CASE STUDY

An Affordable Wastewater Treatment Solution for Municipalities and Communities

GLIDE, OREGON

PROBLEM On-site septic tank and drainfield failures were common in the adjacent small communities of Glide and Idleyld Park, Oregon. Three different engineering firms attempted and failed to find an affordable solution. The health department enacted a moratorium on any further development in the area.

SOLUTION County employees studied numerous options, comparing both up-front and long-term costs of gravity sewers and pressure sewers, including both grinder and liquid-only (effluent) sewers (LOS). When the evaluations were done, the department of public works proposed an LOS system sized to serve the estimated future population of the area.

The Original Liquid-Only Sewer

In the late 1960's, on-site septic tank and drainfield failures were common in both Glide and Idleyld Park, neighboring unincorporated communities in Douglas County, Oregon. The county health department published a survey in 1969 reporting that 68% of the septic systems in Glide and 76% of those in Idleyld Park were malfunctioning.

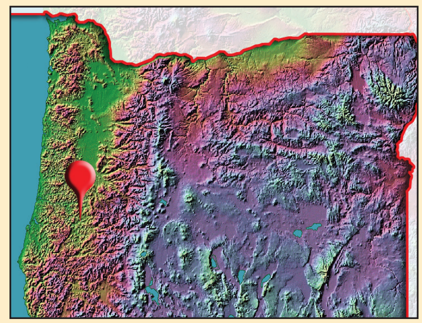
During that time (and continuing through 1972), three different engineering firms had attempted – and failed – to find an affordable solution. Meanwhile, sanitation problems continued, and sewage draining into roadside ditches became an increasingly frequent occurrence. This resulted in the health department enacting a 1973 moratorium on further development in the area. Subsequently, the Oregon Department of Environmental Quality (DEQ) imposed stringent regulations on new, on-site wastewater disposal systems.

Liquid-only sewers operate under pressure and are tested for watertightness, so they're typically free of infiltration, which translates to a lower hydraulic load at the treatment facility.

Municipal and Community Market

PROJECT OVERVIEW

GLIDE, OR



Design Parameters
- 420,000 gpd (1590 m^3/day) design flow for 2319 EDUs
- Design flows based on 60 gpcd (227 Lpcd) or 180 gpd (681 L/day) per EDU

Average Flows (2024)
- 115,900 gpd (438 m^3/day) summer flow
- 170,000 gpd (644 m^3/day) winter flow
- 46 gpcd (174 Lpcd) during dry weather

NPDES Permit Limits
- 10 mg/L each for cBOD$_5$ and TSS (summer)
- 30 mg/L each for BOD$_5$ and TSS (winter)
- <126 MPN/100mL E. coli

Influent Concentrations*
- 105 mg/L BOD$_5$
- 51 mg/L TSS

Effluent Quality*
- 6.6 mg/L BOD$_5$
- 6.5 mg/L TSS

Start-Up Date
- February 1980

Project Cost
- $3130.00 per EDU

Collection System
- Liquid-only sewer
- 20+ miles (32+ km) of mainline pipes
- Pipes of 3-12 inches (76-305 mm) in diameter

*Average of samples collected between 1980 and 2024.

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GLIDE, OREGON

With a liquid-only sewer, a 60-80% reduction of various constituents (BOD, TSS, fat, oil, and grease) occurs in each property's on-lot tank, reducing loads at the treatment stage and allowing for smaller treatment facilities.

These two actions had a major impact on landowners. Many were denied septic permits, and some even lost their existing permits. A number of properties were rendered virtually worthless because of the inability to build on them. As public concern grew about the need to solve the septic problems, members of the Glide-Idleyld Sanitary District requested help from the Douglas County Board of Commissioners in finding an affordable solution.

The commissioners agreed and assigned the county's engineering department the task of studying alternative sewer technologies, in the hope of finding one that was both effective and affordable. Staff studied numerous options, visited sites with innovative alternatives, and compared both up-front and long-term costs for a system of about 2,300 equivalent dwelling units (EDUs). They researched conventional gravity sewers and pressure sewers, including both grinder and LOS.

All three previous, private engineering studies had concluded that gravity sewers would be too expensive for this community. The county's review of those studies agreed. And the research into alternative sewers showed that installation costs for effluent (liquid-only) sewer in the Glide area would be less than half that of gravity sewer.

Twenty-year operation and maintenance (O&M) life-cycle costs were also estimated, although definitive O&M costs for a liquid-only sewer were unknown at that time, so many assumptions had to be made in the process. These estimates showed that a pressure sewer would be more expensive to maintain. Nevertheless, when combining the life-cycle figures for both initial construction and for O&M, the typical gravity sewer still cost about twice as much as the pressure sewer: $4,665,500 vs. $2,384,400.[1]

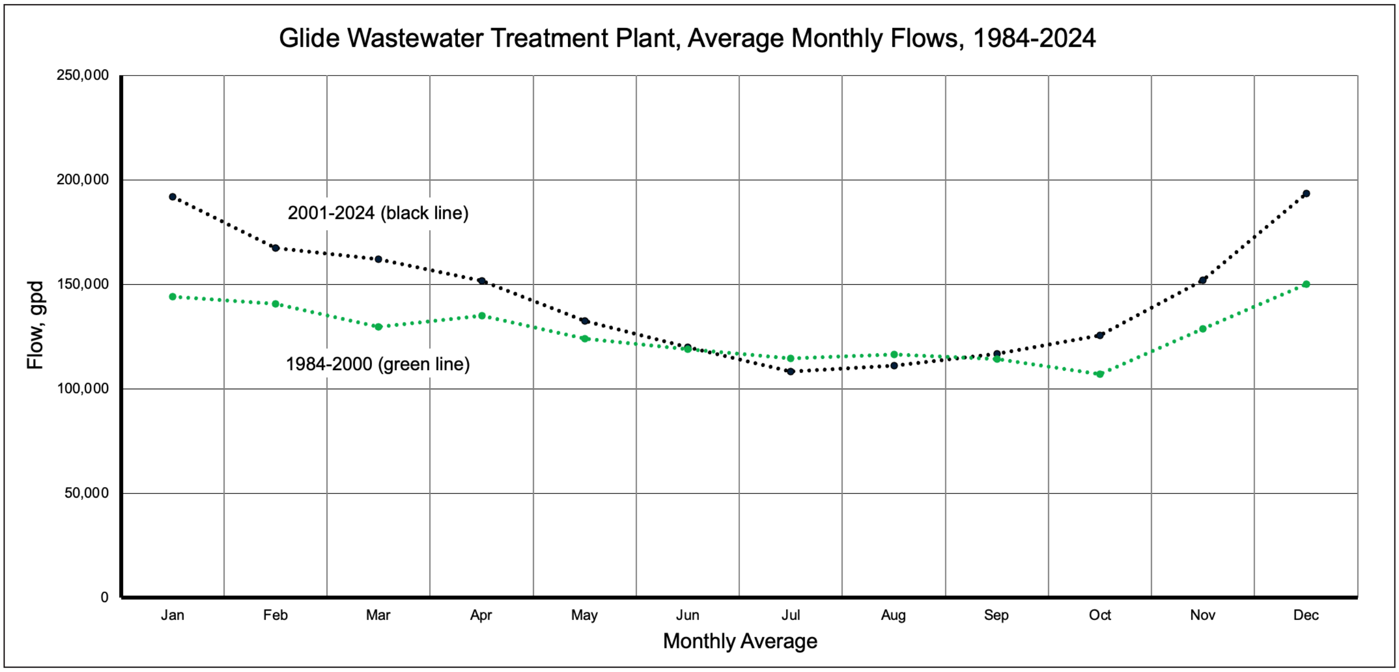
When the evaluations were done, the county Department of Public Works proposed a 2,319-unit LOS to serve an estimated future population of 7000. The initial cost of the system would be $2,341,000 for 748 EDUs,[2] or $3130.00 per EDU (roughly $18,500 per EDU in 2024 dollars).

The system would be the largest of its kind in North America, and this "small-pipe" sewer would cost only half as much as a "big-pipe" gravity sewer. More importantly, it would set a standard for innovative system design by demonstrating that small communities have more wastewater options than conventional wisdom dictated.

LOS Saves on Collection Costs

Glide is spread over an 11-mile (17.7-km) stretch of often hilly, rocky terrain with multiple river crossings. The collection system eventually included more than 20 miles (32.3 km) of mainline piping. Consequently, the choice of an LOS proved to be the major factor in controlling project costs. Liquid-only sewers do not convey solids, so they allow the use of inexpensive small-diameter pipes that follow the contour of the land, at a fraction of the cost of gravity sewer pipes, which must be buried to grade.

And because an LOS operates under low pressure and is tested to ensure watertightness from the on-lot tank to the treatment facility, it's typically free of infiltration (although inflow can sometimes occur through septic tank lids, gutters, downspouts, or leaky building connections).



These are the average monthly flows handled by the Glide plant, divided into two time spans: 1984-2000 and 2001-2024. The winter flows averaged 170,000 gpd (643,520 L/day), while the average summer flow was 115,900 gpd (438,729 L/day). Based on dry-weather flows, the per capita flow rate averaged 46 gpcd (174 Lpcd).

Also, LOS normally requires neither manholes nor lift stations. If a gravity sewer had been installed at Glide, multiple expensive lift stations would have been necessary, along with the typical high operation and maintenance costs associated with them.

In an LOS, the collection system includes a watertight tank with a pumping system and a service line. Property owners purchase a complete installation package directly from the Glide-Idleyld Sanitary District and can include the cost of this package in their mortgage financing, reducing their upfront costs. By 1980, 468 on-lot tanks were in service. To control potential inflow and infiltration (I&I) from the tank, only new, watertight “interceptor” tanks were installed. Today, there are over 900 tanks in the system, both commercial and residential.

LOS Saves on Treatment Costs

One of the key features of LOS collection systems that should be emphasized more frequently is the significant role they play in wastewater treatment. The on-lot treatment associated with an LOS is not only passive and low cost but also begins at the very location where the waste originates.

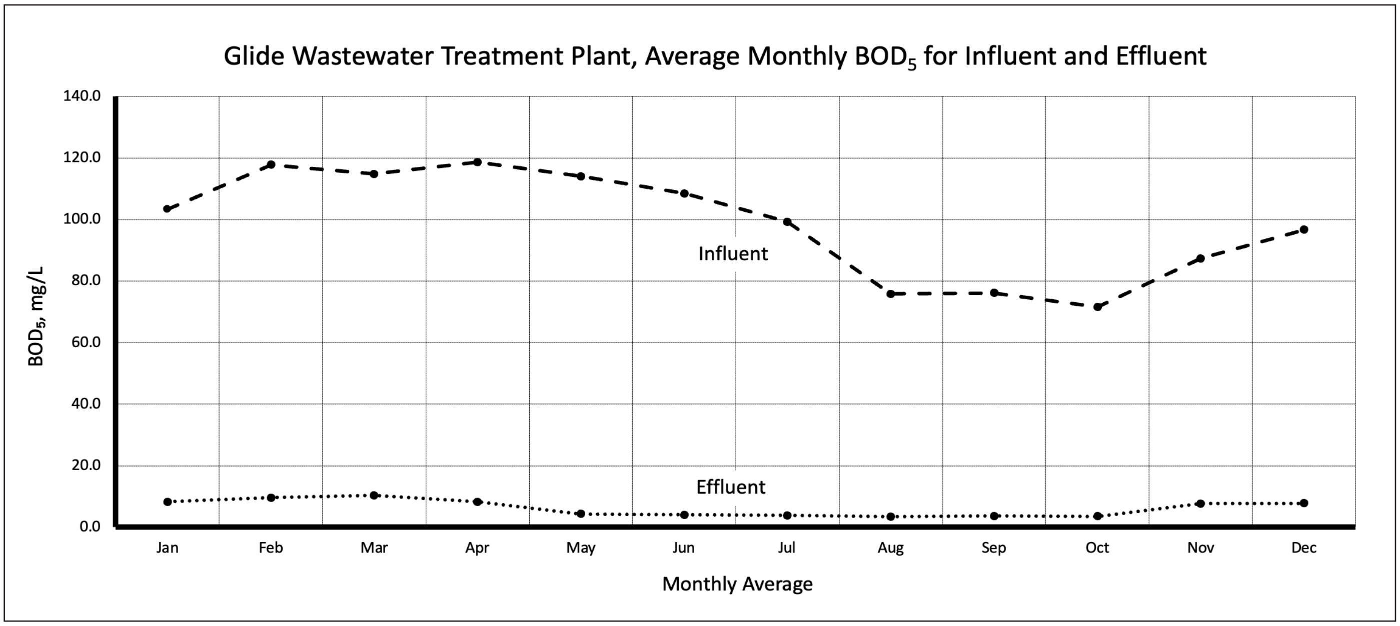
In the Glide liquid-only sewer, the individual on-lot interceptor tanks provide 1000 gallons of primary treatment capacity. They also provide the majority of total treatment, including the removal of 65% or more of biochemical oxygen demand (BOD_5), 70% or more of total suspended solids (TSS), and typically 85% or more of grease and oils.[3]

According to Steve Miles, a former operator at the Glide plant, “Many treatment plants connected to gravity sewer systems have been designed and built to handle three or four times their average flows, just so they can treat excessive wet weather flows caused by I&I. But because an LOS is a closed system, it’s not necessary to design a larger facility to handle excessive seasonal flows. This greatly reduces costs for construction and for operation and maintenance.”

Unfortunately, these reduced loading benefits weren't allowed to be considered when the Glide treatment plant was being planned. That's because effluent sewers were regarded as leading-edge technology with limited operational experience. Thus, the treatment plant design and its associated costs were based on larger loading conditions. The state DEQ, however, did allow the design layout for expansions based on data from actual hydraulic- and wastewater-loading characteristics and treatment experience.

If the decreased loading requirements of a liquid-only sewer (plus the system’s lower hydraulic load due to low I&I) had been understood at the time, Glide could have installed a low-cost, packed-bed filter treatment

GLIDE, OREGON



This chart illustrates the difference between average monthly BOD_5 for influent and effluent at the Glide wastewater treatment plant from 1980 to 2024. In the winter, influent BOD_5 averaged 111 mg/L, while effluent BOD_5 averaged just 8.7 mg/L. In the summer, influent BOD_5 averaged 100 mg/L, while effluent $cBOD_5$ went to 3.8 mg/L.

system. However, packed-bed filters were also considered experimental in the 1970s.

Consequently, Glide installed two oxidation ditches of 170,000 gallons (643.5 m³) each (for an increase in population that never occurred). As it turned out, the treatment plant was effective at processing the effluent sewer constituents using only one of the installed ditches, which led the state to omit the expansion requirement of a third ditch and clarifier. The two oxidation ditches are now about 45 years old.

The motor control center was updated after 34 years of service due to electrical components that were no longer available, and the rotary aeration brushes were replaced after 35 years. Besides those upgrades, Glide's treatment plant hasn't needed a significant overhaul, despite being more than 25 years beyond its theoretical design life.

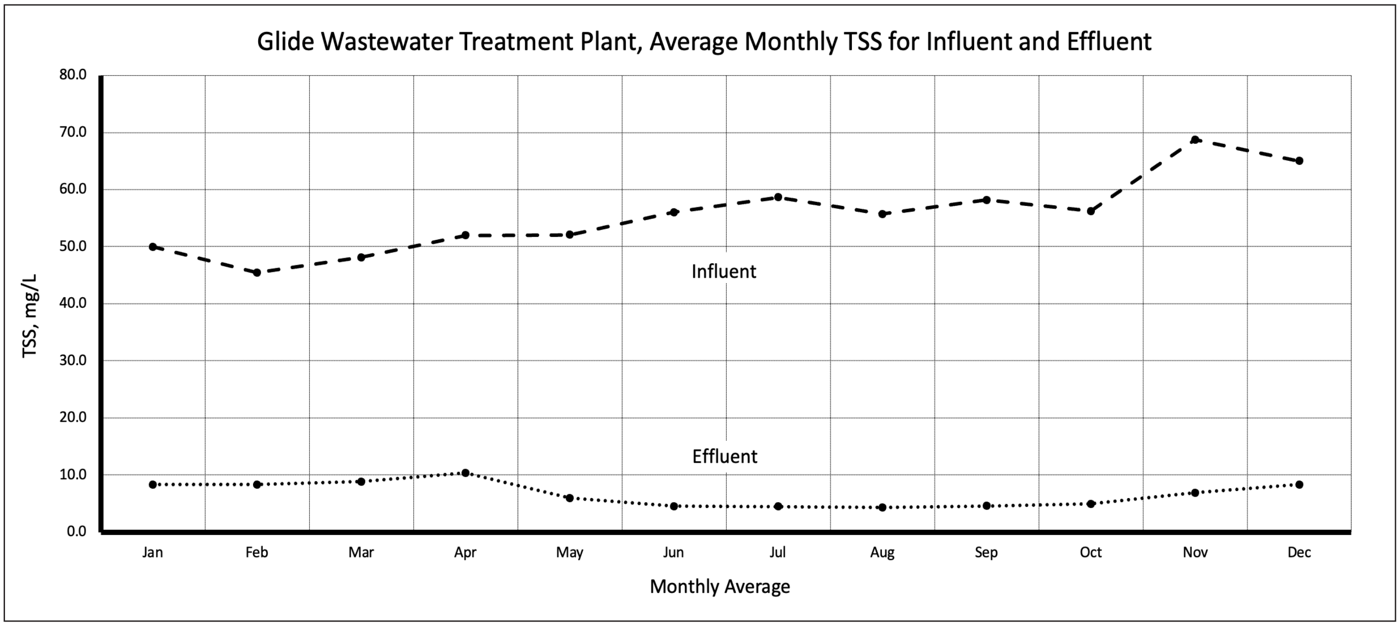
Today, liquid-only sewers are found in hundreds of small communities around the country and are no longer considered experimental. They're paired with a variety of treatment processes, including lagoons, activated sludge plants, membrane bioreactors, and so on. But they lend themselves especially well to packed-bed filters of all kinds, including sand, gravel, and textile. Packed-bed filters are also no longer considered experimental. Countless thousands have been installed all over the world and are widely known to produce outstanding effluent that meets the most stringent permit limits.

LOS Saves on O&M Costs

The Glide system shows that liquid-only sewers require less maintenance than initially expected. A 2009 facility plan[4] showed the collection lines hadn't required cleaning since their installation in the late 1970's. The report also stated that, during line break repairs, only a thin film was found around the pipe wall (see photo on page 6), thus establishing that mainlines of an LOS system don't require regular cleaning, nor do they require a minimum scouring velocity to avoid deposition of solids. Also, because of the low velocities and long hydraulic residence time in the 20 miles of mainlines, it appears that additional reductions in BOD, TSS, and volatile organic acids are occurring within the anaerobic conditions of the lines.

In Glide, once an on-lot package is installed, it becomes the property of the sanitary district, which then covers all O&M costs except for those associated with the building sewer line. From 1980-2011, service calls for the district averaged 19.7 annually per 100 EDUs, which would require only about one tenth the time of a full-time employee. And because the on-lot tanks maintain a lower liquid level than does a typical septic tank with a drainfield, they have a reserve space of at least 24 hours' worth of water usage, reducing overtime labor costs for emergencies.

Two full-time operators handle O&M in Glide for both the collection system and the treatment plant. Preventive maintenance like measuring sludge accumulation in tanks and cleaning filter screens is performed at all commercial



This chart illustrates the difference between average monthly TSS for influent and effluent at the Glide wastewater treatment plant from 1980 to 2024. In the winter, influent TSS averaged 49 mg/L, while effluent TSS averaged just 8.1 mg/L. In the summer, influent TSS averaged 52 mg/L, while effluent TSS dropped to 4.8 mg/L.

sites and sometimes at individual homes. When there's an alarm from a residential control panel, the operator will typically fix the problem and then remain on-site to perform preventive maintenance. Many communities smaller than Glide are able to maintain their liquid-only sewer systems using only part-time or on-call employees.

Septage from on-lot tanks is pumped as needed, with a typical pumping interval of 12-18 years. The district budgets for the cost of pumpouts, which are contracted to a local septic pumper. Because the Glide treatment plant has its own septage receiving station, there's no secondary charge from the pumper for the cost of dumping. At the receiving station, septage is screened to remove debris before being discharged into an aerobic digester or into one of the oxidation ditches.

LOS collection allows for passive primary digestion in the on-lot tanks. Passive digestion means less energy is needed at the plant to finish the treatment process. And lower energy needs translate to lower operational costs. According to Tchobanoglous, et al., "The cost for energy ranges between 15 and 40 percent of the total operation and maintenance costs for wastewater treatment, the second highest after labor costs."[5]

The aerobic digester stabilizes the waste-activated sludge, along with any diverted septage. Periodically, the sludge is dewatered and the liquid returned to the oxidation ditch. The sludge can then be applied to land as a liquid or air-dried in the drying bed. The Glide plant receives primary-treated effluent, so the usual amount of biosolids generated (just 15-20 cubic yards, or 11.5-15.3 cubic meters per year) is a fraction of what typically comes from an activated sludge plant receiving a normal waste stream. This reduced need for biosolids management, testing, and disposal saves money for the sanitary district.

Odor control measures aren't necessary at the Glide facility. Odors from wastewater are caused by the production of hydrogen sulfide gas, which is directly proportional to the waste strength received at the plant. Because the on-lot tanks in the Glide collection system reduce the organic strength of the waste stream, odors are minimal compared to other treatment systems and are easily managed by introducing the effluent into the plant below the normal liquid level.

LOS Saves on Life-Cycle Costs

While liquid-only sewers cost less to install, a common myth is that they cost more to maintain. This myth stems from a lack of information on O&M costs for LOS systems, as well as a tendency to underestimate O&M costs for gravity systems, such as sewer cleaning, flushing, and inspection; manhole inspection and rehabilitation; and maintenance and repair of pipelines, pumps, and lift stations, including odor and grease control at lift stations.

In a 2013 study of Lacey, Washington (a town with about 3,000 liquid-only sewer connections and 12,000 gravity sewer connections), O&M costs for both types of connections were methodically compared for more than a decade. At the beginning of that time, the monthly cost per connection was higher for LOS than for gravity, but as the years went by and the community standardized its LOS servicing protocols, the two cost curves converged until they were pennies apart.

The study concluded that "a well-managed program for [LOS] O&M has annualized costs that run closely in line with typical annualized costs for gravity sewer O&M."[6] When the much higher, up-front capital costs of gravity sewer are factored in, LOS becomes an even more attractive option from an economic standpoint, as has been the case in Glide.

Equally as important, costs for new LOS connections only occur when a property is being developed. Unlike with gravity sewer, current ratepayers aren't burdened with the expense of installing costly infrastructure for growth that, in many cases – and indeed, in Glide's case – never happens. Liquid-only sewers not only have lower life-cycle costs, but they're also more affordable for local residents.

LOS Withstands the Test of Time

"I'm thrilled with the way things have been running," said Don Kidd, president of the Board of Directors for the Glide-Idleyld Sanitary District, adding that his was one of the original homes whose drainfield was underwater so many years ago. "We've worked hard to provide good value to our customers, and I believe our monthly sewer fees are some of the lowest in the state."

When a utility truck accidentally cracked this 35-year-old pipe from the Glide LOS, workers noticed how little buildup was on the inside. LOS systems don't transport solids, so minimum scouring velocities aren't required.

Over the past three decades, Glide has adopted Orenco's advancements in LOS technologies. About 25 years beyond its original design life, the Glide system continues to perform above standards, running smoothly and economically. The plant demonstrates the ease with which septic tank effluent can be treated, thus showcasing the large-scale applicability of liquid-only sewers.

From minimized installation costs to low operational and treatment costs, including drastically reduced biosolids disposal expenses, LOS has proven itself to be the ideal choice for hundreds of small communities around the world.

1. Sewerage Study for the Glide-Idleyld Park Area, Douglas County, Oregon (Douglas County Department of Public Works: December, 1975).
2. Sewerage Study, pp. 111-112.
3. Ron Crites and George Tchobanoglous, Small and Decentralized Wastewater Management Systems, (McGraw Hill: 1998), p. 183.
4. Wastewater Collection and Treatment Facility Plan, Glide, Oregon, (Orenco Systems: December 9, 2009), p. 3-3.
5. George H. Tchobanoglous et al., Wastewater Engineering: Treatment and Resource Recovery, International, 5th ed. (McGraw Hill, 2014), Vol. II, p. 1809.
6. Bill Cagle, Terry Cargil, and Roger Dickinson, "20-Year Life Cycle Analysis of an Effluent Sewer (STEP) System, City of Lacey, Washington," November, 2013.

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Primary Treatment
- 900+ residential and commercial on-lot tanks

Secondary Treatment
- Two oxidation ditches of 170,000 gallons (643.5 m³) each (with only one ditch currently in service)

Discharge
- Outfall to the North Umpqua River

Operation and Maintenance
- Orenco Systems, Inc.

"A well-managed program for [LOS] O&M has annualized costs that run closely in line with typical annualized costs for gravity sewer O&M."

– 20-Year Life Cycle Analysis of an Effluent Sewer (STEP) System, City of Lacey, Washington

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All product and performance assertions are based on proper design, installation, operation, and maintenance according to Orenco's current published documentation.