-inch pipe. Renovate or replace existing MHs depending on lake drawdown. Lake drawdown would significantly simplify construction.</td>
</tr>
<tr>
<td>11 to 22</td>
<td>Main Lake</td>
<td>Replace existing 24-inch to 36-inch pipe by installing 36-inch inside diameter buoyant HDPE pipe and MHs on a new alignment. Renovate existing MHs as required. Replace connections from existing MHs 14, 15, 18, and 21 with 8-inch up to 24-inch buoyant lines. Break down MHs to near lake bottom and plug incoming and exiting lines.</td>
</tr>
<tr>
<td>22 to 27</td>
<td>Lakewood Bay</td>
<td>Continued O&amp;M. Anchor MHs to prevent overturning in a seismic event. Consider when to undertake rehabilitation.</td>
</tr>
<tr>
<td>27 to 30</td>
<td>State Street</td>
<td>Continued O&amp;M.</td>
</tr>
<tr>
<td>30 to 36 and 35 to 42</td>
<td>Foothills Road</td>
<td>Replace deteriorated 24-inch and 36-inch buried pipe with new 36-inch pipe on parallel alignment in Foothills Road. This project begins roughly mid-way between MHs 29 and 30. Revisit sizing after 2007-2008 flow monitoring/modeling and consider whether to include future capacity for Stafford area.</td>
</tr>
<tr>
<td>36 to 40 and 42 to 46</td>
<td>Tryon Creek buried</td>
<td>Continued O&amp;M. Clean pipe to remove debris. Rehabilitate or replace MH 43 to repair corrosion damage.</td>
</tr>
<tr>
<td>40 to 48 and 46 to 48</td>
<td>Tryon Creek elevated</td>
<td>Retrofit pipe supports with structural bracing to meet seismic criteria.</td>
</tr>
</tbody>
</table>

Next Steps

The following are important early activities that should be aggressively pursued to afford the City the best opportunity to accelerate both the start and completion of the project to the extent possible:

- Conclude formal negotiations for easements, property, or rights of access
- Conclude formal negotiations with LOC regarding depth, duration, and timing of drawdown for west end work between MH 9 and MH 12 and in the Main Canal
- Develop and initiate the qualifications-based procurement process for the Construction Manager/General Contractor (CM/GC) to obtain benefits of early input to the design team
- Develop scope of services and level of effort for final design and obtain City Council authorization
- Commence early design phase activities related to finalizing project phasing and schedule so that regulatory permit applications can be prepared and submitted
- Work with LOC and selected CM/GC to finalize alignment for work between MH 9 and MH 12 so that geotechnical investigations can be made in fall 2007 in support of foundation design work
- Develop process to select revenue bonds or general obligation bonds for project financing
Phase 2 Predesign Team

The consultant team and services performed in Phase 2 are summarized in Table 3.

<table>
<thead>
<tr>
<th>Firm name</th>
<th>Service provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown and Caldwell</td>
<td>Lead consultant, project management, support of public outreach, evaluation of pumping options including detailed siting and cost estimating, design of elevated pipe repair near TCWTP, seismic/structural evaluation of existing OLIS, support of City's negotiations for easements and MAO, modeling to project design flows, and investigation of buoyant pipe system components</td>
</tr>
<tr>
<td>Shannon &amp; Wilson</td>
<td>Geotechnical evaluation of seismic risk to existing OLIS and input on likely conditions at pump station sites</td>
</tr>
<tr>
<td>Anchor Environmental</td>
<td>Environmental permitting analysis</td>
</tr>
<tr>
<td>Jeanne Lawson &amp; Associates</td>
<td>Public information and involvement</td>
</tr>
<tr>
<td>Makai Ocean Engineering</td>
<td>Finite element modeling to predict stresses and movement within the in-lake gravity buoyant pipe alternative</td>
</tr>
<tr>
<td>Dick Scheumann</td>
<td>Retired contractor to provide input on pumping alternatives, constructability issues, and cost estimates</td>
</tr>
<tr>
<td>Pipe Experts</td>
<td>Cleaning of west end trunks tributary to MH 11 and from MH 35 to the TCWTP</td>
</tr>
<tr>
<td>Corrosion Probe</td>
<td>Corrosion engineer to review lake water quality data and comment on longevity of various construction materials</td>
</tr>
</tbody>
</table>