Rapid City, South Dakota

Water Reclamation Facility

Trickling Filter and Effluent Solids Reduction Improvements Project

Evaluation Phase Report

City of Rapid City Project No. 12-2031 / CIP No. 50910

HDR Project No. 191776

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1. Executive Summary

1.1. Introduction

The City of Rapid City (City) Water Reclamation Facility (WRF) is located 5 miles east of the City in Pennington County, South Dakota. The WRF uses both a fixed film system (North Plant) and an activated sludge system (South Plant) that operate in parallel to treat wastewater from the facility's service area. The plants have a combined peak hydraulic capacity of 40.0 million gallons per day (MGD).

The fixed film system includes trickling filters and rotating biological contactors. The WRF has had frequent maintenance and operational issues with the tricking filter system, including the Trickling Filter Pump Station, influent piping, and the trickling filter rotary distributors. Additionally, the WRF has had trouble with algae and high solids in the effluent. The algae and high solids have been associated with poor ultraviolet (UV) disinfection performance and have resulted in permit violations for exceeding effluent solids limits.

The purpose of this project is to assess the condition of the existing tricking filter system; to evaluate alternatives for optimizing the performance of the system, for controlling algae growth, and for reducing effluent solids; to evaluate the performance of the disinfection system and post aeration system process; and to prepare capital, operation and maintenance, and life cycle costs for comparison of the improvement alternatives.

1.2. Trickling Filter Pump Station Evaluation

The Trickling Filter Pump Station discharges primary clarifier effluent and a portion of the unsettled trickling filter effluent (that is, recirculation flow) to the trickling filters. The existing Trickling Filter Pump Station is housed in the north end of the Operations Building. The Trickling Filter Pump Station includes two operational vertical turbine axial flow pumps with space for four, an influent chamber, wetwell, and recirculation pit and an above-grade valve room complete with pump discharge isolation valves and piping. Two of the vertical turbine pumps are removed and out of service.

An on-site investigation was conducted on October 15, 2012 to assess the existing condition of the facility and some of the primary findings were:

- Significant corrosion and deterioration of the concrete has occurred in the influent chamber and the wetwell of the existing Trickling Filter Pump Station.
- Complete removal and replacement of the structural beams is required.
- Extensive concrete rehabilitation is required in the influent chamber and wetwell.
- Rehabilitation of the above grade masonry building is required, especially on the west side of the building.

In addition, the configuration of the existing wetwell is not ideal, making the pumps susceptible to adverse hydraulic conditions. The existing pumps have been maintenance intensive and have been replaced frequently due to these adverse hydraulic conditions and the presence of snails. The pumps are difficult to maintain due to overhead limitations, which require two hoists and disassembly of the pumps. This, coupled with the inadequate clearance around the pumps, limits the functionality of the above grade structure.

To address the aforementioned issues with the Trickling Filter Pump Station, one (1) interim alternative and five (5) long-term alternatives were developed. The interim alternative is identified as PS Alt. No. 1 - Interim Improvements to Existing Pump Station with One (1) Vertical Turbine Axial Flow Pump and includes the following:

- **Install one (1) new vertical turbine axial flow pump with stainless steel impeller.**
- **Extend the 30-inch discharge piping from the pump room out through the north wall of the pump station building. This will include core-drilling two openings through the masonry wall.**
- **Excavate down to the 30-inch trickling filter influent forcemain piping and connect the 30-inch discharge piping to the forcemains below grade. This will include removal and replacement of the bituminous pavement.**
- **Remove or abandon in-place the existing discharge elbows located in the influent wet well chamber.**
- **Install a doorway on the north side of the building for access to the valves between the 30-inch discharge piping.**
- **Bypassing flow will be minimized, because one forcemain and trickling filter will remain in service while the connection is made to other forcemain.**

Note that the interim improvements do not address all the concerns with the existing pump station. Implementation of the interim improvements is only recommended to maintain operation and reliability of the Trickling Filter Pump Station until long-term improvements are made and proposed permit limits addressed. The total estimated project cost for PS Alternative No. 1 is $490,000.

The long-term alternatives for improvements to the Trickling Filter Pump Station are summarized as follows:

- PS Alternative No. 2 – Improvements to Existing Pump Station with Four (4) Vertical Turbine Solids Handling Pumps

- PS Alternative No. 3 – Improvements to Existing Pump Station with Three (3) Vertical Turbine Solids Handling Pumps

- PS Alternative No. 4 – Improvements to Existing Pump Station with Vertical Turbine Mixed Flow Pumps

- PS Alternative No. 5 – New Pump Station with Four (4) Vertical Turbine Solids Handling Pumps

- PS Alternative No. 6 – New Pump Station with Four (4) Submersible Solids Handling Pumps

These alternatives were evaluated based on both economic and noneconomic parameters. The parameters included capital cost, life cycle cost, reliability, flexibility, maintainability, and constructability. A rating weighting factor was assigned to each parameter reflecting the relative importance of each upon the overall objectives of the project. Raw scores were then assigned to the alternatives to express how each alternative compares to the others under each of the parameters. The raw score assigned to each alternative was a whole number between one and five, with five being the best. The results of the evaluation are shown in Table ES1 below.

Table ES1. Evaluation Matrix for the Trickling Filter Pump Station Alternatives

Rating Weighting Factor	Rating Category	PS Alt. No. 1		PS Alt. No. 2		PS Alt. No. 3		PS Alt. No. 4		PS Alt. No. 5		PS Alt. No. 6	
		Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
12	Capital Cost	5	60	3	36	4	48	4	48	2	24	3	36
30	Life Cycle Cost	5	150	4	120	4	120	4	120	3	90	2	60
23	Reliability	1	23	4	92	3	69	2	46	5	115	3	69
6	Flexibility	1	6	2	12	1	6	2	12	3	18	3	18
23	Maintainability	1	23	5	115	5	115	4	92	5	115	4	92
6	Constructability	2	12	2	12	2	12	2	12	5	30	5	30
100	**Total**		**274**		**387**		**370**		**330**		**392**		**305**

Alternative No. 5, which is construction of a new pump station with vertical turbine solids handling pumps (VTSH), has the highest overall total score and is recommended for the long-term Trickling Filter Pump Station improvements. The total estimated project cost for PS Alternative No. 5 is $8,930,000.

The recommended improvements include the following:

- **A new pump station constructed between the two existing trickling filters complete with:**
- **Below-grade cast-in-place concrete wetwell,**
- **Above-grade masonry building to house the pumps, discharge piping, valves, hoisting equipment and electrical controls.**
- **Four vertical turbine solids handling pumps with Variable Frequency Drives (VFDs).**
- **A new recirculation metering and valve structure for improved control of recycle flows.**
- **Two new Trickling filter influent metering structures.**
- **Associated junction boxes and piping to reroute flows from the primary clarifiers to the new pump station.**
- **Construction dewatering, excavation shoring, piling-type foundation system, grading, and miscellaneous site work.**

1.3. Trickling Filters Evaluation

The Rapid City WRF has two trickling filters, referred to as the East and West Trickling Filters. The trickling filters are 200 feet in diameter and contain rock media that varies in depth from 6 to 7 feet. The trickling filters at the WRF function primarily to remove Carbonaceous Biochemical Oxygen Demand (CBOD) from the wastewater.

The primary Trickling Filters assessment findings from the on-site inspection are as follows:

- The trickling filter concrete structure appeared to be in good condition,
- There is some repairable concrete corrosion at the connection plates.
- The aluminum domes are also in good condition with no recommended repairs needed.

- The rotary distributor mechanisms, located inside the trickling filters, which are used to disperse wastewater evenly across the rock media, have been well maintained and appear to be in good structural condition require the following repairs:
    - The guy wire support ties and hold down straps for the rotary distributors need to be replaced.
    - The East Trickling Filter rotary distributor bearing needs to be replaced.

The rotary distributors have been working well and have several years of service life remaining, with some maintenance and repairs needed. However, because the rotary distributors are hydraulically driven, control of the rotational speed is limited. Therefore, optimal dosing rates are achieved by pumping at a constant high flow rate where recycle ratios are higher than what would be required if the speed of the rotary distributors could be slowed down.

Three alternatives were evaluated to determine the best solution for improvements to the trickling filters, and primarily the rotary distributors. The alternatives are as follows:

- TF Alternative No. 1 - Optimization and reuse of the existing rotary distributors
- TF Alternative No. 2 - Replace the existing rotary distributors with motorized distributors
- TF Alternative No. 3 - Replace the existing rotary distributors with pneumatic distributors

For TF Alternative No. 2 the existing rotary distributors would be completely removed and replaced. However, for TF Alternative No. 3, the existing center columns would be reused and the distributor arms would be removed and replaced.

These three alternatives were evaluated based on both economic and noneconomic parameters similar to the Trickling Filter Pump Station Alternatives. The results of the evaluation are shown in Table ES2 below.

Table ES2. Evaluation Matrix for the Trickling Filter Improvements Alternatives

Rating Weighting Factor	Rating Category	TF Alt. No. 1		TF Alt. No. 2		TF Alt. No. 3	
		Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
12	Capital Cost	5	60	2	24	3	36
30	Life Cycle Cost	5	150	2	60	3	90
23	Reliability	3	69	4	92	5	115
6	Flexibility	2	12	5	30	5	30
23	Maintainability	3	69	5	115	5	115
6	Constructability	5	30	2	12	4	24
100	**Total**		**390**		**333**		**410**

Alternative No. 3, which is replacement with pneumatic rotary distributors, has the highest overall score and is recommended for the trickling filter improvements. The total estimated project cost for TF Alternative No. 3 is $1,020,000.

The recommended improvements include the following:

- **Removal of the existing rotary distributor arms.**
- **Retrofit the existing center column for attachment of the new distributor arms.**
- **New rotary distributor arms with forward and reversing nozzles that have internal pneumatically operated gates.**
- **Compressor, air piping, valves, and air control panel for control of pneumatically operated gates.**
- **Programmable Logic Controller (PLC) for automatic adjustment to maintain optimal dosing rates as well as periodic flushing dosing rates.**
- **Concrete patching where required.**
- **Replacement of the bearing at the East Trickling Filter.**
- **Supplemental air is not required to meet current permit.**

The benefits of changing the type of rotary distributor are:

- Provides for operator control to optimize wetting rates.
- Eliminates sloughing that impacts treatment performance
- Helps to control snail populations
- Reduces pumping rate resulting in $40,000 to $50,000 savings in annual power costs
- Provides greater process treatment consistency and reliability

1.4. Snail Control Alternatives Evaluation

The Rapid City facility has been challenged by the growth of snails and subsequent sloughing of snail shells from the trickling filters. Studies indicate that snails do not affect the BOD removal efficiency in conventional trickling filters. However, snail infestation has been shown to affect the performance of nitrifying trickling filters. Because the trickling filters at the Rapid City WRF serve primarily to remove BOD, the snail problem is not believed to be affecting the BOD removal efficiency of the trickling filters. Nevertheless, the snails do cause operational problems downstream of the trickling filters, including the accumulation of snail shells in the Trickling Filter Pump Station, wear on the pump impellers due to the abrasiveness of the snail shells, and deposits of snail shells in the secondary clarifiers. Snails that are deposited in the secondary clarifier are removed with solids, sent back to the Headworks of the plant and then removed in the grit removal system.

Several methods have been used for the control of snails at other wastewater treatment facilities. However, the most effective alternatives to prevent snail growth or to provide removal of the shells from the flow stream would be treatment with high strength ammonia or construction of a grit removal system on the trickling filter effluent pipe. High strength ammonia treatment would require the ability to isolate each trickling filter for 10 to 16 hours once each month, while the trickling filter is being dosed with a high strength ammonia solution and then flushed.

A grit removal system would need to be sized for 36 to 40 MGD. Grit pumps could then be used to remove the snails for pumping to a new grit cyclone and classifier system. Grit removal for a 36 MGD facility would require a capital investment of $2.5 to $3 million. Additionally, grit removal systems are labor intensive. Therefore, this method for grit removal is not practical for this facility.

Since the plant does not have the multiplicity required to isolate the trickling filters from treatment, providing trickling filter pumps that are more durable and resistant to the abrasiveness of the snails, is the chosen method for the Rapid City WRF. **No specific new constructed facilities are recommended for snail control.**

1.5. Algae Control Alternatives Evaluation

Algae growth has been an ongoing problem at the WRF that is believed to be a contributor to the limited success of the UV disinfection system. Algae growth is common in the open tanks where there is nutrients (phosphorous and nitrogen) and sunlight to support growth. At the WRF, algae primarily occurs in the final clarifiers and the previous chlorine contract basin. Algae grow on the weirs, launders, channels, walls and baffles in these tanks. Algae causes blinding of the UV disinfection bulb protection plate, which then requires frequent cleaning. Algae also contribute to high effluent solids being discharged from the WRF.

Several alternatives were evaluated for control of algae growth and included:

- Eliminating unused channels – fill and cap the three unused passes of the old chlorine contact basin.
- Light blocking methods
  - Covers on the effluent launders and weirs of the final clarifiers
  - Basin covers over the final clarifiers, effluent channels and chlorine contact basin
  - Channel covers
- Ultrasonic algae control – use sound waves to disrupt algae growth
- Cleaning alternatives
  - Physical cleaning with scrub brushes
  - Automated brush systems
  - Weir washers
- Chemical addition or microorganism addition
  - Chemical addition – Chlorine products or copper sulfate
  - Microorganism addition – Bioaugmentation products/additives

The recommended alternative for control of algae at the Rapid City WRF is to cover the weirs, launders, and the effluent channel of the clarifiers (clariflocculators and tertiary clarifiers), modify the flow path of the old chlorine contact basin, and cover the remaining portion of the influent channel to the UV disinfection system.

A summary of the total project costs for the recommended algae control alternative is shown in Table ES3.

Table ES3. Recommended Algae Control Alternative

No.	Item	Extended Costs
1	FRP Weir Covers on the Clariflocculators	$90,000
2	Flat Panel Aluminum Covers on the weirs, launders, and effluent channel of the Tertiary Clarifiers	$115,000
3	Modify flow path and cover the influent channel of the UV Channels & Old Chlorine Contact Chamber	$103,000
	Undeveloped Design Detail & Contingencies (25%)	$77,000

Total Estimated Construction Cost	**$385,000**
Planning, Design, and Construction Engineering (18%)	$69,000
Construction Materials Testing (1.5%)	$6,000
Legal, Administrative, Bonds, and Financial (4%)	$15,000
OPINION OF PROBABLE TOTAL PROJECT COST	**$475,000**

1.6. Effluent Solids Removal

Another means of reducing the negative impacts the algae and solids have on the UV disinfection process would be through the addition of a solids removal process. This could be implemented to reduce algae concentrations as well as other suspended solids in the effluent prior to UV disinfection. This process can be used alone or in combination with algae growth reduction measures. The following technologies were evaluated for this purpose and are discussed below:

- Conventional filters
- Compressible media filters
- Disk filters
- Dissolved air flotation (DAF)
- Strainers

Most of these processes would require pumping all of the filtered flow either ahead of or after filtration due to the hydraulic limitations of the current WRF process layout, imparting a significant cost on both the initial capital cost and ongoing operation and maintenance costs.

The evaluated processes would improve the effluent quality, reducing the algae and suspended solids very well before reaching the UV disinfection system and would increase the UV system effectiveness. The increased efficiency has not been estimated and would need to be field or lab verified by checking UV disinfected samples of filtered and unfiltered effluent. These processes are considered to be cost prohibitive unless future permit revisions drive the need to incorporate filtration. The capital costs for the processes evaluated ranged from approximately $6 million to over $13 million alone. In addition, providing filtration alone would not remove the algae problems on the launders, weirs, channels, and basins; and cleaning or covering the launders, weirs, channels, and basins would still be recommended. **For these reasons filtration or other effluent solids removal processes are not recommended for improving disinfection alone**.

1.7. Disinfection and Post Aeration System Process Evaluation

1.7.1. Disinfection

Disinfection of wastewater effluent is conducted to reduce or eliminate the pathogenic, disease causing, organisms present in domestic wastewater to levels regulated in the discharge permit. The WRF had historically used chlorine as the chemical disinfectant without significant coliform compliance issues and then dechlorinated with sulfur dioxide to meet effluent chlorine limits. The plant changed disinfection processes to ultraviolet (UV) disinfection in 2003 to eliminate the handling of hazardous chemicals. The conversion to UV disinfection eliminated the need to maintain a risk management plan which also required significant effort. With the UV disinfection process, ultraviolet radiation is generated via mercury vapor lamps located in the wastewater effluent, disrupting the ability of the coli forms to reproduce.

Since its installation, the UV system has not provided the level of pathogen deactivation desired, requiring about twice the anticipated UV dose to achieve adequate disinfection.

The type of wastewater treatment process can have a significant impact on the effectiveness of a UV reactor. Trickling filter plants have a history of being difficult to disinfect with UV due to color that is imparted to the wastewater in that process and also particle related; not necessarily as measured by TSS or turbidity, but the level of bacterial occlusion. Since trickling filter effluent is present at the Rapid City WRF, it was recommended that a collimated beam test be conducted in this evaluation to arrive at an approximate design dose. In our evaluation and discussions with the equipment supplier, this had not been conducted for this installation. It was recommended that this be conducted as an additional task in the evaluation, to determine if the UV disinfection equipment can function as desired. The results of this testing are summarized later in this section and in Section 8 of the report.

Abnormally high UV intensities measured by the online sensors and recorded by the data loggers at the WRF indicate that the actual transmittance can be significantly greater than the design, which would not be expected for this type of effluent. It is recommended that the sensors be calibrated and field verified. It is also recommended that field transmittance be measured and possibly install an on-line transmittance monitor. This will depend upon what the final recommendations are for the UV system and the disinfection process.

In addition to the algae growth reduction with the covers recommended, measures to keep the algae from coating the UV quartz sleeves will enhance the UV system performance. Providing a spare baffle plate which captures significant amounts is recommended, such that a plate can be in place at all times, even when one is taken out for cleaning. Verifying the effectiveness of the automated sleeve wiping system and keeping it in good working order will reduce algae and solids attachment to the sleeves which would block the UV rays.

Total suspended solids (TSS) are measured daily from composite samples collected over a 24-hour period. These composite samples do not account for peaks in the TSS that occur in the system. Such peaks impact the effectiveness of the UV system since they shield some of the microorganisms from the UV rays. Periodic TSS levels could be significantly higher at times such as during flow spikes, post-aeration blower startup and during weir and launder cleaning to remove algae. A turbidity meter was recently installed which gives insight into the real-time variations in turbidity, which likely parallels a TSS trend. The data shows that turbidity trends upward in relation to increases or spikes in flow and returning the effluent aeration blower to service after being offline. The increased turbidity reduces the effectiveness of the UV system by reducing the transmittance.

As described previously, to determine if the plant effluent required dose levels are outside of the targeted design dose (which would affect the system sizing and operation), collimated beam dose-response tests were conducted on unfiltered and filtered aliquots for samples collected on April 23rd and May 7th. The analysis was done on: 1) the Blended Effluent, 2) the North Plant Effluent and 3) the South Plant Effluent. Sampling results indicate a relatively high quality biologically treated Effluent with TSS levels ranging from 12 to 21 milligrams/liter (mg/l) and unfiltered fecal coliform levels ranging from 10,000 to 32,000 coliform organisms/100 mL (4 to 4.5 log concentration). Filtered log fecal coliforms were 0.2 to 0.7 less than unfiltered densities, indicative of the particulate fecal coliforms in the effluent. The collimated beam tests results indicated that the 30 mJ/cm^2 design minimum dose requirement used for sizing the UV system is reasonable. However, based on a UV design sizing assessment, the system is undersized and not able to deliver the minimum dose at the design flow rate, ultraviolet transmittance (UVT), and intensity attenuation factor. The original design basis used a model that has limitations and is most commonly used as a screening tool rather than for final system design. The original design also assumed a UV output efficiency that is too high. Direct dose-delivery challenges using added coliphage organisms is recommended to confirm the capacity of the existing UV system. These factors resulted in the system being undersized significantly, approximately 1/3 of what would be expected.

Upgrades are needed to correct the UV system deficiencies for the plant to consistently meet permit limits. A summary of the total project costs for a new UV disinfection system is shown in Table ES4. However, additional evaluation is recommended during the design phase to determine the most effective method for upgrades to the UV system. Alternatives to be evaluated would include supplemental disinfection with chemical such as chlorine or peracetic acid, replacement of the existing UV system with a new system, and expansion of the existing system.

Table ES4. UV Disinfection System Improvements Cost Data

No.	Item	Capital Cost	Installation	Total Installed Costs
1	Remove existing UV disinfection system	$0	$10,000	$10,000
2	New UV disinfection system (Based on proposal for Trojan UV3000 Plus)	$1,300,000	$520,000	$1,820,000
3	Upgrades to existing electrical and controls	$75,000	$30,000	$105,000
4	Upgrades to existing HVAC system	$22,000	$8,000	$30,000
5	Miscellaneous UV channel modifications	$25,000	$10,000	$35,000
	Subtotal	$1,422,000	$578,0000	$2,000,000
	Undeveloped Design Detail & Contingencies (25%)			$500,000
	Total Estimated Construction Cost			$2,500,000
	Planning, Design, and Construction Engineering (18%)			$450,000
	Construction Materials Testing (1.5%)			$37,000
	Legal, Administrative, Bonds, and Financial (4%)			$100,000
	OPINION OF PROBABLE TOTAL PROJECT COST			**$3,087,000**

1.7.2. Post Aeration System Performance

The post aeration system has a single constant speed rotary tri-lobe blower and fine bubble diffusers to raise the effluent dissolved oxygen (DO) to comply with the discharge permit. Since it is a constant speed, the blower cycles on and off to maintain the effluent DO level. This allows solids to settle and re-suspend during the cycling, causing solids spikes. There is a single DO probe used for this control, which does not allow for trimming the aeration and results in over aeration to consistently meet the permit. It is recommended that a second blower be installed since aeration is required to meet permit levels during most of the warm-weather months and if this lone blower were to go out of service, effluent DO violations are likely. To better trim and reduce cycling of the blower(s), it is also recommended to add variable speed drives to the blower(s) and another DO probe for DO level, reducing power consumption and solids spikes.

A summary of the total project costs for the recommended post aeration system improvements is shown in Table ES5.

Table ES5. Recommended Aeration System Improvements Cost Data

No.	Item	Capital Cost	Installation	Total Installed Costs
1	Blower (W/Sound Enclosure, Valves, Controls, Etc.	$42,000	$17,000	$59,000
2	Dissolved Oxygen Probe w/Controller	$4,000	$2,000	$6,000
3	VFD for Existing Blower (Optional)	$5,000	$2,000	$7,000
4	SCADA & Interconnection with Existing Facilities	$12,000	$4,000	$16,000
	Subtotal	$63,000	$25,000	$88,000
	Undeveloped Design Detail & Contingencies (25%)			$22,000
	Total Estimated Construction Cost			**$110,000**
	Planning, Design, and Construction Engineering (18%)			$20,000
	Construction Materials Testing (1.5%)			$2,000
	Legal, Administrative, Bonds, and Financial (4%)			$4,000
	OPINION OF PROBABLE TOTAL PROJECT COST			**$136,000**

1.8. *Proposed Permit Analysis*

The City is currently operating the WRF with a National Pollutant Discharge Elimination System (NPDES) permit that has been expired and administratively continued for several years. The South Dakota Department of Environment and Natural Resources (SDDENR) recently provided the City with new, proposed ammonia limits. The proposed ammonia limits are significantly lower than the current NPDES permit. A review of both the basis for the proposed limits and the dates used to calculate the permit were performed and resulted in some recommended corrections to the proposed ammonia limits.

The WRF discharges to Rapid Creek, which has a designated use at the outfall of the WRF of "warm water permanent fish life propagation". In South Dakota a 7Q25 flow is used for both acute and chronic concentrations for cold and warm water permanent fish life propagation waters. This low flow value is more restrictive than suggested by the EPA guidance. The 7Q25 low flow is calculated using data from the U.S. Geological Survey (USGS) gage just downstream of the WRF discharge and estimating the upstream flow by subtracting the WRF flow from the USGS flow. As part of the permit analysis review, the 7Q25 low flows were checked using two different models. The results of the flow models were not identical, but were very close, to the flows determined by the SDDENR. Some of the differences are because the SDDENR used the average monthly plant flow, on a daily basis, while the two "check" models used the actual daily plant flow data.

The stream data for temperature, pH and ammonia used in the program for modeling the processes were also reviewed. These parameters define the controlling conditions for ammonia toxicity, predict the biological removal of ammonia and project the downstream affects of ammonia present in the discharge from the WRF. It was determined that the SDDENR used WRF discharge data from the entire period from 1983 to 2012. Based on discussions with City staff it was determined that discharges during the period prior to 2004 are not representative of current conditions due to changes in plant operation. Therefore, proposed setpoints for temperature and pH downstream of the WRF discharge should be based on data from 2004 to 2012. The inputs in the model were updated using the revised data range. During input of the revised data it was discovered that there were two errors in the model. These errors, which affected the chronic criteria calculations, were corrected and the model was rerun to recalculate the limits. In general the differences between the original SDDENR proposed total ammonia limits and the recalculated limits would result in an increase the proposed limits from less than 1 mg/l to 5 mg/l.

Withdrawal of water by irrigators during the irrigation season leaves Rapid Creek relatively dry. As a result, further investigation is recommended to determine if the Creek should no longer be designated as a "Warmwater permanent fish life propagation water" water body. Redesignation of the Creek would be beneficial to the City, but would require considerable effort. If the proposed ammonia criteria are too difficult to meet, an option the City may consider is a compliance schedule to allow the City time to make the necessary changes to meet the proposed limits.

Past treated effluent ammonia values were compared to both the proposed flow-based monthly and daily limits. Based on this comparison, with the exception of the period from April 12 – April 14, 2012, the WRF would have met proposed effluent ammonia limits.

1.9. Summary Recommendations

During the preparation of this evaluation report, the South Dakota Department of Environment and Natural Resources (SD DENR) initiated discussions with the City regarding a proposed new NPDES permit. The proposed ammonia permit levels are significantly lower than the limits for which the current facility was designed to meet. The capacity of the current trickling filter treatment process to meet a significantly lower ammonia limit is marginal. However, based on past performance the plant has demonstrated the ability to meet proposed permit conditions. It is anticipated that the final ammonia limits will be higher than what the SD DENR initially proposed as a result of adjustments and corrections to the model used to determine the proposed effluent limits. Therefore, it is recommended that the City proceed with proposed improvements to the trickling filter pump station, the trickling filter rotary distributors, and other improvements that are intended to reduce effluent solids and increase disinfection performance.

A summary of the recommended improvements are shown in Table ES6 below.

Table ES6. Recommendations Summary Table

Recommendations	Construction Cost	Total Project Cost
PS Alt. No. 1 – Interim Improvements to Existing Trickling Filter Pump Station with One (1) New Vertical Turbine Axial Flow Pump	$390,000	$490,000
PS Alt. No. 5 – New Pump Station with Four (4) Vertical Turbine Solids Handling Pumps	$7,200,000	$8,930,000
TF Alt. No. 3 – Replace the existing rotary distributors with pneumatic distributors	$830,000	$1,020,000
Algae Control Alternatives	$385,000	$475,000
Post Aeration System Improvements	$110,000	$136,000
UV System Improvements	$2,500,000	$3,087,000

1.10. Proposed Projects

The recommended improvements will be combined into four projects that will be phased over the next 1 to 5 years. The projects have been identified as Project A, Project B, Project C, Project D, and Project E. These five projects are described in the following paragraphs.

1.10.1. Project A – Interim Trickling Filter Pump Station Improvements

Project A has been designed and includes the interim trickling filter pump station improvements. This project has been designed and is planned for construction in the fall of 2013. Project A improvements are being completed to increase equipment redundancy and plant reliability while long-term improvements are implemented. This project would be completed by a general water and wastewater contractor. The City is purchasing and installing the pump separately. A summary of the Project A costs are shown in Table ES7 below:

Table ES7. Project A Cost Summary – Interim Trickling Filter Pump Station Improvements

Recommendations	Construction Cost	Total Project Cost
PS Alt. No. 1 – Interim Improvements to Existing Trickling Filter Pump Station with Vertical Turbine Axial Flow Pumps	$390,000	$490,000
Total Estimated Cost	**$390,000**	**$490,000**

A proposed implementation schedule for Project A is shown in Table ES8.

Table ES8. Proposed Implementation Schedule for Project A

Description	Completion Date
Design	
Design Contract Award	May 15, 2013
Final Design Submittal	July 10, 2013

Description	Completion Date
Bid	
Request Bids	July 10, 2013
Contract Award	August 6, 2013
Construction	
Shop Drawing Submittal Approvals	August 30, 2013
Site Restoration and Construction Completion	November 1, 2013

1.10.2. Project B – Modifications to Flow Path of Chlorine and UV Channel, Post Aeration System Improvements, and UV Disinfection System Improvements

Project B will include improvements that would primarily serve to increase equipment redundancy, plant reliability, and increase UV disinfection capacity. Project B will include Modifications to the Flow Path of the Chlorine and UV Channels, Post Aeration System Improvements, and UV Disinfection System Improvements. This project would be completed by a general water and wastewater contractor. A summary of the Project B costs are shown in Table ES9 below:

Table ES9. Project B Cost Summary – Post Aeration System Improvements and UV Disinfection System Improvements

Recommendations	Construction Cost	Total Project Cost
Modifications to Flow Path of Chlorine & UV Channel	$110,000	$136,000
UV Disinfection System Improvements	$2,500,000	$3,087,000
Post Aeration System Improvements	$110,000	$136,000
Total Estimated Cost	**$2,720,000**	**$3,359,000**

A proposed implementation schedule for Project B is shown in Table ES10. Construction permitting and the submittal to the SDDENR are included as part of the design phase schedule and would be dependent on whether or not the project is funded with a State Revolving Fund (SRF) Loan.

Table ES10. Proposed Implementation Schedule for Project B

Description	Completion Date
Design	
Design Contract Award	September 5, 2013
Predesign Services (UV disinfection system upgrades evaluation)	October 17, 2013
Final Design Submittal	March 13, 2014
Bid	
Request Bids	March 14, 2014
Contract Award	May 1, 2014

Description	Completion Date
Construction	
Shop Drawing Submittal Approvals	June 15, 2014
Project Completion	December 31, 2014

1.10.3. Project C – Cover Improvements

Project C, includes the cover over the remaining chlorine & UV channels, FRP weir covers on the clariflocculators, and flat panel aluminum covers on the weirs, launders, and effluent channel of the tertiary clarifiers. Project C improvements would increase plant performance. Project C could be completed by a manufacturer's specialty contractor that commonly works with certain manufacturers or by a general water and wastewater contractor. A summary of the Project C costs are shown in Table ES11 below:

Table ES11. Project C Cost Summary – Cover Improvements

Recommendations	Construction Cost	Total Project Cost
Cover Influent Channel to old Chlorine Contact Chamber/UV Basins	$19,000	$23,000
FRP Weir Covers on Clariflocculators	$112,000	$138,000
Flat Panel Aluminum Covers on the Weirs, Launders, and Effluent Channels of the Tertiary Clarifiers	$144,000	$178,000
Total Estimated Cost	**$275,000**	**$339,000**

The design and bidding schedule for Project C will be similar to Project B. However, the construction schedule for Project C will be shorter than Project B. A proposed implementation schedule for Project C is shown in Table ES12.

Table ES12. Proposed Implementation Schedule for Project C

Description	Completion Date
Design	
Design Contract Award	September 5, 2013
Final Design Submittal	January 9, 2013
Bid	
Request Bids	January 10, 2014
Contract Award	February 27, 2014
Construction	
Shop Drawing Submittal Approvals	April 1, 2014
Project Completion	June 1, 2014

Projects B and C could be completed as separate projects. However, it may be beneficial to complete both projects as one to simplify the planning, design, and review process as well as obtain better bid pricing from a larger project.

1.10.4. *Project D – Long-Term Improvements to Trickling Filter Pump Station*

Project D will be the recommended long-term improvements to the Trickling Filter Pump Station, which is PS Alternative No 5 - New Pump Station with Four (4) Vertical Turbine Solids Handling Pumps. A breakdown of Project D costs is shown in Table ES 13.

Table ES13. Project D Cost Summary – Long-Term Improvements to Trickling Filter Pump Station

No.	Item	Extended Cost
1	General Conditions (5%)	$325,000
2	Division 2 - Site Work	$781,000
3	Division 3 - Concrete	$757,000
4	Division 4 - Masonry	$197,000
5	Division 5 - Metals	$176,000
6	Division 6 - Carpentry	$10,000
7	Division 7 - Thermal & Moisture Protection	$74,000
8	Division 8 - Doors & Windows	$51,000
9	Division 9 - Finishes	$144,000
10	Division 10 - Specialties	$12,000
11	Division 11 - Equipment	$2,400,000
12	Division 12 - Furnishings	$ -
13	Division 13 - Special Construction	$66,000
14	Division 14 - Conveying Systems	$100,000
15	Division 15 - Mechanical	$144,000
16	Division 16 - Electrical	$529,000
	Undeveloped Design Detail & Contingencies (25%)	$1,434,000
	Total Estimated Construction Cost	**$7,200,000**
	Planning, Design, and Construction Engineering (18%)	$1,300,000
	Construction Materials Testing (1.5%)	$110,000
	Geotechnical (0.5%)	$40,000
	Legal, Administrative, Bonds, and Financial (4%)	$280,000
	OPINION OF PROBABLE TOTAL PROJECT COST	**$8,930,000**

A proposed implementation schedule for Project D is shown in Table ES14. Construction permitting and the submittal to the SDDENR are included as part of the design phase schedule and would be dependent on whether or not the project is funded with a State Revolving Fund (SRF) Loan.

Table ES14. Proposed Implementation Schedule for Project D

Description	Proposed Completion Date
Design Design Contract Award Final Design Submittal	 September 5, 2013 September 3, 2014
Bid Request Bids Contract Award	 September 4, 2014 October 29, 2014
Construction Equipment Submittal Approvals Pump Station Startup & Final Acceptance	 January 1, 2015 December 31, 2015

1.10.5. Project E- Trickling Filter Improvements

Project E will be the recommended improvements to the Trickling Filters, which is TF Alternative No. 3 - Replace the existing rotary distributors with pneumatic distributors. A breakdown of Project E costs is shown in Table ES 15.

Table ES15. Project E Cost Summary –Trickling Filter Improvements

No.	Item	Extended Cost
1	Division 1 - General Conditions	$50,000
2	Division 2 – Site Work	$40,000
2	Division 3 - Concrete	$20,000
3	Division 5 – Metals	$20,000
4	Division 11 - Equipment	$478,000
5	Division 16 - Electrical	$52,000
	Construction & Undeveloped Design Detail Contingencies (25%)	$170,000
	Total Estimated Construction Cost	**$830,000**
	Planning, Design, and Construction Engineering (18%)	$150,000
	Construction Materials Testing (1.5%)	$10,000
	Legal, Administrative, Bonds, and Financial (4%)	$30,000
	OPINION OF PROBABLE TOTAL PROJECT COST	**$1,020,000**

A proposed implementation schedule for Project E is shown in Table ES16. Construction permitting and the submittal to the SDDENR are included in the design phase schedule and would be dependent on whether or not the project is funded with a State Revolving Fund (SRF) Loan.

Table ES16. Proposed Implementation Schedule for Project E

Description	Proposed Completion Date
Design	
Design Contract Award	September 5, 2013
Final Design Submittal	September 3, 2014
Bid	
Request Bids	September 4, 2014
Contract Award	October 29, 2014
Construction	
Equipment Submittal Approvals	January 1, 2015
Trickling Filter Startup & Final Acceptance	December 31, 2015

1.11. Recommended Improvements Verses Expansion of the Activated Sludge Facilities

The recommendations in this report are primarily for upgrades to the existing trickling filter system for the north plant at an estimated cost of approximately $10 million for interim plus long term improvements. In comparison, an alternative to upgrading the trickling filter system would be to expand the activated sludge system of the south plant and decommission the north plant. Based on the February 2000 Facilities Plan, prepared by McLaughlin Water Engineers for the WRF, the existing south plant, activated sludge system, was designed for an average day capacity of 2.2 MGD, a peak day capacity of 5 MGD, and a peak hydraulic capacity of 10 MGD. However, the peak flow through the south plant is limited because flows exceeding 4.0 MGD will damage the curtain walls at the head end of the aeration basins. The curtain walls need to be removed or replaced to improve hydraulic capacity.

The activated sludge system would need to be expanded to provide an additional average day capacity of 10 MGD and additional peak hydraulic capacity of 36 MGD to match the capacity of the existing north and south plants combined of 12.2 MGD average day and 40 MGD peak. In other words the existing activated sludge system would need to be duplicated 5 to 6 times (5 to 6 added trains). Additional land would need to be acquired to expand the activated sludge facilities, because the existing site only allows for doubling the size of the existing activated sludge system. An estimated 10 to 15 acres of additional land would be needed for the expansion.

Expansion of the activated sludge facilities, not including solids handling, would cost an estimated $40 to $60 million based on rule of thumb costs per gallon of treatment capacity. The upper end includes potential pumping/equalization requirements to handle peak flows. If new primary clarifiers are included ahead of the activated sludge system expansion, an additional cost of approximately $10 million will need to be added.

An advantage in expanding the activated sludge facilities verses upgrading the trickling filter system is that activated sludge is more adaptable to meeting potential future nutrient limits.