ITEM #: 3

Staff Report

WATER POLLUTION CONTROL DIGESTER GAS UTLITIZATION STUDY

October 17, 2017

POLICY ISSUE:

The policy issue before the Council is to determine if the sustainability benefits of continuing to generate electrical power from methane gas produced on-site ("cogeneration") offset the increased capital and operating expenses when compared to simply purchasing electricity from the rural electrical cooperative.

Ames Water Pollution Control has a long standing history of utilizing cogeneration. The previous plant south of Highway 30 near Hunziker Youth Sports Complex used cogeneration to offset, at times, nearly 100% of the electricity needed for the plant. When the most recent plant was constructed in 1989, cogeneration was continued. With increased electricity demands on this facility, cogeneration has been offsetting approximately 15-20% of the electricity demand.

The current capital improvements plan has over $1.5 million in improvements in the next three years to the cogeneration and grease receiving systems. This includes a replacement of Methane Generator No. 1 with a boiler and overhauling Methane Generator No. 3 in the current fiscal year and replacing Methane Generator No. 2 in FY 19/20. These systems are operation- and maintenance-intensive, leading staff to hire Strand & Associates to help the City evaluate the full picture of the costs involved before proceeding with the budgeted projects. **Staff had anticipated that the study would reaffirm the continued use of cogeneration. However, upon evaluation of all the costs, it was determined savings from the electricity generation did not offset all the capital and operation costs incurred.**

Staff is now seeking the City Council's direction for choosing one of the following paths:

- Replace the methane engines entirely with boilers to supply the necessary heat, but no electricity for the plant ($1.25 million) or

- Choose a path that includes cogeneration supplying both the heat and electricity for the plant at higher cost ($3.1 million).

- Choose a short-term path that splits the difference, staying with cogeneration in the short-term, essentially "buying time" to see how the economics might change over the next few years.

The project cost comparison looks at capital costs, future equipment costs, and projected annual operations and maintenance costs over 20 years.

BACKGROUND:

The Ames Water Pollution Control Facility (WPCF) treatment process includes an anaerobic digestion process to stabilize the solids removed from the entering wastewater. The anaerobic digestion process creates methane ("biogas") as a by-product. The facility captures that gas and uses it as a feedstock for three cogeneration engines. Each cogeneration engine drives a generator that is connected to the plant's electrical grid via automatic switchgear. Heat recovered from the cogeneration engines is used to heat the digesters to maintain anaerobic digestion, eliminating the need to purchase natural gas for this purpose.

Two of the three dual-fuel gas generators (MG Nos. 1, 2) are original to the construction of the plant in 1989, and one (MG No. 3) was added in 2003. The original cogeneration engines operated for years without any problems with routine maintenance procedures. About ten years after the initial installation, the maintenance costs of the cogeneration engines began to increase. The presence of siloxanes (a common contaminant in municipally-generated biogas) has led to premature fouling of the engines' valves and the more frequent need for complete engine overhauls. In 2007, staff increased the frequency of oil changes which has helped to decrease maintenance costs associated with the cogeneration engines. These oil changes, along with regular overhauls, have allowed the cogeneration engines to remain operational.

Staff undertook the study of the facility's digester gas handling components as a result of two factors. The first is the implementation of a new Fats, Oils, and Grease (FOG) control ordinance and how it may impact the loadings and gas production at the digestion facilities. The second factor is the capacity and condition of the existing engine-generator system. The study is intended to be used as a guideline for future planning and design of projects related to the solids treatment process. **Over $1.5 million dollars of improvements are scheduled within the next five years and it was important to ensure that spending those dollars is in the best interest of the utility and its rate payers.**

On December 20, 2016 City Council awarded a contract to Strand Associates, Inc. of Madison, Wisconsin to perform this study.

STUDY SUMMARY:

Eight alternatives were evaluated on a present worth basis to compare various options for beneficially using the digester gas. These alternatives include four cogeneration options and three options for using biogas in boilers. Alternative 4 was found not to be feasible and therefore not fully evaluated. The table provides a summary of the options, with a narrative description that follows.

Alternative	Existing Engines	New Engines	Boilers	Micro-Turbines	Gas Conditioning	Controls Upgrade	Sell Gas to Pipeline
1	X					X	
2a		X				X	
2b		X			X	X	
3				X	X	X	
4						X	X
5a			X			X	
5b	X		X			X	
5c		X	X		X	X	

- Alternative 1 – Use digester gas to fuel the existing cogeneration engines. This alternative does not include gas conditioning and does not include future engine replacement. ($1.5 Million).

- Alternative 2a – This continues to use digester gas in one or more new cogeneration engine(s). This alternative does not include digester gas conditioning,.($2.7 million)

- Alternative 2b – This continues to use digester gas in one or more new cogeneration engine(s) with gas conditioning. ($2.5 million).

- Alternative 3 – Use digester gas to fuel a CHP system with microturbines. This alternative includes digester gas conditioning. ($2.7 million)

- Alternative 4 – Use digester gas to produce pipeline quality natural gas. The treatment system could be owned and operated by a third party or by the City. The location of the WPCF likely makes compressed natural gas (CNG) production for vehicle fueling impractical so this alternative was not further priced.

- Alternative 5a - Use digester gas in a dual fuel boiler without cogeneration ($1.25 million)

- Alternative 5b – Use digester gas in a duel fuel boiler with existing engines. This does not include any future replacement of engines. ($2.3 million).

- Alternative 5c - Use digester gas in a dual fuel boiler with a new cogeneration engine with digester gas conditioning. ($3.1 million). This alternative best reflects the current projects planned in the CIP; however staff had not accounted for the need to have gas conditioning for newer efficient engines.

Each alternative includes the costs of instrumentation, controls, and SCADA graphics upgrades.

CONCLUSION:

Based on the present worth analyses conducted at all digester gas flow rates, the alternative with the *lowest present worth cost* is alternative 5a. This alternative uses digester gas as a fuel for two boilers and includes demolition of the existing cogeneration engines. **If this approach were pursued, the Water Pollution Control Facility would no longer generate power on-site from a renewable source (biogas). Instead, the facility would need to purchase additional electricity from the rural electrical cooperative.**

The City Council has adopted a goal of expanding the City's sustainability efforts. When evaluating the net impact of a switch away from cogeneration, consideration needs to be given to where to draw the line between the City's carbon contributions as opposed to those of a third party energy provider. If you look at the City's carbon contribution alone, then elimination of cogeneration would not eliminate the facility's carbon emissions. This is because the same amount of biogas will still be produced and will still need to be burned – either in an engine or in a flare. However, since the facility would need to increase its consumption of purchased power if it no longer uses cogeneration, the carbon emissions of a third party electric provider would clearly go up, with an overall net increase in carbon emissions.

The Water Pollution Control Facility has a long history (50+ years) of using biogas as a fuel source to heat the digesters and produce electricity. Stepping away from this current practice is a change that would have a significant impact on how future dollars would be allocated. The staff is seeking direction from the City Council, so that the preferred project can be inserted in the Capital Improvements Plan.

The question being presented to Council is this: **Do the sustainability benefits of continuing to maintain a cogeneration system offset the increased capital and operating expenses?**

- If the Council finds the answer to that question to be "yes," direction can be given to staff to purse alternative 5c and continue the practice of on-site cogeneration and pursue the $3.1 million present-worth project. Or

- If the Council finds the answer to that question to be “yes,” but wishes to defer the large dollar capital expenses to see how much hauled grease and high strength waste may be received at the facility, direction can be given to staff to pursue alternative 5b ($2.3 million present worth project).

  Of the two alternatives shown above, the staff would recommend this option should the Council believe the benefits of continuing to maintain a cogeneration system offset the increased capital and operating expenses.

- If the Council finds the answer to that question to be “no,” direction can be given to staff to pursue Alternative 5a, which implements long-term alternatives to handling the biogas and heating the digesters using boilers and a waste gas flare at a cost of $1.25 million present worth project).

OPINION OF PRESENT WORTH COST ANALYSIS WITHOUT HSW

Digester Gas Alternatives							
	Alternative 1 Existing Engines[1]	Alternative 2 New Engine without Gas Conditioning	Alternative 2b New Engine with Gas Conditioning	Alternative 3 Microturbines	Alternative 5a Boilers	Alternative 5b Boiler and Existing Engines	Alternative 5C Boiler and New Engines
Total Capital Costs	**$ 790,000**	**$ 693,000**	**$ 693,000**	**$ 2,839,000**	**$ 1,172,000**	**$ 1,515,000**	**$ 1,203,000**
Total Future Equipment Costs[5]		**$ 1,564,000**	**$ 2,222,000**				**$ 2,222,000**
Average Annual O&M Costs							
Power	$ -	$ -	$ 1,500	$ 5,500	$ 300	$ 300	$ 1,500
Value of Electrical Production[1]	$ (36,000)	$ (46,500)	$ (43,500)	$ (35,500)	$ -	$ (36,000)	$ (43,500)
Gas Conditioning Equipment and Media Replacement[2]	$ -	$ -	$ 5,000	$ 8,500	$ -	$ -	$ 5,000
Equipment Maintenance and Overhaul[3]	$ 84,000	$ 109,500	$ 60,500	$ 17,500	$ 7,000	$ 88,000	$ 64,500
Subtotal Opinion of Annual O&M	**$ 48,000**	**$ 63,000**	**$ 23,500**	**$ (4,000)**	**$ 7,150**	**$ 52,150**	**$ 27,500**
Present Worth of O&M	$ 714,000	$ 940,000	$ 272,000	$ (58,000)	$ 108,000	$ 777,000	$ 370,000
Present Worth of Future Equipment	$ -	$ 1,283,000	$ 1,821,000	$ -	$ -	$ -	$ 1,821,000
Present Worth of Salvage	$ -	$ (191,000)	$ (265,000)	$ (63,000)	$ (34,000)	$ (31,000)	$ (275,000)
Total Present Worth[4]	**$ 1,504,000**	**$ 2,725,000**	**$ 2,521,000**	**$ 2,718,000**	**$ 1,246,000**	**$ 2,261,000**	**$ 3,119,000**

Notes:

[1] Value of electrical production is based on $0.04/kwh.

[2] Alternatives 2b, 3, and 5c include costs for gas conditioning.

[3] Maintenance costs were provided by equipment manufacturers or based on engineering judgement.

[4] Based on a 20-year project life using the Iowa DNR discount rate of 2.875 percent.

[5] Engine replacement is assumed to occur in Year 7.

Table 8.02-14 Summary of Nonmonetary Considerations

	Alternative 1– Existing Engines	Alternative 2a– New Engine w/o Gas Conditioning	Alternative 2b– New Engine w/ Gas Conditioning	Alternative 3– Microturbines	Alternative 5a– Boilers	Alternative 5b– Boiler and Existing Engines	Alternative 5c– Boiler and New Engine
Operational Complexity	0	0	-1	-1	1	0	-1
Future Expandability	1	1	0	0	1	0	-1
Energy Reuse/Sustainability	1	1	1	1	0	1	1
Air Emissions	-1	0	0	0	1	-1	0
Constructability	1	1	0	0	1	1	0
Total	**2**	**3**	**0**	**0**	**4**	**1**	**-1**