CITY OF RAPID CITY

RAPID CITY, SOUTH DAKOTA 57701-2724

Public Works Department

300 Sixth Street
Telephone: (605) 394-4165
FAX: (605) 394-6636
Web: www.rcgov.org

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To: Public Works Committee

From: Dirk Jablonski, PE
Public Works Director

Ref: Phase I Findings Document
Water Reclamation Facility
Digester Repair and Improvements Project

In September 2006 the City of Rapid City contracted with Burns & McDonnell Engineering Company, Inc. to conduct an evaluation of the City's Water Reclamation Facility (WRF) biosolids management system. This evaluation was predicated by the need to replace the digester covers and upgrade the gas handling equipment of the original part of the facility which was constructed in 1967. Instead of just replacing the roofs on all three digesters an evaluation of the biosolids handling and treatment for the facility was warranted. The project focused on the handling and treatment of the biosolids generated by the original fixed film treatment process. However, impacts to the new activated sludge treatment process were considered in the evaluation process.

A findings document of this evaluation was developed for the project. The Executive Summary of the findings document is attached. City staff requests approval of this document and the recommended approach in conducting the improvements to the biosolids processing and handling system at the Rapid City WRF as contained in the document.

Approval of this findings document does not constitute approval of funding for all phases of the project. Contracts for design and construction of each phase of the project will be brought forward for approval by the City Council prior to beginning that phase of the project.

Executive Summary

City of Rapid City, SD
Water Reclamation Facility
Digester Repair and Improvements Project
Phase I Findings Document

Burns & McDonnell Engineering Company, Inc.
Centennial, Colorado

March 23, 2007
Final

City of Rapid City Project Number WRF06-1549
Burns & McDonnell Project Number 43561

EXECUTIVE SUMMARY

SCOPE OF WORK

Burns & McDonnell Engineering Company was contracted by the City of Rapid City, South Dakota, to complete the Rapid City Water Reclamation Facility (WRF) Digester Repair and Improvements Project (City Project No. WRF06-1549). Phase I of the project consisted of an evaluation of the current biosolids management system at the WRF with special emphasis on the original facility (i.e., North Plant or fixed-film treatment train). Burns & McDonnell, in conjunction with the City of Rapid City, finalized the project scope, deliverable end products, and timeline for the overall project with the issuance of this Phase I Findings Document. The Phase II Scope of Services will generally consist of developing design drawings and specifications and provide construction phase services in accordance with the Phase I findings.

The Phase I Scope of Work consisted of the following:

- Conduct a kickoff meeting with the City of Rapid City project team.
- Conduct two status meetings with the City of Rapid City project team.
- Conduct a coordination meeting with the Rapid City Solid Waste Division.
- Prepare, distribute, and review Operator's Questionnaire related to the existing solids processing and handling system.
- Evaluate the existing biosolids treatment process and system including review of historic solids quality and quantity production from both the fixed-film treatment train and the activated sludge treatment train.
- Preparation of a solids model summarizing solids production from the secondary treatment facilities and digestion facilities.
- Evaluate the existing digester gas handling system including the gas handling equipment, boiler system, and heat exchanger system based on historic gas production rates, theoretical gas production rates, historic digester gas quality, and general condition of the existing equipment.
- Prepare heat balance to establish the required heat exchanger capacity for the primary anaerobic digester heating system.
- Develop a maximum of three process alternatives (e.g., anaerobic digestion, aerobic digestion, aerated solids holding) for the overall solids processing and handling system.
- For the alternatives developed, evaluate each alternative based on both capital and operation and maintenance costs for the systems identified and provide a

recommendation regarding the type of solids processing and handling (i.e., treatment) system.

- Prepare a Phase I Findings Document.

This Phase I Findings Document presents the results of the work completed to address the Scope of Work items described above and provides a recommendation for the solids handling and processing improvements necessary to meet the capacity of the current WRF.

PHASE I FINDINGS

The recommendation for solids processing and handling at the WRF during the planning period is to continue the use of anaerobic digestion and implement improvements as outlined below. Anaerobic digestion has the following advantages over conversion to aerobic digestion:

1. Capital Cost: The total opinion of probable cost for the anaerobic digestion alternative is $4.4M. The total opinion of probable cost for the aerobic digestion alternative is approximately $4.4M.
2. O&M Cost: Aerobic digestion will require a significant electrical demand and associated costs of approximately $124,000/year (315 HP * 0.746 kW/HP * 24 hours * 365 days * $0.06/kW-hr). The anaerobic digestion system would require an electrical demand and associated cost for mixing and recirculation of approximately $20,000/year (50 HP * 0.746 kW/HP * 24 hours * 365 days * $0.06/kW-hr).
3. Phasing: The anaerobic digestion alternative can be phased-in to allow cost to be distributed over an increased number of bid packages or as budgeting allows. The aerobic digestion alternative would require that costs (and construction) be incurred at the same time to produce a fully operation system.
4. Design: Anaerobic digestion is generally accepted as the best approach to solids processing and handling for a facility with influent flows above 5 MGD. Gas mixing has a capital cost approximately $200,000 lower than mechanical mixing and is recommended for use with anaerobic digestion.
5. Space Requirements: The anaerobic digestion alternative requires significantly less site space and space is currently restricted at the Rapid City WRF.
6. Operator Familiarity: The plant operations staff is familiar with anaerobic digestion.
7. Long-Term Benefits: The anaerobic digestion alternative would better provide a Class B material.

An opinion of probable cost was developed for Capital Improvements Plan (CIP) items and optional items not directly associated with the solids processing and handling alternatives. These costs are presented in Table ES-1. A timeline for implementation can be found at the end of this Findings Document. Coordination with the Utility System Master Plan will be required in order to adequately address the needs of the WRF and meet the City's budgeting requirements. The CIP and optional items identified include:

- Sludge Handling Building
  - Thickened Sludge Storage Tank (expanded capacity)
  - Centrate Storage Tank (expanded capacity)
  - Polymer system improvements
  - HVAC system improvements
- Odor control and digester gas cleaning system
- Water line extension to the Rapid City WRF
- Rolloff container for additional sludge hauling
- Re-route secondary humus lines
- Replacement of digested solids pumps
- Replacement of the primary scum pumps
- Additional storage tank at the MRF
- Truck and tanker trailer

RECOMMENDATIONS

The recommended improvements to the solids processing and handling system at the Rapid City WRF exceed the currently budgeted funds for the entire scope of recommendations. As such, a phased implementation schedule of the improvements is recommended. During preparation of the WRF Facilities Plan in 1999, the City evaluated Alternative Contracting Scenarios and Funding Sources for the WRF expansion. The chosen contracting scenario was a Design-Bid-Build and the City has indicated that this scenario will be required for the Digester Repair and Improvements Project. City staff has also indicated that the overall improvements program will be funded by the currently budgeted funds as well as future annual budget requests as part of the City's overall CIP program.

Given these factors, certain contracting and technical aspects of phasing the project must be considered and below is a summary of those issues. Contracting issues include:

- If possible, the City would prefer consistency in the General Contractor hired to minimize mobilization costs and provide long-term quality in construction over all of the projects.
- In order to limit spare parts inventory and to provide consistent maintenance requirements, the City desires to have consistency in process equipment which is to say that all of the digesters should ideally have the same manufacturer provide the mechanical equipment.

Technical issues include:

- The WRF will require one primary digester to be on-line at all times.
- If the secondary digester is out of service, both primary digesters must be in operation.
- The primary digesters will need to remain heated and mixed in order to provide digestion.
- Installation of the boiler/heat exchangers will require that the Digester Control Building meet NFPA 820.
- Compliance with NFPA 820 will require removal of the gas handling equipment from the existing Digester Control Building as it is currently configured and designed.

Given these factors, it is recommended that the improvements be completed in the following sequence:

- Project I – Replacement of the Secondary Digester Gas Holder Cover and Modification of the Gas Handling System
    - Project I would provide the necessary gas storage volume and would complete the cover replacements. The gas mixing and handling system would be moved to the Digester Control Building roof.
- Project II – Replacement of the North Primary Digester Cover and Installation of a Draft Tube Gas Mixing System
    - Project II would convert the North Primary Digester to a fixed cover and replace the gas mixing system. The gas handling system would be located on the fixed cover of the digester.
- Project III – Replacement of the South Primary Digester Cover and Installation of Draft Tube Gas Mixing System
    - Project III would convert the South Primary Digester to a fixed cover and replace the gas mixing system. The gas handling system would be located on the fixed cover of the digester. Phases I, II, and III would result in the removal of the gas handling equipment from the Digester Control Building. The Digester Control

Building would then only be used for the Boiler/Heat Exchanger equipment and biosolids transfer equipment.

- Project IV – Replacement of the Boiler/Heat Exchanger Equipment in the Digester Control Building and Other Digester Control Building Modifications/Improvements
    - Project IV would provide the necessary digester heating capacity and a space in compliance with NFPA 820.

It is anticipated that these projects would be performed a series of "one-year" projects in order to provide the funding and to facilitate proper sequencing. This sequencing will minimize the impacts on facility operations. The costs for each project are presented in Table ES-2.

Table ES-1 Solids Processing and Handling Alternatives
City of Rapid City, SD
Water Reclamation Facility

Opinion of Probable Capital Costs

Item	*Anaerobic Digestion*	*Aerobic Digestion*	*CIP or Optional Items*								
			Potable Water Line	*Centrate Storage Tank*	*Iron Salts System*	*Digested Solids Pumps*	*Thickened/Dewatered Solids Rolloffs*	*MRF Thickened Solids Storage Tank*	*WRF Thickened Solids Storage Tank*	*Solids Processing Building HVAC Improvements*	*Miscellanious*
Digester Control Building											
Primary Digester Cover (North)											
Demolition of Existing Cover	$ 30,000										
New Fixed Cover and Mixing System	$ 280,000										
Construction/Installation/Fabrication	$ 150,000										
Painting	$ 60,000										
Electrical	$ 30,000										
Gas Piping and Appurtenances	$ 25,000										
Primary Digester Cover (South)											
Demolition of Existing Cover	$ 30,000										
New Fixed Cover and Mixing System	$ 280,000										
Construction/Installation/Fabrication	$ 150,000										
Painting	$ 60,000										
Electrical	$ 30,000										
Gas Piping and Appurtenances	$ 25,000										
Secondary Digester Cover											
Demolition of Existing Cover	$ 30,000										
New Gasholder Cover and Mixing System	$ 280,000										
Construction/Installation/Fabrication	$ 200,000										
Painting	$ 50,000										
Gas Piping and Appurtenances	$ 25,000										
Boilers/Heat Exchangers											
Demolition/Removal of Existing Boilers and Gas Compressors	$ 30,000										
New Boilers/Heat Exchangers (2)	$ 275,000										
Construction/Installation	$ 65,000										
Gas Piping and Appurtenances	$ 40,000										
Waste Gas Flare and Controls											
Demolition of Piping and Appurtenances	$ 2,000										
New Concrete Base	$ 2,000										
Gas Piping and Appurtenances	$ 10,000										
Enclosure for Equipment/Controls	$ 8,000										
HVAC System Improvements	$ 30,000										
Electrical Improvements (Class 1, Division 1)	$ 75,000										
Controls	$ 25,000										
Roof and Handrail Repair	$ 15,000										
Blower Building											
Demolition of Anaerobic Digester Equipment		$ 150,000									
Additional Digester Tank		$ 450,000									
Blower Building		$ 650,000									
Blower System and Controls		$ 525,000									
Aeration Piping		$ 150,000									
Coarse Bubble Diffused Air System		$ 200,000									
Process Piping		$ 75,000									
Decant Devices (4)		$ 40,000									
Power Supply		$ 90,000									
Sludge Processing Building											
WRF Thickened Sludge Storage Tank (expanded capacity)									$ 100,000		
Piping									$ 20,000		
Centrate Storage Tank (expanded capacity)				$ 100,000							
Piping				$ 20,000							
Polymer System Improvements											$ 10,000
HVAC System Improvements										$ 35,000	
Odor Control and Digester Gas Cleaning Systems											
5,000-gallon FRP Storage Tank					$ 25,000						
HVAC Improvements					$ 25,000						
Metering Pumps					$ 25,000						
Secondary Containment					$ 10,000						
Piping and Valves					$ 25,000						
Electrical and Controls					$ 20,000						
Miscellaneous Facility Improvements											
Potable Water Line Extension			$ 2,500,000								
Rolloff Containers							$ 25,000				
Digested Solids Pumps (replacement)						$ 20,000					
Secondary Scum Pump (replacement)											$ 20,000
Material Recovery Facility											
MRF Thickened Sludge Storage Tank (expanded capacity)								$ 100,000			
Piping								$ 20,000			
Truck and Sludge Trailer											$ 200,000
Construction Cost Subtotal	**$ 2,312,000**	**$ 2,350,000**	**$ 2,500,000**	**$ 120,000**	**$ 130,000**	**$ 20,000**	**$ 25,000**	**$ 120,000**	**$ 120,000**	**$ 35,000**	**$ 230,000**
Contractor's General Conditions (8%)	$ 185,000	$ 188,000	$ 200,000	$ 10,000	$ 10,000	$ 2,000	$ 2,000	$ 10,000	$ 10,000	$ 3,000	$ 18,000
Contractor's Overhead and Profit (15%)	$ 347,000	$ 353,000	$ 375,000	$ 18,000	$ 20,000	$ 3,000	$ 4,000	$ 18,000	$ 18,000	$ 5,000	$ 35,000
Contingency (30%)	$ 694,000	$ 705,000	$ 750,000	$ 36,000	$ 39,000	$ 6,000	$ 8,000	$ 36,000	$ 36,000	$ 11,000	$ 69,000
Total Construction Cost	**$ 3,538,000**	**$ 3,596,000**	**$ 3,825,000**	**$ 184,000**	**$ 199,000**	**$ 31,000**	**$ 39,000**	**$ 184,000**	**$ 184,000**	**$ 54,000**	**$ 352,000**
Professional Engineering Services (15%)	**$ 531,000**	**$ 539,000**	**$ 574,000**	**$ 28,000**	**$ 30,000**	**$ 5,000**	**$ 6,000**	**$ 28,000**	**$ 28,000**	**$ 8,000**	**$ 53,000**
Administration Services (8%)	**$ 283,000**	**$ 288,000**	**$ 306,000**	**$ 15,000**	**$ 16,000**	**$ 2,000**	**$ 3,000**	**$ 15,000**	**$ 15,000**	**$ 4,000**	**$ 28,000**
Total Project Cost	**$ 4,352,000**	**$ 4,423,000**	**$ 4,705,000**	**$ 227,000**	**$ 245,000**	**$ 38,000**	**$ 48,000**	**$ 227,000**	**$ 227,000**	**$ 66,000**	**$ 433,000**

Note: Costs are based on March 2007 dollars and a cost escalation factor should be considered when budgeting for all projects.

Table ES-2 Phased Project Approach
City of Rapid City, SD
Water Reclamation Facility

Opinion of Probable Capital Costs

Item	*Project I*	*Project II*	*Project III*	*Project IV*
Primary Digester Cover (North)				
Demolition of Existing Cover		$ 30,000		
New Fixed Cover and Mixing System		$ 280,000		
Construction/Installation/Fabrication		$ 150,000		
Painting		$ 60,000		
Electrical		$ 30,000		
Gas Piping and Appurtenances		$ 25,000		
Primary Digester Cover (South)				
Demolition of Existing Cover			$ 30,000	
New Fixed Cover and Mixing System			$ 280,000	
Construction/Installation/Fabrication			$ 150,000	
Painting			$ 60,000	
Electrical			$ 30,000	
Gas Piping and Appurtenances			$ 25,000	
Secondary Digester Cover				
Demolition of Existing Cover	$ 30,000			
New Gasholder Cover and Mixing System	$ 280,000			
Construction/Installation/Fabrication	$ 200,000			
Painting	$ 50,000			
Gas Piping and Appurtenances	$ 25,000			
Boilers/Heat Exchangers				
Demolition/Removal of Existing Boilers and Gas Compressors				$ 30,000
New Boilers/Heat Exchangers (2)				$ 275,000
Construction/Installation				$ 65,000
Gas Piping and Appurtenances				$ 40,000
Waste Gas Flare and Controls				
Demolition of Piping and Appurtenances				$ 2,000
New Concrete Base				$ 2,000
Gas Piping and Appurtenances				$ 10,000
Enclosure for Equipment/Controls				$ 8,000
HVAC System Improvements				$ 30,000
Electrical Improvements (Class 1, Division 1)				$ 75,000
Controls				$ 25,000
Roof and Handrail Repair				$ 15,000
Construction Cost Subtotal	**$ 585,000**	**$ 575,000**	**$ 575,000**	**$ 577,000**
Contractor's General Conditions (8%)	$ 47,000	$ 46,000	$ 46,000	$ 46,000
Contractor's Overhead and Profit (15%)	$ 88,000	$ 86,000	$ 86,000	$ 87,000
Contingency (30%)	$ 176,000	$ 173,000	$ 173,000	$ 173,000
Total Construction Cost	**$ 896,000**	**$ 880,000**	**$ 880,000**	**$ 883,000**
Professional Engineering Services (15%)	**$ 134,000**	**$ 132,000**	**$ 132,000**	**$ 132,000**
Administration Services (8%)	**$ 72,000**	**$ 70,000**	**$ 70,000**	**$ 71,000**
Total Project Cost	**$ 1,102,000**	**$ 1,082,000**	**$ 1,082,000**	**$ 1,086,000**

Note: Costs are based on March 2007 dollars and a cost escalation factor should be considered when budgeting for all projects.