SAN LUIS OBISPO COUNTY

LOS OSOS WASTEWATER PROJECT DEVELOPMENT

SECONDARY TREATMENT PROCESS EVALUATION

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TABLE OF CONTENTS

Page No.

LIST OF FIGURES

SECONDARY TREATMENT PROCESS EVALUATION

1.0 INTRODUCTION AND BACKGROUND

Two extended aeration process alternatives, Biolac® and oxidation ditch, were approved for secondary treatment in the Final Environmental Impact Report (EIR) and Coastal Development Permit (CDP) for the Los Osos Water Recycling Facility. The approval of these two processes was the result of an alternatives analysis in the Fine Screening Analysis (Carollo Engineers, 2007) and subsequent co-equal environmental review. While these alternatives are considered essentially equal in the environmental documents and CDP, it is necessary to update the engineering evaluation in order to streamline the preliminary design and planned design-build contracting process. The purpose of this memo is to identify the recommended extended aeration process, Biolac® or oxidation ditch, for predesign of the Los Osos Water Recycling Facility.

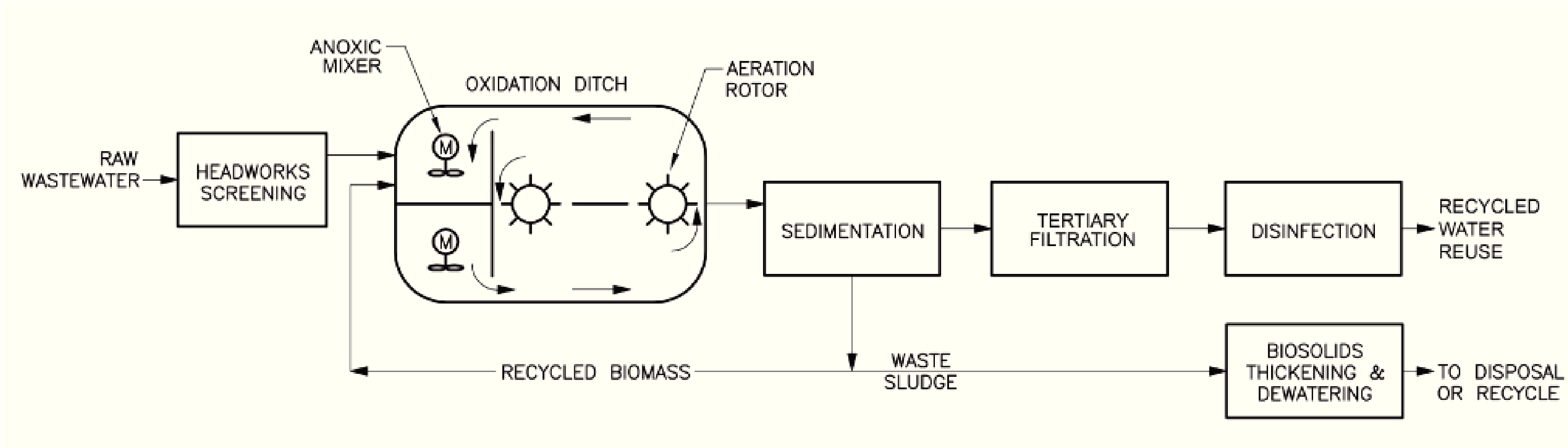
2.0 PROCESS DESCRIPTIONS

Both the Biolac® system and an oxidation ditch are extended aeration activate sludge treatment systems (ExAAS) that operate using a long solids retention time (SRT), through which excellent removal of wastewater constituents - five-day biological oxygen demand (BOD_5), total suspended solids (TSS) and total nitrogen (TN) - occurs. ExAAS can achieve 90 percent or greater removal efficiency of these constituents. Process descriptions are discussed in this section.

2.1 Oxidation Ditch

An oxidation ditch is a modified activated sludge biological treatment process that utilizes long solids retention times to remove biodegradable organics. Oxidation ditch treatment systems consist of a single or multichannel configuration within a ring or oval shaped concrete basin. Mechanical aeration devices (brush rotors or disc aerators), provide circulation, oxygen transfer, and aeration in the ditch. A flow schematic of an oxidation ditch is shown in Figure 1.

Biological nutrient removal is achieved in the oxidation ditch through a long solids retention time and creating a zone where the dissolved oxygen concentration is minimized, called an anoxic zone, where microorganisms that metabolize nitrogen compounds and denitrify the wastewater have a competitive advantage. Distinct anoxic zones are created within the oxidation ditch by using baffle walls.



OXIDATION DITCH SYSTEM FLOW SCHEMATIC

FIGURE 1

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Secondary clarifiers are used after the oxidation ditch to separate biological solids from the effluent stream. The biological solids are primarily returned to the oxidation ditch as return activated sludge (RAS). Periodically, as required to optimize process conditions, a portion of the biological solids are removed from the system as waste activated sludge (WAS) and sent to solids handling facilities. For water recycling facilities with tertiary treatment, as planned for the Los Osos Project, secondary effluent from the secondary clarifiers is then sent to a filtration process using cloth media or sand filters and then through a disinfection process with ultraviolet light. This process results in turbidity and coliform bacteria levels that meet State standards for unrestricted irrigation reuse.

Oxidation ditches are very common throughout the United States. Over 9,000 municipal oxidation ditch installations are in operation (WEF, 1998). Nitrification/denitrification to 7 mg/L total nitrogen reliably occurs when ditches are designed and operated for nitrogen removal.

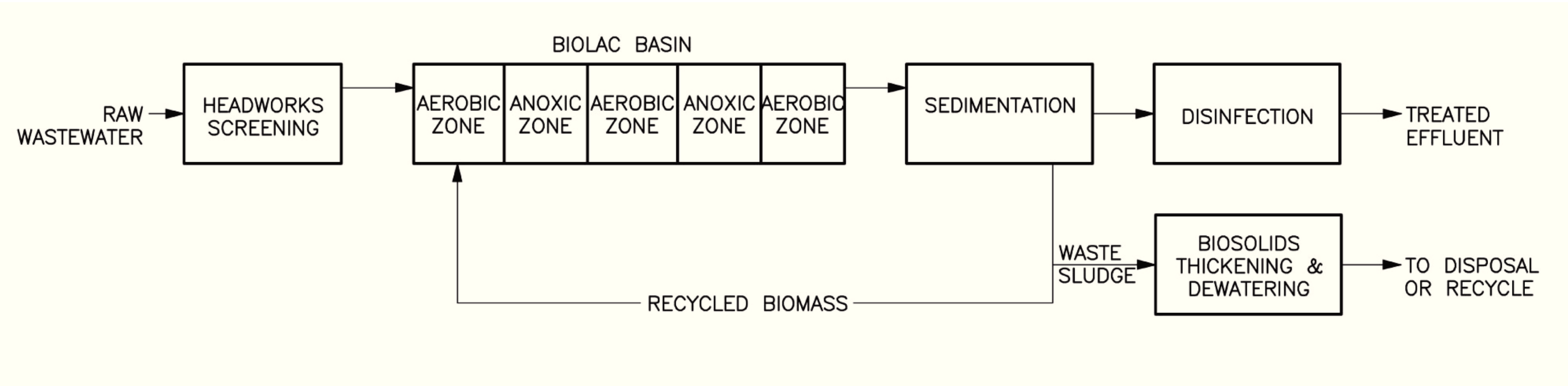
2.2 Biolac®

The Biolac® system is similar to an oxidation ditch with the primary difference being the tankage configuration and the air transfer. The Biolac® wastewater treatment system is a product of Parkson Corporation. Biolac® systems use a rectangular shaped earthen basin or multiple basins as capacity requires. A flow schematic of the Biolac® process is shown in Figure 2.

The Biolac® aerator system consists of floating and moving aeration headers that suspend submerged fine-bubble diffusers near the bottom of the basin. The system can provide air transfer and mixing at greater depths than can be achieved with traditional surface aerators. The aeration system uses blowers to create and deliver compressed air.

Biological nutrient removal occurs by balancing and timing the air distribution to the headers so that aerobic/anoxic zones are created. The motion of the floating air headers creates waves of oxic and anoxic zones within the basin allowing periodic selective growth of microorganisms throughout the basin. Previous Carollo studies have found that while some Biolac® systems are successfully operating to nitrify/denitrify, it is not reliable for denitrification due to the variable anoxic tank volume. It is uncertain whether the Biolac® system would consistently meet the low total nitrogen discharge limit required at Los Osos.

Similar to oxidation ditches, secondary clarifiers would be used after the Biolac® basin to separate biological solids from the effluent stream. Biological solids would be returned to the basin or diverted as waste to solids handling facilities.



BIOLAC® SYSTEM FLOW SCHEMATIC

FIGURE 2

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For water recycling facilities with tertiary treatment, as planned for the Los Osos Project, secondary effluent from the secondary clarifiers is then sent to a filtration process using cloth media or sand filters and then through a disinfection process with ultraviolet light. This process results in turbidity and coliform bacteria levels that meet State standards for unrestricted irrigation reuse.

3.0 CAPITAL COST COMPARISON

The Fine Screening Analysis reported planning level cost estimates for treatment plants using Biolac® or an oxidation ditch as the secondary treatment process. Cost ranges were first estimated based on similar projects and refined in accordance with Carollo's Unit Price Catalog.

These planning level estimates show a treatment plant with the Biolac® system provides a 15 percent capital cost savings over an oxidation ditch system. At the planning level of project cost estimating, the relative cost of these processes is not significant. The planning level accuracy is generally considered to be -30% to + 50%. Therefore, the capital costs of the two alternatives are considered essentially the same and are not a significant factor in the evaluation.

4.0 OPERATIONS AND MAINTENANCE CONSIDERATIONS

Operation and maintenance of the two options was considered based on energy use, labor, and equipment maintenance.

4.1 Energy Use

The Fine Screening Report presented the annual power usage for an oxidation ditch system as 900,000 kWh/yr and for a Biolac® system as 1,100,000 kWh/yr. The difference is primarily attributed to aeration system efficiency. Based on current energy rates of $0.12 per kWh, this represents an annual cost difference of approximately $24,000.

4.2 Labor

The Fine Screening Report presented the annual labor for both oxidation ditch and Biolac® systems as 5,200 hrs or 2.5 FTE. This does not include periodic maintenance related to the Biolac® system aeration hose and diffuser replacement discussed below.

4.3 Maintenance

Oxidation ditches require relatively little maintenance compared to other secondary treatment processes. The mechanical units include the aerators, RAS pumps, and low horsepower mixers. As described above, two aerators would be used for each oxidation ditch. Assuming one mixer for each oxidation ditch and a RAS/WAS pump station with three pumps the total number of mechanical components for a two-unit oxidation ditch facility is nine.

The Biolac® system relies on a more complex aeration system. Two or three blowers are used to supply air to a series of air headers that support a bank of diffusers. Air is delivered to the diffusers through a hose that is clamped to the air header. Each air header includes a butterfly valve with a motorized operator that must be automatically cycled to open and close to achieve the aerobic/anoxic zones. The Biolac® system would also include a RAS/WAS pump station with three pumps. Based on other Biolac® systems, the Biolac® System for Los Osos would likely use on the order of 24 headers and hundreds of diffusers. The total number of mechanical components for a two-basin Biolac® System would be approximately 30 including all the valve operators, pumps, and blowers.

Periodic maintenance of the Biolac® system includes reclamping aeration feeder hoses that have slipped loose from the header. This requires an operator to use a small boat to reach the header connection point and to make the repair while working from the boat in the middle of the basin filled with wastewater. Initial and ongoing optimization of the aeration system would require manual manipulation of the numerous header valves. Every five to seven years, diffusers should be replaced.

Analysis of the Biolac® system versus oxidation ditch for other treatment plants has found that when capital costs are similar, alternative selection favors the oxidation ditch due to the increased maintenance requirements of the Biolac® system. In 2002, a project to upgrade the secondary treatment process for the City of Petaluma, Lakeville Highway Water Recycling Facility, was initially designed for a Biolac® system in an existing pond. Carollo Engineers participated in a detailed review of this project at the 50% design level as part of a value engineering process. The City of Petaluma implemented the value engineering recommendation to construct an oxidation ditch, in lieu of Biolac®. The following considerations were important to the decision:

- A higher degree of process control for nitrification/denitrification.
- Less equipment to maintain with no blowers.
- The ability to dewater/degrit the basin.

Similarly, a facility planning evaluation by Carollo Engineers (Carollo, 2009) for the City of Taft Wastewater Treatment Plant expansion estimated slightly lower capital costs for a Biolac® system versus an oxidation ditch but recommended conversion of existing aerated ponds to an oxidation ditch due to ease of operation and operator familiarity with an oxidation ditch.

5.0 QUALITATIVE EVALUATION CONSIDERATIONS

5.1 Experience/Similar Installations

Oxidation ditches are very common throughout the United States. Over 9,000 municipal oxidation ditch installations are in operation (WEF,1998).

Biolac® systems are used throughout the United States at both municipal and industrial treatment facilities. Over 500 installations are currently in operation (Parkson, 2009).

5.2 Process Footprint

Planning level treatment plant site layouts were presented in the Fine Screening Analysis.

The earthen basins of the Biolac® system require sloped walls for soil stabilization which results in a larger basin surface area than an oxidation ditch with concrete vertical walls. The area needed for a Biolac® system is approximately 10 acres and the area needed for an oxidation ditch is approximately 8 acres. The area required for the oxidation ditch could be further reduced to 6 acres by using a common wall between the two oxidation ditches.

The flexibility to reduce the footprint by up to 4 acres may be crucial to completing a cost effective design on a moderately sloped site that will also include tertiary processes and 50 AF of recycled water storage.

5.3 Competitive Bidding

For publicly funded projects in particular, it is preferable to allow the marketplace to create competitive pricing from several qualified vendors. This principle applies to both traditional low bid contracting and design-build contracting. Since a Biolac® system is provided by one vendor, there is no opportunity for competitive pricing. An oxidation ditch, however, requires common equipment that can be provided by several equipment manufacturers in a competitive procurement process.

5.4 Denitrification

The Waste Discharge Requirements include a monthly average total nitrogen limit of 7 mg/L. In order to meet this stringent limit, operation of the secondary treatment process must be highly controllable and consistent. There is concern whether the Biolac® system can reliably meet this limit. Greater process control and industry experience with the operation and performance of an oxidation ditch system allows for a higher level of confidence in consistently meeting the total nitrogen limit.

6.0 SUMMARY OF FACTORS AND RECOMMENDED ALTERNATIVE

The Biolac® and oxidation ditch secondary treatment evaluation considerations discussed in this technical memorandum are summarized below:

- Capital Costs: The capital cost of the Biolac® system is estimated to be slightly less than an oxidation ditch system. However, there is a significant range of uncertainty for planning level cost estimates and the two alternatives are considered essentially equal.

- Energy/Labor/Maintenance: Energy use is slightly lower for an oxidation ditch system. Labor is estimated to be the same for both systems. Maintenance costs are expected to be greater for a Biolac® system and require more challenging activities to control denitrification and maintain the Biolac® aeration system.

- Experience/Similar Installations: Overall, there are many more existing oxidation ditch systems than Biolac® systems (9,000 vs 500). While there are several existing and planned Biolac® facilities near SLO County, these facilities have modified (or plan to modify) existing pond systems to a Biolac® system to reduce capital cost, which is not the case for Los Osos. Additionally, these facilities are not treating to meet a 7 mg/L monthly average total nitrogen limit. Oxidation ditch systems in the vicinity of SLO County include Pismo Beach, California Men's Colony in San Luis Obispo, Lompoc, and planned facilities at Morro Bay.

- Denitrifcation: The ability of the Biolac® system to denitrify to meet the stringent total nitrogen discharge requirement is uncertain. Greater process control and industry experience with the operation and performance of an oxidation ditch system allows for a higher level of confidence in meeting the total nitrogen limit.

- Footprint: An oxidation ditch system requires a smaller footprint than the Biolac® system which may become crucial to facility design on a site with irregular shape and slope.

- Competitive Bidding: Competitive bidding would be limited with a Biolac® system.

These considerations lead to the recommendation to plan for an oxidation ditch system for the Los Osos Water Recycling Facility.

7.0 REFERENCES

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3. Carollo Engineers, 2009, City of Taft Municipal Wastewater Treatment Plant Expansion Report.

4. Parkson Corporation, 2009. Biolac® Wastewater Treatment System Brochure (BIOL – BL020109).

5. Water Environment Federation, 1998, Design of Municipal Wastewater Treatment Plants, 4th edition, Manual of Practice No. 8: Vol 2, Water Environment Federation: Alexandria, Virginia.