SPEEDWAY WASTEWATER TREATMENT PLANT UNOX AND BIOSOLIDS UPGRADE

Summary

- The Speedway WWTP has entered into an agreed order (AO) due to repeated violations of ammonia discharge limits. The treatment facilities were evaluated after the AO was reached to determine what improvements were necessary to achieve full compliance with the NPDES Permit. Changes to the biosolids process by adding a Storage – Nitrification – Denitrification – Reactor (SNDR) process to reduce the internal plant recycle was determined to be the most cost effective solution to the ammonia violations. The evaluation also recommended significant upgrades to the biological process used to oxidize the organic load in the wastewater. This Business Case addresses project components which are considered to meet the requirements for the Green Project Reserve.

- Estimated Loan amount: $19,550,000 (all projects)

- **GPR Energy Efficiency based on final bid pricing is $4,342,648 ($3,971,120 for construction and $371,528 for design for this portion.)** The green portion represents 100 percent of the loan amount for this part of the total project.

Project Background

The Town of Speedway Wastewater Treatment UNOX and Biosolids Upgrades include two major changes to the plant. The projects are described below.

1. UNOX and PSA Upgrade

   The UNOX system is a high purity oxygen biological system utilized to oxidize the carbonaceous BOD in the wastewater. The oxygen is manufactured on site by a Pressure Swing Adsorption (PSA) system. It is supplemented with Liquid Oxygen (LOX) when the PSA system cannot manufacture enough oxygen or the PSA system is down for service. The oxygen is dissolved into the wastewater by surface mixers which also have submerged blades to keep the mixed liquor suspended.

   1.1. This project replaces the 125 Hp main air compressor in the PSA Building used to make oxygen which is 40 years old with a new 150 Hp compressor with a premium high efficiency motor.

   1.2. The eight constant speed mixers on the UNOX reactor tank (also 40 years old) are also being replaced with new more efficient mixers with premium high efficiency motors. The motors are the same size as the existing motors but four of them will have adjustable frequency drive (AFD).

   1.3. The control systems for the PSA oxygen generation and the UNOX system will also be replaced. The existing system is not functional.

1.4. The UNOX reactor tank will also be repaired to eliminate the gas leaks (the tank is supposed to be gas tight). This will reduce the amount of oxygen required for the biological process by reducing the waste.

2. Storage – Nitrification – Denitrification – Reactor (SNDR)

   The Biosolids process currently in use at the Speedway WWTP includes anaerobic digestion of the primary and waste activated sludge followed by dewatering on a belt filter press. The anaerobic digestion process generates a significant amount of ammonia. At times, the ammonia load on the plant has prevented the plant from meeting its NPDES discharge limits.

   2.1. This project adds the SNDR process to oxidize the ammonia to nitrogen gas. This conversion is accomplished by alternating between aerobic and anoxic conditions to allow the nitrifiers and denitrifiers to change the ammonia to nitrate/nitrite and then to nitrogen gas. The resulting sludge will have approximately 70 percent less ammonia when it is dewatered. This reduction is predicted to eliminate the ammonia exceedances except during the Indianapolis 500 race. On this day, the ammonia load at the plant is a direct result of the influent wastewater characteristics. The plant will utilize the equalization basin to store part of the high strength waste on race day.

   2.2. The project will reuse the existing digested sludge storage tank as the SNDR Reactor. It will continue to provide storage to allow optimum utilization of the belt filter presses.

   2.3. The project will add one 75 Hp jet mixing pump and one 75 Hp blower. Both of these will have high efficiency premium motors and AFDs.

   2.4. The process will be controlled by a SCADA system to minimize the time the blower must be in service and to adjust the jet mixing pump speed to compensate for the tank volume.

Energy Efficiency Discussion - UXOX and PSA

The PSA oxygen generation system can generate 4.1 tons of oxygen per day. Due to the type of compressor, leaks in the bioreactor, and the dysfunctional control system, the PSA system produces 4.1 tons of oxygen every day regardless of the oxygen demand. The current BOD load to the plant requires 4,300 lbs of oxygen per day. The system is generating 8,200 pounds of oxygen per day.

With the proposed improvements, the new compressor will load and unload to provide air to the PSA system in response to the oxygen demand in the biological process. This loading and unloading will reduce the amount of time the compressor is running. Based on the current annual average flow and loading, the compressor would be not running about 47.5 percent of the time.

The power consumption and costs for the compressor are shown in the following table:

Scenario	KWH/year	Power Cost 2010	Cumulative 20 year cost	Cumulative 40 year cost
Current System	816,542	$47,686	$1,376,354	$3,688,050
Proposed System	514,421	$30,042	$ 867,103	$2,323,475
Gross Savings	**302,120 kwh/yr**		**$ 509,250**	**$1,364,581**

The gross savings were estimated with a 2.5 percent inflation factor each year. The estimated power savings from automating the main air compressor is 37 percent. The AFDs on the mixers will also contribute to a reduction in the power utilized at the plant. Two 10 Hp motors and two 7.5 Hp motors will be operated with AFDs. The total energy savings is estimated to approach 40 percent.

Elements of the new facility intended to improve the efficiency and reduce electrical consumption include adjustable frequency drive (AFD) motors for the first and last stage mixers in the UNOX tank. The AFD motors reduce electrical demands by allowing mixers to be operated at variable rates to provide only the energy required to dissolve the oxygen into the wastewater at any point in time.

The Supervisory Control and Data Acquisition (SCADA) system to be installed for the UNOX and PSA systems will optimize equipment operation, allow modulation of, oxygen production, and mixing rates, allow remote monitoring of equipment and system conditions, and reduce staffing requirements. Implementation of the SCADA system will result in reduced energy consumption. The PLC and SCADA control of the PSA oxygen production and feedback from the instruments installed in the UNOX system are critical elements to reducing power consumption by these processes.

According to the PER prepared by Commonwealth Engineers, the estimated construction cost for the PSA and UNOX upgrades is $1,441,000. All of the proposed upgrades to the PSA and UNOX system are required to realize the projected power savings. The existing equipment experienced a useful life of 40 years and we expect the new equipment to have a similar life. Therefore the cost of the project is paid back by the projected energy savings during the useful life of the project.

The WWTP operations staff will be tracking the power utilized by the main air compressor and new mixers to document the savings. This process will start with monitoring the existing equipment prior to it being taken out of service. The other measure which will be tracked is the number of pounds of oxygen produced and the pounds of BOD reduced.

Environmentally Innovative Discussion - SNDR

The SNDR process is environmentally innovative since it minimizes the amount of residuals generated, significantly reduces the volume of biosolids to be disposed and reduces the amount of chemicals in the residuals. In addition to the reduction of ammonia in the filtrate from the biosolids process, the SNDR process further destroys solids during the biological process resulting in an estimated 10 percent loss of total solids generated. The resulting sludge is easier to dewater. A drier cake sludge can be achieved, typically 25 percent total solids, while using less polymer to process, typically 10 percent less. With the reduced solids generated, the drier cake sludge produced and less polymer required for processing, the volume of sludge to disposed is 35 percent less and the polymer usage is 19percent less. These benefits yield cost savings as shown in the following table.

Scenario	Current Process	Proposed Process	Estimated Savings
Polymer Utilized lb/yr	18,652	15,108	3,544
Polymer Cost: 20-yr Cumulative	$ 900,358	$ 722,408	$ 177,950
Tons of Biosolids to Dispose	3,986	2,583	1,403
Disposal Cost: 20-yr cumulative	$2,635,884	$1,568,053	$1,067,830
Projected 20-year cumulative savings			**$1,245,781**

The cumulative costs were estimated with a 2.5 percent inflation factor each year. Part of the cost savings is a reduction in the number of round trips from Kokomo to Speedway for land application of the biosolids. It is estimated that 2,020 gallons of fuel will not be used to transport the sludge each year. In the course of 20 years, this is a savings of 40,400 gallons of diesel fuel not consumed. The cost of the fuel is included in the calculations above.

In addition to the environmentally innovative characteristics of the SNDR process, there are energy savings incorporated into the design. Elements of the new facility intended to improve the efficiency and reduce electrical consumption include adjustable frequency drive (AFD) motors for the large pump and blower in the SNDR system and the smaller fan on the odor control system. The AFD motors reduce electrical demands by allowing pumps and blowers to be operated at variable rates to provide only the pumping and aeration capacity required at any point in time; also, the pumps and blowers can be operated in a more continuous mode to reduce the number of motor starts and stops thereby extending the life of the equipment.

The Supervisory Control and Data Acquisition (SCADA) system to be installed for the SNDR systems will optimize equipment operation, allow modulation of pumping rates and blower speed, allow remote monitoring of equipment and system conditions, and reduce staffing requirements. Implementation of the SCADA system will result in reduced energy consumption. The instrumentation proposed to be installed with the SNDR process will monitor conditions in the reactor and the SCADA system will change the operating points of the blower and mixing pump speed and blower speed and need (ie – it will be turned off when it isn't needed).

The estimated construction cost for the SNDR process in the PER is $775,500. Given this estimated cost, this project will reach a payback in 14 years.

Conclusion

The PSA/UNOX upgrade will result in significant energy savings. The estimated electrical power reduction in the PSA/UNOX system is nearly 40 percent less power utilized per year because the compressor can be turned down to produce only the oxygen required.

The SNDR process results in a less residuals produced, significant decrease in the quantity of biosolids to disposed, and a reduction in the polymer utilized. The SNDR process is considered to be environmentally innovative. In addition, the SNDR process will be energy efficient by the inclusion of AFD on new motors, use of the SCADA system to optimize the operation, and reduction in fuel costs associated with the disposal of biosolids.