

City of Riverside

**WASTEWATER COLLECTION AND TREATMENT  
FACILITIES INTEGRATED MASTER PLAN**

**VOLUME 9: ENERGY MANAGEMENT  
CHAPTER 5: POWER SUPPLY ALTERNATIVES**

**FINAL**  
February 2008



**WASTEWATER COLLECTION AND TREATMENT  
FACILITIES INTEGRATED MASTER PLAN**

**VOLUME 9: ENERGY MANAGEMENT  
CHAPTER 5: POWER SUPPLY ALTERNATIVES**

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## POWER SUPPLY ALTERNATIVES

### 5.1 PURPOSE

The purpose of this chapter is to present alternatives for future power supply for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP).

### 5.2 CONCLUSIONS AND RECOMMENDATIONS

- Due to more stringent emission requirements for cogeneration engines, the City has decided to convert their existing cogeneration engines to standby generators, which do not require the same ultra-low emissions.
- The City has decided to install a new 1,000-kW fuel cell cogeneration system and follow with another 1,200-kW fuel cell system once the first project is installed and proven.
- At the project meeting on April 16, 2007, the City decided to install a low-pressure gasholder because of the higher capital and maintenance costs associated with high-pressure digester gas systems.

### 5.3 BACKGROUND

The RWQCP is a tertiary wastewater treatment plant that currently treats approximately 33 mgd. The RWQCP has a rated capacity of approximately 40 mgd. The City seeks to develop an Integrated Master Plan for the Wastewater Systems Facilities to identify and plan for expansion and replacement needs for up to the year 2025. Energy systems are an integral part of the RWQCP operation. With proper planning and appropriate implementation of energy system improvements, the RWQCP will be able to cost effectively treat and dispose of wastewater solids.

### 5.4 POWER SUPPLY ALTERNATIVES

Various electrical power supply alternatives are available at the RWQCP. These include the following:

1. Utility Power (Dual Feeds).
2. Continued Use of Existing Cogeneration System.
3. Use of New Fuel Cells (currently being installed).
4. Planned Fuel Cell Expansion.

The above alternatives are discussed in more detail as follows.

### **5.4.1 Utility Power (Dual Feeds)**

The plant receives utility power from the Riverside Public Utilities at a 12-kV voltage level. The Riverside Public Utilities provides dual feeds, which originate from the same utility substation into the plant distribution system. Only the feed coming into the plant entrance on Acorn Street is in service, while the other feed is disconnected and is used as a backup when the Acorn feed is out of service for maintenance.

At present, it is not known if there is a plan for the Riverside Public Utilities to provide a separate utility substation for the other feed. Because it is a single feed, the existing utility configuration does not provide power reliability to the plant. The plant will lose power when the utility substation requires maintenance or when the substation experiences an electrical disturbance/fault. The existing plant generation system is not currently able to operate as a standby power source.

Standby power alternatives are discussed in Volume 9, Chapter 6 - Standby Power.

### **5.4.2 Existing Cogeneration System**

The plant currently has three 1,100-kW lean-burn engine generators installed that are used to generate heat and power for the RWQCP. The engines were installed in approximately 1999. The engines are fueled with a mixture of digester gas and natural gas. Typically, one or two engines are operated depending on gas availability and the economics of the operating units. During periods of high electric utility cost (on peak periods) two engines are operated as much as possible to minimize the purchase of high-priced power. The RWQCP generates enough digester gas when the digesters are not augmented with Fats, Oils, and Grease (FOG) to generate approximately 900 kW of electric power on average. Operation of one engine at full load and/or operation of the second engine requires either digester gas augmentation with FOG addition or natural gas usage.

The engines have heat recovery systems installed which recover heat from the engine jacket water-cooling system as well as from the engine exhaust. Heat is recovered as hot water into the RWQCP's hot water heating system. Heat provided by the operating engine(s) is sufficient to provide plant heating needs during all but the most extreme cold weather conditions.

Recent proposed changes by South Coast Air Quality Management District (SCAQMD) will impact the existing cogeneration engine generators.

#### **5.4.2.1 SCAQMD Regulations**

SCAQMD has recently proposed new regulations for both new and existing engine generators operating within the SCAQMD air basin. The new emission rule, while not final and approved, is expected to be implemented in 2008. The proposed rule is SCAQMD Rule 1110.2. The rule will require new and existing engine generators to meet ultra-low NOx, CO, and VOC emission requirements, as well as require installation of Continuous

Emissions Monitoring (CEMS) equipment. The rule mandates that existing non-standby engine generators be modified to meet the new ultra-low emission requirements or be shut down. There is a sliding schedule for implementation of the new standard that will affect the existing engines. Engines fueled with natural gas must be retrofitted or shut down prior to 2010, while engines fueled with digester and/or landfill gas must be retrofitted or shut down prior to 2012. The existing engine generators likely would fall into the 2010 scheduling window.

The existing engine generators currently have CEMS equipment installed. In order to meet the ultra-low emissions requirements, the existing engine generators would need to be modified to include both Selective Catalytic Reduction (SCR) and CO oxidation catalyst equipment. In order to assure that this equipment will be operational with digester gas, fuel treatment equipment designed to remove all H<sub>2</sub>S and siloxane compounds from the digester and landfill gas would also be required.

Cost estimates for installing systems are included in Appendix A and are summarized in Table 5.1.

<b>Table 5.1 Estimated Construction Costs Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside</b>	
	<b>Estimated Construction Costs</b>
Fuel Conditioning System	\$2,479,000
SCR Equipment	\$1,125,000
CO Oxidation Catalyst Equipment	\$471,000
<b>Total Project Costs</b>	<b>\$5,297,000</b>

These systems will also significantly increase operations and maintenance costs of the existing engine generator systems.

The City has made a decision, based on the expected costs, to convert the existing engines to natural gas only operation for use as standby generators. Emission rules for standby generators do not require the ultra-low emissions noted above, thus the modifications noted above would not be required.

### **5.4.3 New Cogeneration System**

As part of the conversion of the existing engine generator systems to standby engines, the City has decided to install a new cogeneration system. The City is currently installing a new 1,000-kW fuel cell project and plans to follow this with another 1,200-kW fuel cell project once the first project is installed and proven.

#### **5.4.3.1 Existing Fuel Cell Project**

The City has contracted with Alliance Power to install a new 1,000-kW fuel cell cogeneration system at the RWQCP. The project is currently under design with installation expected to be complete in early 2008. The existing fuel cell project consists of installing a Fuel Cell Energy FCE1500 fuel cell system complete with hot water heat recovery equipment, fuel treatment, and all ancillary equipment required to install and operate the new fuel cell system at the RWQCP. The City will receive a grant from the State of California Self Generation Incentive Program (SGIP). The SGIP will provide \$4,500,000 to the City once the project is operational.

#### **5.4.3.2 Planned Fuel Cell Expansion**

The City plans to install a similar 1,200-kW fuel cell system following installation of the existing fuel cell project. Estimated construction and project costs associated with this project are included in Appendix A and are summarized in Table 5.2.

<b>Table 5.2 1,200-kW Fuel Cell Installation Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside</b>	
<b>Estimated Construction Costs</b>	
Estimated Construction Costs	\$10,139,000
Total Project Costs	\$13,181,000

The City has indicated that they expect to receive grant funding for a portion of the project cost from the SGIP. As currently written, the SGIP only allows funding to be received up to a total of \$4,500,000 for fuel cell installations. In order for the City to realize additional funding from the SGIP, program changes must first be made by the program administrators. The possibility of receiving additional funding cannot be assured at this time.

#### **5.4.4 Existing Digester Gas System**

The existing digester gas system is comprised of a piping network that collects digester gas from all active digesters. The digester gas is conveyed either via numerous gas boosters to existing boilers or via compressors to the existing cogeneration system. Digester gas not used by the above boilers or existing cogeneration equipment is automatically flared in the RWQCP emergency flare. The digester gas system collects digester gas at pressures that range from 7 to 14 inches of water column. The City has expressed concern regarding operation of the existing digester gas system. Control of blower, compressors, and the flare are very difficult due to lack of adequate volume within the digester gas system. When devices start/stop or change load, the pressure within the digester gas system changes. These abrupt changes impact the control schemes of the operating equipment causing operational issues with the digester gas utilizing equipment. The City has requested that digester gas storage be included within the digester gas system to alleviate the pressure

control problems. Two types of storage are utilized within digester gas systems, low-pressure digester gasholders or high-pressure digester gasholders.

**5.4.4.1 Low-Pressure Digester Gasholders**

Low-pressure digester gasholders consist of an expandable storage vessel capable of holding approximately 10,000 cubic feet (can be larger or smaller). As digester gas production increases or digester gas usage decreases, excess digester gas expands the gasholder, similarly as digester gas production decreases or digester gas usage increases, digester gas is drawn from the gasholder. As long as the gasholder is not completely full or empty the pressure within the digester gas system remains constant during these changes. Thus operation of digester gas equipment would no longer be impacted by pressure fluctuations. A key advantage offered by this type of system is the ability to utilize level (or volume) measurements within the gasholder as control signals for the operating digester gas equipment. Because of the large volumes stored in the gasholder, control is greatly simplified.

The costs to install a 10,000 cubic foot gasholder into the existing low-pressure digester gas system has been estimated. Estimated construction and project costs associated with this project are included in Appendix A and are summarized in Table 5.3.

<b>Table 5.3 10,000-Cubic Foot Gasholder Installation Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside</b>	
<b>Estimated Construction Costs</b>	
Estimated Construction Costs	\$1,046,000
Total Project Costs	\$1,360,000

**5.4.4.2 High-Pressure Digester Gasholders**

High-pressure digester gasholders appropriate for the RWQCP would consist of a high-pressure storage sphere capable of holding approximately 250,000 cubic feet of digester gas. The sphere would have a design pressure of approximately 75 psig. One or two high-pressure compressors would be part of the system. The compressors would compress low-pressure digester gas for storage into the high-pressure gasholder. Typically, high-pressure storage spheres are used to allow storage of digester gas for later use. A common use is to allow for multiple engines to be run during peak power periods. Using a high-pressure gasholder for pressure control in a low-pressure digester gas system is not typically done, although it is possible. Unlike the low-pressure gasholder previously described, installation of a high-pressure gasholder will not allow the low-pressure gas system to operate at constant pressure. Operation of the gas storage system is typically done by pressure control, such that as pressure increases above a preset value, the lead compressor operates to store gas, as gas pressure falls below a preset value a pressure-reducing valve opens to admit high-pressure digester gas into the low-pressure

system. Without significant design attention, such a system may not address the issue of pressure fluctuation control desired by the City.

The costs to install a 250,000-cubic foot high-pressure gasholder into the existing low-pressure digester gas system have been estimated. Estimated construction and project costs associated with this project are included in Appendix A and are summarized in Table 5.4.

<b>Table 5.4    250,000-Cubic Foot High-Pressure Gasholder Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside</b>	
<b>Estimated Construction Costs</b>	
Estimated Construction Costs	\$4,076,000
Total Project Costs	\$5,299,000

In addition, high-pressure digester gasholders require significant operating and maintenance expenses. The digester gas compression equipment will include an approximately 150-hp compressor. The compression equipment is very maintenance-intensive and requires electricity to operate. In addition, annual inspections of the ASME-stamped storage vessel are required. Annual operating costs for a high-pressure storage system could be \$25,000 to \$75,000 per year.

**Appendix A**  
**COST ESTIMATES**

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**PROJECT :** Cogen Preliminary Design  
 Riverside RWQCP  
**JOB # :** 7472A.00  
**SUBJECT:** Fuel Treatment System

**DATE :** 15-Jun-07  
**BY :** TGM  
**CHECKED :**  
**DATE :** 15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
<b>2 thru 10</b>	<b><u>BUILDING &amp; SITE WORK</u></b> None	0	SF	\$0	1.00	\$0
<b>11</b>	<b><u>EQUIPMENT</u></b> Fuel Treatment System	1	LS	\$1,000,000	1.25	\$1,250,000
<b>15</b>	<b><u>MECHANICAL</u></b> Misc. piping	1	LS	\$15,000	1.00	\$15,000
	SUBTOTAL					\$1,265,000
<b>16</b>	<b><u>ELECTRICAL AND INSTRUMENTATION - 15%</u></b>	1	LS	\$190,000	1.00	\$190,000
	SUBTOTAL					\$1,455,000
	<b><u>CONTINGENCY - 30%</u></b>					\$437,000
	SUBTOTAL					\$1,892,000
<b>0</b>	<b><u>GENERAL CONDITIONS</u></b> General Conditions - 10% General Overhead & Profit - 15% Sales Tax - 7.75% on material SUBTOTAL Bid Market Allowance - 15%					\$189,000 \$284,000 \$73,000 \$546,000 \$41,000
	<b><u>TOTAL CONSTRUCTION COST</u></b>					\$2,479,000
	<b>DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%</b> SUBTOTAL	1	LS	\$744,000	1.00	\$744,000 \$744,000
	<b><u>Total Project Cost</u></b>					\$3,223,000

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment. When listed as 1.00, these costs are included in the unit price.



PROJECT : Cogen Preliminary Design  
 Riverside RWQCP  
 JOB # : 7472A.00  
 SUBJECT: SCR System Installation

DATE : 15-Jun-07  
 BY : TGM  
 CHECKED :  
 DATE : 15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
<b>2 thru 10</b>	<b><u>BUILDING &amp; SITE WORK</u></b> None	0	SF	\$0	1.00	\$0
<b>11</b>	<b><u>EQUIPMENT</u></b> SCR System	3	LS	\$145,000	1.25	\$543,750
<b>15</b>	<b><u>MECHANICAL</u></b> Misc. piping	3	LS	\$10,000	1.00	\$30,000
	SUBTOTAL					\$573,750
<b>16</b>	<b><u>ELECTRICAL AND INSTRUMENTATION - 15%</u></b>	1	LS	\$86,000	1.00	\$86,000
	SUBTOTAL					\$659,750
	<b><u>CONTINGENCY - 30%</u></b>					\$198,000
	SUBTOTAL					\$857,750
<b>0</b>	<b><u>GENERAL CONDITIONS</u></b> General Conditions - 10% General Overhead & Profit - 15% Sales Tax - 7.75% on material SUBTOTAL Bid Market Allowance - 15%					\$86,000 \$129,000 \$33,000 \$248,000 \$19,000
	<b><u>TOTAL CONSTRUCTION COST</u></b>					\$1,124,750
	<b>DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%</b>	1	LS	\$337,000	1.00	\$337,000
	SUBTOTAL					\$337,000
	<b><u>Total Project Cost</u></b>					\$1,461,750

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment. When listed as 1.00, these costs are included in the unit price.



**PROJECT :** Cogen Preliminary Design  
 Riverside RWQCP  
**JOB # :** 7472A.00  
**SUBJECT:** CO Catalyst Installation

**DATE :** 15-Jun-07  
**BY :** TGM  
**CHECKED :**  
**DATE :** 15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
<b>2 thru 10</b>	<b><u>BUILDING &amp; SITE WORK</u></b>					
	None	0	SF	\$0	1.00	\$0
<b>11</b>	<b><u>EQUIPMENT</u></b>					
	CO Catalysts	3	LS	\$60,000	1.25	\$225,000
<b>15</b>	<b><u>MECHANICAL</u></b>					
	Misc. piping	3	LS	\$5,000	1.00	\$15,000
	SUBTOTAL					\$240,000
<b>16</b>	<b><u>ELECTRICAL AND INSTRUMENTATION - 15%</u></b>	1	LS	\$36,000	1.00	\$36,000
	SUBTOTAL					\$276,000
	<b><u>CONTINGENCY - 30%</u></b>					\$83,000
	SUBTOTAL					\$359,000
<b>0</b>	<b><u>GENERAL CONDITIONS</u></b>					
	General Conditions - 10%					\$36,000
	General Overhead & Profit - 15%					\$54,000
	Sales Tax - 7.75% on material					\$14,000
	SUBTOTAL					\$104,000
	Bid Market Allowance - 15%					\$8,000
	<b><u>TOTAL CONSTRUCTION COST</u></b>					\$471,000
	<b><u>DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%</u></b>	1	LS	\$141,000	1.00	\$141,000
	SUBTOTAL					\$141,000
	<b><u>Total Project Cost</u></b>					\$612,000

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment.  
 When listed as 1.00, these costs are included in the unit price.



**PROJECT :** Cogen Preliminary Design  
 Riverside RWQCP  
**JOB # :** 7472A.00  
**SUBJECT:** Low Pressure Digester Gas Storage

**DATE :** 15-Jun-07  
**BY :** TGM  
**CHECKED :**  
**DATE :** 15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
<u>2 thru 10</u>	<b><u>BUILDING &amp; SITE WORK</u></b> Pad	2000	SF	\$25	1.00	\$50,000
<u>11</u>	<b><u>EQUIPMENT</u></b> 10,000 cu. Ft. Low pressure storage holder	1	LS	\$500,000	1.00	\$500,000
<u>15</u>	<b><u>MECHANICAL</u></b> Misc. piping	1	LS	\$20,000	1.68	\$33,600
	SUBTOTAL					\$533,600
<u>16</u>	<b><u>ELECTRICAL AND INSTRUMENTATION - 15%</u></b>	1	LS	\$80,000	1.00	\$80,000
	SUBTOTAL					\$613,600
	<b><u>CONTINGENCY - 30%</u></b>					\$184,000
	SUBTOTAL					\$797,600
<u>0</u>	<b><u>GENERAL CONDITIONS</u></b> General Conditions - 10% General Overhead & Profit - 15% Sales Tax - 7.75% on material SUBTOTAL Bid Market Allowance - 15%					\$80,000 \$120,000 \$31,000 \$231,000 \$17,000
	<b><u>TOTAL CONSTRUCTION COST</u></b>					\$1,045,600
	<b>DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%</b>	1	LS	\$314,000	1.00	\$314,000
	SUBTOTAL					\$314,000
	<b><u>Total Project Cost</u></b>					\$1,359,600

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment. When listed as 1.00, these costs are included in the unit price.



**PROJECT :** Cogen Preliminary Design  
 Riverside RWQCP  
**JOB # :** 7472A.00  
**SUBJECT:** High Pressure Digester Gas Storage

**DATE :** 15-Jun-07  
**BY :** TGM  
**CHECKED :**  
**DATE :** 15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
<b><u>2 thru 10</u></b>	<b><u>BUILDING &amp; SITE WORK</u></b>					
	40'x30' compressor bldg @ \$125/sq ft	1200	SF	\$125	1.00	\$150,000
	Storage Sphere Pad	2500	SF	\$25	1.00	\$62,500
<b><u>11</u></b>	<b><u>EQUIPMENT</u></b>					
	500scfm 150 HP 70 psig Oil flooded rotary screw compr.	2	LS	\$100,000	1.50	\$300,000
	250,000cfm / 50 psig CS storage sphere	1	LS	\$1,750,000	1.00	\$1,750,000
<b><u>15</u></b>	<b><u>MECHANICAL</u></b>					
	Misc. piping	1	LS	\$20,000	1.50	\$30,000
	SUBTOTAL					\$2,080,000
<b><u>16</u></b>	<b><u>ELECTRICAL AND INSTRUMENTATION - 15%</u></b>	1	LS	\$312,000	1.00	\$312,000
	SUBTOTAL					\$2,392,000
	<b><u>CONTINGENCY - 30%</u></b>					\$718,000
	SUBTOTAL					\$3,110,000
<b><u>0</u></b>	<b><u>GENERAL CONDITIONS</u></b>					
	General Conditions - 10%					\$311,000
	General Overhead & Profit - 15%					\$467,000
	Sales Tax - 7.75% on material					\$121,000
	SUBTOTAL					\$899,000
	Bid Market Allowance - 15%					\$67,000
	<b><u>TOTAL CONSTRUCTION COST</u></b>					\$4,076,000
	<b><u>DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%</u></b>	1	LS	\$1,223,000	1.00	\$1,223,000
	SUBTOTAL					\$1,223,000
	<b><u>Total Project Cost</u></b>					\$5,299,000

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment.  
 When listed as 1.00, these costs are included in the unit price.



**PROJECT :** Cogen Preliminary Design  
 Riverside RWQCP  
**JOB # :** 7472A.00  
**SUBJECT:** Fuel Cell System

**DATE :** 15-Jun-07  
**BY :** TGM  
**CHECKED :**  
**DATE :** 15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
<u>2 thru 10</u>	<b><u>BUILDING &amp; SITE WORK</u></b> Pad	3500	SF	\$25	1.00	\$87,500
<u>11</u>	<b><u>EQUIPMENT</u></b> Fuel Cell System	1	LS	\$3,720,000	1.30	\$4,836,000
<u>15</u>	<b><u>MECHANICAL</u></b> Misc. piping	1	LS	\$150,000	1.68	\$252,000
	SUBTOTAL					\$5,175,500
<u>16</u>	<b><u>ELECTRICAL AND INSTRUMENTATION - 15%</u></b>	1	LS	\$776,000	1.00	\$776,000
	SUBTOTAL					\$5,951,500
	<b><u>CONTINGENCY - 30%</u></b>					\$1,785,000
	SUBTOTAL					\$7,736,500
<u>0</u>	<b><u>GENERAL CONDITIONS</u></b> General Conditions - 10%					\$774,000
	General Overhead & Profit - 15%					\$1,160,000
	Sales Tax - 7.75% on material					\$300,000
	SUBTOTAL					\$2,234,000
	Bid Market Allowance - 15%					\$168,000
	<b><u>TOTAL CONSTRUCTION COST</u></b>					\$10,138,500
	<b>DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%</b>	1	LS	\$3,042,000	1.00	\$3,042,000
	SUBTOTAL					\$3,042,000
	<b><u>Total Project Cost</u></b>					\$13,180,500

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment. When listed as 1.00, these costs are included in the unit price.