Clean Water State Revolving Fund Green Project Reserve

- Interim -

City of Jerome FY15 WWTP Upgrade Project

SRF Loan #WW 1502 (pop. 11,189)

$22,200,000

Interim Green Project Reserve Justification

Categorical GPR Documentation

1. AERATION IMPROVEMENTS (Energy efficiency). Categorical per GPR 3.2-2: *"projects that achieve a 20% reduction in energy consumption; retrofits to compare existing system to that proposed…New POTW projects or capacity expansion projects should be designed to maximize energy efficiency and should select high efficiency premium motors and equipment where cost effective."* ($3,480,000).

2. INSTALL ANAEROBIC DIGESTION IN LIEU OF AEROBIC DIGESTION (Energy Efficiency). *Categorical per GPR 3.2-2: "projects that achieve a 20% reduction in energy consumption."* ($3,721,000).

3. INSTALL LED LIGHTING (Energy Efficiency)
Categorical GPR per Section 3.2-2: "*projects that achieve a 20% reduction in energy consumption."* ($102,500).

State of Idaho SRF Loan Program

February 2015

Categorical

1. AERATION IMPROVEMENTS

Summary

- Aeration improvements will include higher efficiency blowers and improved dissolved oxygen controls to optimize aeration.
- Total Loan amount = $22,200,000
- Estimated Categorical energy efficient (green) portion of loan =15.7% ($3,480,000)
- Annual Energy savings = 84%

Background[1]

- The City of Jerome Waste Water Treatment Plant (WWTP) currently services approximately 11,189[2] people and includes three large industrial connections as of 2015.
- Current treatment processes include screening, grit removal, trickling filter/solids contact, aeration basins, MBR filtration and ultraviolet disinfection.
- Phase II WWTP Improvements include an additional aeration basin, intermediate clarifiers, anaerobic digesters, a new solids handling building with gravity belt thickening and a new belt filter press, a blower building.

Energy Efficiency Improvements

(i) Fine Bubble Diffusers & Turbo Blowers

The GPR-eligibility of Fine Bubble Diffusers & High Speed Turbo Blowers is established by a comparison of energy efficiencies to a Baseline Standard Practice (BSP). The BSP in this instance is Coarse Bubble Diffusers and Positive Displacement Blowers.

- Fine bubble diffusers provide for a decreased actual oxygen requirement (AOR) to standard oxygen requirement (SOR) ratio of 0.33 compared to 0.50 for coarse bubble diffusers.[3]
- Fine bubble diffusers provide an oxygen transfer efficiency (OTE) of 2 percent per foot of submergence compared to 0.75 percent for coarse bubble diffusers. [4]
- High-speed turbo blowers operate with an increased wire to air efficiency of approximately 80 percent compared to multi-stage centrifugal blowers which operate with a wire to air efficiency of approximately 60 percent.[5]
- The dissolved oxygen control system allows for precise control of the air flow to match the diurnal D.O. demand which will substantially decrease the power demand of the new system.

---

[1] 2013 Facility Planning Study, City of Jerome, Keller Associates Inc. September 2013
[2] http://quickfacts.census.gov/qfd/states/16/1641320.html
[3] Sanitaire Diffused Aeration Design Guide.
[4] Sanitaire Diffused Aeration Design Guide.
[5] Comparison of blower curves for multi-stage centrifugal blowers to high-speed turbo blowers.

AERATION IMPROVEMENTS (CONT.)

POWER SAVINGS:

Table 1. Fine Bubble Diffusers and Turbo Blowers

Item	**Amount**	**Unit**	**Note**
Actual Oxygen Demand (AOR)	5,441	lb/day	Oxygen Req'd for New Aeration Basin
Elevation	3680	ft.	
Residual DO	2	mg/L	
Std. Oxygen Transfer Efficiency (SOTE)	2.12	%/ft	
AOR/SOR	0.231		
Standard Oxygen Required (SOR)	23,596	lb/day	
Req'd Airflow for Biological Treatment	2,906	SCFM	
Estimated Power	118	BHP	Assume 90% (0.9) efficiency
Estimated Daily Power Usage	2,120	kW-hrs/day	Assume 24 hours operation
Estimate Annual Power Usage	**773,827**	**kW-hrs/year**	

Table 2. Coarse Bubble Diffusers and Positive Displacement Blowers

Item	**Amount**	**Unit**	**Note**
Peak Oxygen Demand (AOR)	5,441	lb/day	Oxygen Req'd for New Aeration Basins
Blower Inlet Air Temperature	104	°F	
Residual DO	2	mg/L	
Std. Oxygen Transfer Efficiency (SOTE)	0.75	%/ft	
AOR/SOR	0.230		
Standard Oxygen Required (SOR)	23,610	lb/day	
Req'd Airflow for Biological Treatment	8,328	SCFM	
Estimated Power	539	BHP	Assume 60% (0.6) efficiency
Estimated Daily Power Usage	9,641	kW-hrs/day	Assume 24 hours operation
Estimated Annual Power Usage	**3,518,862**	**kW-hrs/year**	

∴ Total Estimated Annual Power Saved = 2,745,035 kW-hrs/year

(ii) Intermediate Clarifier vs. Additional Power without Clarifiers

- The GPR-eligibility of providing an intermediate clarifier is established by a comparison of energy efficiency to a Baseline Standard Practice (BSP). The BSP in this instance to provide additional energy to satisfy the increased oxygen demand in the aeration basins (7993 lbs. O2/day) that occurs in the absence of intermediate clarifiers.

POWER SAVINGS:

Table 3. Intermediate Clarifier Power Usage

Item	**Amount**	**Unit**
Clarifiers in Operation	2	--
Scum Skimmer	0.91	kW
Hours of Operation/ Day	24	hrs/day
Sludge Flow	127,116	gpd
Sludge Pump Rate	150	gpm
Pump Power Required	5	HP
Hours of Pumping per day	7.1	hrs/day
Daily Power Consumption	48.3	kW-hrs/day/clarifier
Estimated Annual Power Consumption	**35,235**	**kW-hrs/year**

Table 4. Add'l Power Requirements at Aeration Basins without Intermediate Clarifiers

Item	Amount	Unit
Oxygen Required	7,993	lbs. O2 /day
Residual DO	2	mg/L
Std. Oxygen Transfer Efficiency (SOTE)	2.12	%/ft
AOR/SOR	0.231	
Standard Oxygen Required (SOR)	34,665	lb/day
Req'd Airflow	4,269	SCFM
Estimated Power (70% efficiency)	239	BHP
Daily Power Usage (24 hr. operation)	4,277	kW-hrs/day
Estimated Annual Power Usage	**1,561,285**	**kW-hrs/year**

∴ Total Estimated Annual Power Saved with Intermediate Clarifiers =1,526,050 kW-hrs/year

Results

- The estimate energy consumed by the combined BSPs would be 5,080,147 kW-hr per year.
- The estimated energy consumed by the system to be installed will be 809,000 kW-hr per year.
- Therefore the proposed system results in a savings of 4,271,147 kW-hr per year.

Conclusion

- By using a combination of high speed turbo blowers and dissolved oxygen control system in the aeration basin, and the installation of intermediate clarifiers that will reduce the aeration demand in the aeration basins, the City will reduce power demand by approximately 84 percent.
- **GPR Costs:**

Equipment Name	Cost
Fine Bubble Diffusers	$ 158,000
High-speed Turbo Blowers	$ 992,000
Dissolved Oxygen Control System	$ 130,000
Blower Building	$ 600,000
Intermediate Clarifiers	$ 1,600,000
∴ FY15 Total =	**$ 3,480,000**

- **GPR Justification:** Categorically GPR-eligible (Energy Efficiency) per Section 3.2-2: *projects that achieve a 20% reduction in energy consumption*.

2. Anaerobic Digestion

Summary

- The City will install anaerobic digesters in lieu of additional aerobic digesters to conserve energy and increase the dewaterability of the biosolids. Total Loan amount = $22,200,000
- Estimated Categorical energy efficient (green) portion of loan = 16.8% ($3,721,000)
- Annual Power savings = 97.9%

Background

- The solids to be treated anaerobically rather than aerobically, thereby significantly reducing the required energy consumption.
- The City will use gravity belt thickeners to thicken the waste activated sludge and clarifier sludge from approximately 1% solids to 4% solids, thereby reducing the size of the anaerobic digesters.

Energy Efficiency Improvements

- The GPR-eligibility of Anaerobic Digestion is established by a comparison of energy efficiency to a Baseline Standard Practice (BSP). The BSP in this instance is Aerobic Digestion.
- Anaerobic digestion only requires power for mixing the contents of the digester; natural gas and biogas will be used to heat the contents. Aerobic digestion has much higher energy requirements due to the larger sludge volumes (1 – 2% solids concentrations) that require treatment, and additional mixing and aeration requirements.[6]
- Anaerobically digested sludge is typically easier to dewater and results in higher cake solids with the same polymer usage. This results in a lower volume of biosolids for disposal and reduces hauling costs.[7]

Anaerobic Digester Power Estimate (Mixing)[8]

Item	Time (hr)	HP	Daily Power (kW-hr)	Annual Power Consumption (kW-hr)
Rapid Mixing	2	36.5	54	19,849
Constant Mixing	22	18.2	299	109,169
		Total	**353**	**129,018 /year**

Aerobic Digester Power Estimate (Air Supply and Mixing)

Item	Amount	Unit
% Volatile Solids Reduction	38%[9]	--
Min. SRT (winter)	60	d
Sludge Concentration (Digester)	3%	--
Diffused air mixing is used.		
Oxygen transfer efficiency	5%	--
Total Mass of VSS	5,883	kg VSS/d
Oxygen Required (Avg. of Winter & Summer)	24,026	lbs. O2 /day
Residual DO	2	mg/L
Std. Oxygen Transfer Efficiency (SOTE)	0.75	%/ft
AOR/SOR	0.438	
Standard Oxygen Required (SOR)	54,827	lb/day
Req'd Airflow for Biological Treatment	14,505	SCFM
Estimated Power	944	BHP
Estimated Daily Power Usage	16,903	kW-hrs/day
Estimated Annual Power Usage	**6,169,499**	**kW-hrs/year**

[6] Wastewater Engineering Treatment and Reuse, 4th Ed., Metcalf and Eddy, Pg.1533.
[7] Wastewater Engineering Treatment and Reuse, 4th Ed., Metcalf and Eddy, Pg. 1566.
[8] Aeration is not required for anaerobic digesters
[9] Approximately Class B biosolids - equivalent to anaerobic digester

ANAEROBIC DIGESTION (CONT.)

Results

- The estimated power consumed by the BSP (aerobic digestion) is 6,169,499 kW-hr per year.
- The estimated power consumed by the proposed digesters is 129,000 kW-hr per year.
- Therefore the proposed alternative saves 6,040,499 kW-hr per year.

Conclusion

- By constructing anaerobic digestion facilities, the City will reduce power demand by approximately 98% as compared to the Baseline Standard Practice of installing aerobic digestion. The reduction in power is due to the elimination of the need for aeration, reduced mixing requirements, and smaller digesters that can treat thicker sludge concentrations.
- **GPR Cost:**

Equipment Name	Cost
Anaerobic Digestion Facilities	$ 3,721,000
∴ FY15 Total =	**$ 3,721,000**

- **GPR Justification:** Categorically GPR-eligible (Energy Efficiency) per Section 3.2-2: *"projects that achieve a 20% reduction in energy consumption."*

3. LED Lighting

Summary

- The design will incorporate high efficiency LED lighting for interior/exterior lighting. LED fixtures with high efficiency electronic drivers will be used for all applications.
- Total Loan amount = $22,200,000
- Estimated Categorical energy efficient (green) portion of loan ≅ 0.46% ($102,500)
- Annual Energy savings for interior lighting = 53%
- Annual Energy savings for exterior lighting = 38%

Energy Efficiency Improvements

- Energy efficient LED lighting is approximately 54 percent more energy efficient than standard T-12 magnetic fluorescent lighting for relatively the same light output.[10]
- LED lighting is approximately 58 percent more energy efficient that typical high pressure sodium lighting for relatively the same light output.[11]
- The design will incorporate lighting control at an individual space level, where applicable, in the form of dual local switching. Lighting control for building exterior and site lighting will be provided in the form of photocell control.

Conclusion

- **GPR Costs:**

Equipment Name	Cost
LED Lighting	$ 102,500
∴ FY15 Total =	**$ 102,500**

- **GPR Justification:** Categorically GPR-eligible (Energy Efficiency) per Section 3.2-2: *"projects that achieve a 20% reduction in energy consumption."*

[10] Calculation based upon 34 Watt T-12 output of 2,750 lumens vs. 40 Watt LED output of 5,001 lumens.
[11] Global Green Energy, *ROI Analysis - 250W high pressure sodium vs. EcoBright 120W LED street light*, accessed via http://www.gg-energy.com/