

LAGOON IMPROVEMENTS

SPRING CREEK SANITARY DISTRICT

Facility Plan, December 22, 2021

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1 – INTRODUCTION

This facility plan was commissioned by the Spring Creek Sanitary District to evaluate the facilities for compliance with their operating permit and long-term planning of system improvements. The Sanitary District currently operates the treatment lagoons which are located in the NE ¼ of Section 4, T112N, R80W, Hughes County, South Dakota. It serves a number of residents, RV parks, and two restaurants which are part of the Spring Creek Recreational area.

This engineering report provides information and recommendations for the Sanitary District to bring their treatment lagoon into compliance with State guidelines.

2 – PROJECT DEVELOPMENT

Compliance Inspection and Purpose of the Report

The Facility Plan for the Spring Creek Sanitary District (SPSD) was created in response to The South Dakota Department of Agriculture and Natural Resources (DANR) Surface Water Discharge Compliance Inspection completed on July 17, 2019. That inspection noted the water levels in the lagoon particularly Cell #1 has seen little change and upon reviewing influent flows the facility should have more water in the lagoons. It was mentioned the likelihood of Cell #1 liner may be compromised thus causing the influent flows to infiltrate the soil. Due to this leakage the facility needs to evaluate alternatives to repair and rehab the existing liner and lagoon system and consider other modes of operating the system. A copy of the 2019 inspection report is included in the Appendix.

Included in the facility plan is background information on the project need, tabulation of current and future users within existing development and related effluent, review of three different design alternatives, design calculation for both organic and hydraulic loading, cost estimates for each alternative, summary comparison, and schedule.

Existing Surface Water Permit

The Spring Creek Sanitary Sewer District is regulated under surface water discharge (SWD) permit SD-SDG826751 – included in the Appendix – which requires permission to operate and inspection by the SD DANR. Currently the lagoon is operating as a non-discharge facility.

Map of Project Area

A map of the project area showing the location of the main collection system, primary lift station and lagoon cells is included in the Appendix.

3 – ENVIRONMENTAL INFORMATION DOCUMENT

Description of Project Area

The Spring Creek Sanitary District and lagoon system is about 15 miles north of Pierre, South Dakota and is located on the northeast edge of the Lake Oahe Reservoir and the Missouri River. It serves a mixture of seasonal and permanent homes along with a number of RV parks and restaurants.

The collection system consists of nearly 2 miles of 8-inch and 10-inch PVC gravity sewer that flow into a main wet well and duplex lift station located about half a mile west of the lagoon facility. A 6-inch force main delivers the wastewater effluent from the main lift station to the lagoon system. The original lagoon system built in 1991 was designed with two cells however this was modified in 2002 and the cells divided to create three cells out of the same footprint.

On three sides, the lagoon facility is bordered by agricultural land and open fields. An RV Park is situated to the north. Most of the agricultural land in the area are cropped in corn or beans with some hay ground as well. It appears to be highly productive ground when irrigated with water from the Missouri River and nearby Reservoir.

In recent years the area has seen strong growth. Permanent housing permits are up. Seasonal housing due to the recreational appeal and the popular fishing and boating activities available in the region are also increasing. Discussions with local staff validate the area will likely see strong and sustained growth for the near future.

Project Purpose and Need

The general purpose of the recommended WWTF improvements is to bring the system back into compliance with the existing permit as a non-discharge system. More specifically, addressing concerns with the lagoon liner and dissipation of effluent that is noted to be more than anticipated by evaporation. The focus of this study are improvements to the lagoon system needed to meet DANR requirements. The sanitary District should also continue to maintain the collection system, improve metering at the lift station, and investigate possible inflow and infiltration (I&I) issues.

4 – EVALUATION OF PRESENT CONDITIONS

Condition of Existing *Lagoon Treatment Facility*

The existing treatment facility was built in 1991 and upgraded in 2002 when they divided Cell #1 into two smaller cells. This division seemingly occurred in response to the system being unable to maintain water in the ponds. The system, according to their permit, serves a population of 250. The system currently consists of three cells, 1.6 acres, 3.8 acres, and 2.3 acres respectively.

Based on a visual inspection of the system and review of the DANR Surface Water Discharge Compliance Inspection report, it appears that Cell #1 is covered with 80% cattails. As stated in the inspection report this has been noted since 2007. The inspection report also noted other lack of maintenance issues that have since been remedied. Pond Cells #2 and #3 are dry and overgrown with grass. The rip rap lined berms are present but overgrown with vegetation.

At the time of the visual inspection of the system only cell #1 had standing water. The water level in cell #1 is shallow with a depth of 6-12 inches of water. It has been noted by the system operator that the water level in cell #1 never really changes. The following figures are photos of the existing lagoon cells at time of the visual inspection and a site survey for the report.



Figure 1—Lagoon Pond Cell #1, Looking Northeast



Figure 2—Berm Separating Pond Cell #1 and #2, Looking East



Figure 3—Lagoon Cell #2, Looking Northeast



Figure 4—Lagoon Cell #3, Looking Northeast

Existing Lagoon Volume, Surface Area and Layout

For the purpose of this study the layout and numbering of the pond cells shall be as follows:



Figure 5—Numbering Order of Lagoon Pond Cells

A summary of the volume and surface area at a depth of 5' for each of the lagoon cells is tabulated below. This is used in evaluating the available capacity of the system against the current and future hydraulic and organic loading.

Table 1—Lagoon Volume and Surface Area

Lagoon Volume and Surface Area			
Spring Creek Sanitary District			
Lagoon Cells	Water Depth	Surface Area * (acres)	Volume * (gal)
Cell 1	5.0	1.55	2,149,528
Cell 2	5.0	3.79	5,569,159
Cell 3	5.0	2.26	3,238,092
Total		7.6	10,956,779
* Based on indicate water depth and volume			

Permeability Testing

To evaluate the soils and condition of the existing lagoon cells, Bartlett & West took 6 soil samples from existing cell #2 and #3 to American Engineering Testing, Inc. for proctor and permeability testing. The results are included in the Appendix. It is the opinion of American Engineering Testing Inc., the existing clay soils are suitable for use as a clay liner.

Site Survey

In order to evaluate current condition and confirm size and elevations of existing lagoon cells to the original plans, Bartlett & West performed a site topographic survey. Survey information was incorporated into the alternative's evaluation.

5 - PROJECTIONS OF FUTURE NEEDS

Current and Future Metered Connections and Users

The Spring Creek Sanitary District has a total of 227 active sewer accounts in the Spring Creek Recreational area. This includes approximately 209 residential users, some of which are part time and/or seasonal residents and six (6) different RV parks in the service area. The remaining twelve (12) are commercial accounts and include small businesses and restaurants. The RV parks range in size from 24 to 275 units for a total of approximately 652 RV units.

In addition to the users mentioned above, there are unimproved platted lots within the existing system that the Sanitary District is anticipating will be improved on with approximately 190 new residential meters (permanent and seasonal) planned and additional RV park units of 200.

A tabulation of the current and anticipated users on the system is provided below.

Table 2—Current and Future System Users and Metered Connections

Current and Future System Users and Metered Connections					
Spring Creek Sanitary District					
Account	Residential Users		Commercial	RV Lots	Comments
	Full Time (meters)	Part Time (meters)	Est. Pop. (population)	(units)	
RV Parks					
Codger's Cove				275	
Cow Creek Estates				100	
Dakota Sky RV				85	
Oahe Speedway				68	
Outpost Lodge (2nd meter)				24	
SD GFP - Cow Creek				100	
Residential Users					
Residential Full Time	116				
Residential Part Time		93			
Commercial Users					
Outpost Lodge (24 Units)			80		restaurant & lodge 24 units
Dakota Sky Lodge			5		convenience store
SD GFP - Lake Place			10		lodge and convenience store
SD GFP - Spring Creek Ventures			30		restaurant
Hofer Crop			2		sewered restroom
SD GFP - Spring Creek Fish Cleaning			5		fish cleaning station
SD GFP - Spring Creek Marina			5		fish cleaning station
Total Existing Users	116	93	137	652	
New Users in Existing Developments					
Potential Users in Platted Areas	110	80		200	
Total New Users	110	80	0	200	
SD GFP - South Dakota Game Fish and Parks					

Current and Projected Population and Design Flows

Using the current and future metered connections and number of users within the system a design population was developed along with related design flows. The design population is based on 2.5 residents per metered residential user and 2.0 persons per RV unit. The recreational area is also seasonally occupied with nearly 100% use during peak periods like the 4th of July weekend. During the off season for seven (7) months, the RV parks are closed along with about half of the commercial users. For this reason, the population is estimated for the summer and “off-season” period and then a maximum day use. During the summer season, permanent residential homes are 100% occupied. Part time homes and the RV Parks are estimated to be 40% occupied as many of these are used predominately over the weekend. During the off-season permanent residential uses remain 100% occupied but the part time residents and RV parks have 0% occupancy. A max day calculation estimates the effluent for 100% occupation and a multiplier of 2.0 for max day dry weather flow and a multiplier of 3.5 for max day wet weather flow.

The design criteria for determining design flow is based on the South Dakota Administrative Rule 74_53_01_20 and historical information and flows, as noted below.

A summary of the design criteria is as follows:

- Design population is based on 2.5 persons / residential unit and 2.0 person / RV unit.
- Average day resident and commercial use of 50 gallons / person / day.
- Average day RV use is 33.5 gallons / person / day (67 gallons per RV unit per day).
- Summer occupancy is 100% full time residential and 40% part time residential and RV units.
- Off season occupancy is about 50% residential, 42% commercial and 0% RV units.
- Max day is 100% occupancy with factor of 1.5 for dry weather, 3.5 factor for wet weather.
- Annual Avg. Day prorates summer use for 150 days and off season use as 215 days.
- To match industry standard flow projections with historical flows observed on site a factor of 90% was used.

Table 3—Current and Future Design Population and Design Flows

Current and Future Design Population and Design Flows						
Spring Creek Sanitary District						
Account	Residential Users		Commercial Est. Pop.	RV Lots	Total	
	Full Time	Part Time				
Design Population						
Existing Summer Population	290	93	137	522		
Existing Off Season Population	290	0	57	0		
Existing Annual Average Population					633	
Future Summer Pop.	275	80		160		
Future Off Season Pop.	275	0		0		
Future Annual Avg Pop.					374	
Design Flows					Total	
Max Effluent per Person per Day	75	75	75	50		
Avg Effluent per Person per Day	50	50	50	33.3		
Historical Adjustment Factor	90%					
Existing System Users						
Avg Day Summer Eff. (90 Days)	13,050	4,185	6,165	15,648	39,048	
Avg. Day Off-Season Eff. (275 days)	13,050	0	2,569	0	15,619	
Future Users in Existing Developments						
Avg. Day Summer Effluent	12,375	3,600	0	4,800	20,775	
Avg. Day Off Season Effluent	12,375	0		0	12,375	
		Existing System	Future System		Combined	
Design Population		633	374		1,006	
Avg Day Off-Season Loading (gpd)		15,619	12,375		27,994	
Annual Average Day Loading (gpd)		25,247	15,827		41,074	
Max Day Dry Weather Loading (gpd) --2.0x		137,595	66,750		204,345	
Peak Day Wet Weather Loading (gpd) --3.5x		240,791	116,813		357,604	
Peak Day Wet Weather Loading (gpm) --3.5x		167	81		248	

Historical Data versus Design Flows

The reported inflows from the influent lift station for the years 2018 and 2019 are as shown in the following table. The annual average day flow for 2019 is about 40% more than the annual average flow for 2018. This is likely due to the higher-than-average rainfall in 2019 resulting in above average I&I (Inflow and Infiltration). Because the calculated value is greater than both the historical information from 2018 and 2019, a 90% adjustment factor is used to match the historical records with the calculated values. After adjustment, a calculated average day dry weather of nearly 25,250 gpd compares with the measured annual flow in 2019 of nearly 24,000 gpd.

Table 4— Measured and Calculated Inflow at Primary Lift Station

Measured vs Calculated Inflow at Lift Station			
Spring Creek Sanitary District			
Year	Annual Avg Day (gpd)	Annual Prorated Population	Effluent Per Person (gpcd)
2018	16,546	633	26
2019	23,953	633	38
Calculated Annual Avg. from population & design flows			
	25,247	633	40
Calculated is based on a historical factor adjust of 90%			

As a back-check and comparison, drinking water records were also reviewed to compare actual data against calculated values. The calculated maximum dry weather wastewater flow (100% use and multiplier of 2.0) of 137,600 gpd compares with a 4th of July peak weekend water use documented at 147,700 gallons per day.

6 – EVALUATION OF ALTERNATIVES WITH DESIGN CALCULATIONS

Summary Discussion of Alternatives

Four possible treatment alternatives were evaluated. These include 1) rehabbing the existing pond liners, 2) converting the secondary treatment to a wetland, 3) converting the secondary treatment to a subsurface dispersal system, and 4) developing a similar system in a new location. All the alternatives bring the system into compliance with permit and DANR directives and are based on continuing to operate the lagoon as a non-discharging system.

Drawings showing the layout of the various alternatives are provided in the Appendix

Alternative 1 – Rehab Pond Liners: Rehab the liner in all three cells by installing a flexible poly liner in cells #1 and #3 and rehabbing cell #2 in the middle with a mixture of bentonite and compacted on-site soils. Continue to operate the system as a non-discharging lagoon with current and future capacity based on maintaining an evaporating system and maximum seepage of .0125 inches per day for all three ponds.

Alternative 2 – Convert to a Wetland with Pretreatment: Converting the largest middle cell to a wetland and purposely growing native plants for secondary treatment and uptake of the effluent. Rehab and install poly liners in both smaller cells #1 and #3 for pretreatment.

Alternative 3 – Convert to a Subgrade Dispersal System with Pretreatment: Convert the largest middle cell to a buried dispersal system, add network of underground header and laterals for effluent dispersal. Rehab and install poly liner in smaller cells #1 and #3 for pretreatment.

Alternative 4 – Develop a new Lagoon Site: Move the existing treatment lagoon to a new site and develop new cells for primary treatment along with a similar sized wetland.

Alternative #1: Rehabilitate Liners of All Lagoon Cells

The first design alternative considers a rehab of all the existing cells and their associated liners starting with lagoon cell #2 and #3 that are currently not in use. The rehab would consist of the following:

- Regrade and install a flexible poly liner in existing pond cell #3.
- Install a splitter box, piping and manholes and route influent flows to pretreatment pond cell #3.
- Add bentonite and recompact with moisture the clay liner in Pond Cell #2.
- Put newly reconstructed cell #3 and #2 into service, bypassing existing pond cell #1.
- Prefill pretreatment pond cell #3 and overflow into renovated pond cell #2, use potable water as needed for complete filling. Cell #2 shall maintain a minimum of 2 ft water depth to protect the liner.

- Allow cell #1 to dry out, remove sludge and rehab with new flexible poly liner.
- Prefill pond cell #1 and put into service.

The lagoon cells when initially constructed were done so utilizing on-site soils. It is evident that this approach was either unsuccessful due to the way the cells were initially constructed and put into service or the way the cells were maintained. In the case regarding the initial project construction, the soils may not have been sufficiently compacted and/or the soils themselves did not have enough clay or cohesive material.

The other potential reason for failure is that the water depth within the lagoon cells were not maintained after initial project completion. The industry standard for prefill and minimum water depth in a wastewater lagoon is 2 ft. With lack of moisture, cracks develop in the bottom of the clay liner and with the growth of volunteer grasses and shrubs, the integrity of the liner is further compromised. Reasons which could have contributed to the less-than-ideal conditions for startup of the initial lagoon project, including 1) the seasonal type of users, 2) limited number of users at initial completion of the project and/or 3) lack of rainfall for an extended period of time.

Based on the initial and limited soils samples, it is the opinion of the Geotech AET that the on-site soils are suitable for use as a clay liner. However, due to the failure of the existing cell liner it is recommended to use a poly (rubber) liner with a minimum of 30 mill thickness for the two smaller cells. For the larger cell, it is recommended to mix bentonite with on-site soils at a rate of 2 pounds per square foot to a minimum liner depth of one foot and compacting the base. The addition of bentonite will help lower the permeability rate of the clay liner.

In addition, once the liner rehab is complete, it is recommended that the new cells be filled to a minimum of 2 feet of depth, even using potable water, if necessary to prevent the liner from drying and damage from occurring again.

Alternative #2: Convert the Secondary System to a Wetland

Another option considers converting the larger middle cell into a wetland and lining (with poly liner) and using the remaining portion of the pond cells for pretreatment. Native reeds and a mixture of hydrophilic and facultative grasses planted in the wetland portion of the lagoon will uptake nutrients and moisture from the effluent to provide a non-discharging solution and maintain the current status of the lagoon. Built with a header to aid in distributing the effluent biological loading more evenly across the wetland and having a mixture of natural grass cover with varying moisture demands, it responds well to seasonal flow variations. Water within the wetland portion of the lagoon is to be designed to maintain a depth of 6-24-inches with nine (9) inches as an optimum depth.

With no special liner requirements and only limited seed bed preparation it is also a low-cost solution, especially when compared to options which require compaction and mixing bentonite into the subsoil.

In addition, there are no regulated maximum seepage rates for the wetland portion of the lagoon. The maximum seepage rate of 1/16 of an inch per day will still apply for the two pretreatment pond cells. Again though, for these ponds it is anticipated that a flexible poly liner will be installed.

Construction of the system includes the following:

- Regrade and install a flexible poly liner in existing pond cell #3.
- Install a splitter box, piping and manholes and route influent flows to pretreatment pond cell #3.
- Clear, scarify and plant native reeds and hydrophilic grasses in the newly designated wetlands.
- Construct at the maximum design water depth discharge headers from ponds #1 and #3 in the wetland.
- Prefill pond cell #3 and put the newly constructed wetland into service, initially bypassing existing pond cell #1.
- Allow cell #1 to dry out, remove sludge and rehab with new flexible poly liner
- Prefill pond cell #1 and connect to wetland discharge header and put into service

Wetland Locations

Consideration was given to using the middle cell for pretreatment and converting the two smaller cells to the north and south for use as a wetland. The advantage to this approach is existing lagoon cell #1 is currently operating much like a wetland, albeit without pretreatment, and could easily be modified for use as a wetland with minimum changes.

However, upon review of design criteria in the DANR Design Criteria Manual, Chapter IV Basis of Wetland Design it was decided that the middle cell #2 is the most suited for wetland design. These considerations are summarized below:

- A rectangular configuration for the wetland is preferred with a 5 to 10x width to length ratio
 - Existing Cell #1 and #3 are more like squares, existing cell #2 is about 2x L x W.
- A discharge header should be installed to prevent erosion and channeling of the inflow.
 - Existing pond cell #1 already has some channeling in it.
 - It would be difficult to install a discharge header
- The establishing of specific indigenous plant species and vegetation is recommended.

For these reasons the wetland alternative is configured on the basis of cells #1 and #2 providing pretreatment and the middle cell #2 being converted into a wetland.

Alternative #3: Convert to A Subgrade Dispersal System

Finally, similar to a wetland, consideration was given to converting about half of the existing lagoon cells into a subgrade dispersal system and using the remaining portion of the pond cells for pretreatment. The advantage of a dispersal system over a wetland is no open water surface resulting in less mosquito breeding and reduced odors. Built with headers, a splitter box, and

multiple perforated laterals distributed and spaced evenly and buried in a minimum of 6"-12" of gravel to allow even distribution and lateral flow of the effluent.

Topsoil is then spread over the mounded lateral system and seeded to maintain a natural grass cover. The topsoil is sloped away from the mound for surface runoff and to prevent water from entering the subgrade and lateral system. Finally, similar to Alternative #2 existing pond cells #1 and #3 are lined with a flexible poly liner to provide pretreatment prior to the drain field.

Because DANR is limited to review and approve subgrade drainfield / drainage systems of 15,000 gpd or smaller the approval for this type of system comes through the EPA office in Denver. An application was prepared and submitted to EPA Denver for this type of system and a response letter was received allowing the District to operate a disposal system without a full permit in accordance with an "authorized by rule" review. See the Appendix for a copy of their review letter.

One option for the drain field is to utilize a proprietary drain field product that offer a complete system subgrade system for dispersal of the effluent. These infiltration systems include slotted HDPE laterals wrapped in a geo-textile fabric and a biomat with wraparound end plugs. In addition to dispersal, they offer biological treatment as the biomat develops at the bottom of the lateral. Effluent passes into the geo-textile fabrics and grows a protected bacterial surface. Sand then wicks the liquid from the geotextile fabric and enables the air to transfer to the bacterial surface. This surface helps break down solids and the air supply help promote bacterial efficiencies. Infiltrator Water Technologies, formerly Presby Environmental Products, is one such manufacturer which produce this type of product. They also offers assistance in layout and design of the system.



Figure 6-- Enviro-Septic® Product for Reference

Construction of the system includes the following:

- Regrade and install a flexible poly liner in existing pond cell #3.
- Install a splitter box, piping and manholes and route influent flows to pretreatment pond cell #3.
- Construct the header with subsurface drainage system in pond cell #2.
- Prefill pond cell #3 and put the newly constructed dispersal / drainfield into service, bypassing existing pond cell #1.
- Allow cell #1 to dry out, remove sludge and rehab with new flexible poly liner
- Prefill pond cell #1 and connect to dispersal system and put into service

Alternative #4: Develop a New Lagoon System with a Wetland

The final alternative considered moving the treatment facility to a new location and constructing new primary treatment ponds and a wetland. A specific site has not been identified; however, it is anticipated that the location would be within two to three miles of the existing lagoon site. Because of the soils in the region, it is likely that the primary treatment cell would still need lining (with poly liner) for pretreatment. Similar sized cells would be needed for both treatment and the proposed wetland.

Consideration was given to the need to extend the existing force main, rehab the existing primary lift station, finding a suitable site, and land purchase.

Design Calculations for Alternatives

Design Calculations (BOD Loading)

Table 5—Design Calculation for BOD Loading

Organic Loading					
Spring Creek Sanitary District					
Parameter	South Cell Cell #1 Primary #2	Middle Cell Cell #2 Wetland	North Cell Cell #3 Primary #1	Current Design	Future Design
Design Parameters					
Design Population				633	1006
Avg. Day Off Season Flow (gpd)				15,620	27,990
Avg. Day WW Flow (gpd)				25,250	41,070
BOD Loading for Current & Projected Effluent					
BOD Design Concentration (mg/L)				300	300
BOD Produced (lbs/day)				63.2	102.8
BOD production = 300 mg/l x .025 mgd x 8.34 = 63.2 lbs/day (current design effluent)					
Total Pond Surface Area for BOD Treatment (rehab existing cells option)					
Available Pond Surface Area	1.55	3.79	2.26		
Cell #2 and #3 Surface Area at 5' Depth				6.06	
Combined Surface Area at 5' Depth					7.60
Total Pond Surface Area for BOD Treatment Required (acres)				3.16	5.14
Required BOD loading = 20 lbs/ BOD/acre/day for Total Pond				okay	okay
Primary Pond Area for BOD Treatment (wetland option)					
Primary Cell #3 Surface Area at 5' Depth				2.26	
Primary Cell #1 and #3 Surface Area at 5' Depth					3.81
Alt #2 --Primary Surface Area for BOD Treatment Required (acres)				2.11	3.43
Required Primary BOD loading = 30 lbs/ BOD/acre/day for Primary Treatment				okay	okay

Note the BOD loading is acceptable for the projected flows for both the total pond surface area loading (alternate #1) and for using existing cell #1 and #3 as pretreatment or Primary Ponds. The BOD loading for the total surface area is 20 lbs/acre/ day and the BOD loading for the primary ponds is 30 lbs/acre/day. BOD has an estimated concentration of 300 mg/L.

Design Calculations (Hydraulic Loading Alt #1)

Based on the Recommended Design Criteria for Wastewater Stabilization and Pollution Control Ponds, the following calculations are provided for the hydraulic loading of a non-discharging lagoon system. The water loss design calculation includes the seepage (75% of allowed), evaporation, and precipitation during the design period. Using water loss and the volume of inflow into the system, a calculation was done for both Total Retention and Year-Round Retention. A tabulation of this calculation at lagoon depths is shown below.

Table 6--Non-Discharge Retention Calculation

Non-DischargeRetention Calculations Spring Creek Sanitary District					
Total Retention Calcuatlion		Actual	Actual	Current	Future
A = I/WL		2018	2019	Design	Design
	Volume of Inflow (gpd) =	16,546	23,953	25,250	41,070
	Vol. of Inflow (acre-feet/day) =	0.0508	0.0735	0.0775	0.1260
	Acres Required (A = I/WL)	4.262	6.170	6.504	10.579
Year Round Retention Calcuatlion		Actual	Actual	Current	Future
A = I/H+WL		2018	2019	Design	Design
	Volume of Inflow (gpd) =	16,546	23,953	25,250	41,070
	Design Period (days)	365			
	Vol. of Inflow (acre-feet/day) =	18.5327	26.8291	28.2818	46.0013
	Operating Depth (ft)=	5.0	5.0	5.0	5.0
	H (ft) =	3.0	3.0	3.0	3.0
	Acres Required) = I / H + WL	2.522	3.651	3.849	6.260
Compares to a combined Surface Area at 5' depth of			7.51 acres		
A =	Estimated surface area in acres				
I =	Volume of in-flow in acre-feet for the design period				
WL =	New water loss (evaporation + seepage - precipitation) in feet for the design period				
S =	Seepage in feet for the design period				
H =	Operating depth in feet above the 2-foot level				
P =	Precipitation				
Water Loss (WL) Calculation					
	Average Annual Precipitation (in/year) =		19.93	(1)	
	Average Annual Precipitation (ft/day) =		0.0046		
	Mean Annual Evaporation (in/year) =		55.0	(2)	
	Mean Annual Evaporation (ft/day) =		0.0126	(3)	
	Seepage (ft/day) =		0.0039	(4)	
	Percent of Allowable Seepage		75%		
	WL (ft/day) =		0.0119		
(1)	(Pierre)Taken from U.S. Climate Data				
(2)	(Oahe Dam) NOAA Technical Report NWS 34 June 1982				
(3)	(note this compares with pan evapo maps of about 50" annually.)				
(4)	Maximum Seepage is 1/16" per day for the primary cell & 75% of allowable Seepage used				

Based on the Year-Round Retention Calculation and using all three cells having a surface area at the 5 ft water depth of approximately 7.5 acres, there is sufficient evaporation occurring to accommodate the current and future effluent projections.

Design Calculations (Hydraulic Loading Alt #2)

Based on the Recommended Design Criteria for Wastewater for Artificial Wetland Systems (Chapter XVI, the following calculations are provided for a non-discharging wetland system. The three main criteria that were evaluated for determining the feasibility of using existing cell #2 as a wetland are as follows:

- 1) Maximum design loading in the primary cells of 30 lbs of BOD per surface acre per day for the current and future populations. (see BOD calc)
- 2) Design average day flow rate to provide a minimum combined (pretreatment and wetlands) storage volume of 180 days and the pretreatment stabilization pond cells to provide 150 days.
- 3) Wetland detention time of 7 to 14 days based on the annual average day flow.

Table 7— Calculation of Hydraulic Loading of Wetland

Wetland Design Parameters and Features					
Spring Creek Sanitary District					
Parameter	South Cell Cell #1 Primary #2	Middle Cell Cell #2 Wetland	North Cell Cell #3 Primary #1	Current Design	Future Design
Design Parameters					
Design Population				633	1006
Avg. Day Off-Season Flow (gpd)				15,620	27,990
Avg. Annual Day WW Flow (gpd)				25,250	41,070
Combined Pond and Wetland Storage Volume					
From the 2' to 5' depth, Pretreatment	1,377,023		2,047,934		
From the 0' to 2' depth cell (Wetland)		2,084,526			
Available Wetland and Pond Storage Volume (gallons)				4,132,461	5,509,484
Off Season Days of Wetland & Pond Storage (days)				265	197
Avg. Annual Days of Wetland & Pond Storage (days)				164	134
Required Combined Wetland & Pond Storage of 180 days				okay	okay
Stabilization Pond Pre-Treatment Storage Volume					
Available Stabilization Pond Storage Volume (gallons)				2,047,934	3,424,957
Off Season Days of Stabilization Pond Storage (days)				131	122
Avg. Annual Days of Wetland & Pond Storage (days)				81	83
Required Stabilization Pond Storage of 150 days				??	??
Minimum Recommended Wetland Detention Time					
Wetland Volume with Six Inches Water Level		509,523			
Actual Detention Time in Days				20	12
Actual available detention time (based on 6" of water depth) is 12 to 20 days.				okay	okay
Recommended wetland detention time is 7 to 14 days with 14 days recommended.					

Based on the average off-season or wintertime design effluent flows the combined pond and wetland system meet the combined storage requirements of 180 days for the current system and future conditions. If evaluated based on the average annual flow it provides about 90%

and 70% of the existing and future design conditions respectively. And while the stabilization pond storage (cells #1 and #3) is sufficient capacity for the BOD loading, they are smaller than the 150 days of storage needed. The wetland meets the required detention time of 7-14 days.

Given the history of this lagoon system and the difficulty of keeping water in the ponds due to the seasonal nature of users, evaporation and seepage that occurs it is our recommendation that the Sanitary District secure options for additional lands adjacent to the lagoon system and that these be made available for purposing into a wetland and additional lagoon cells as the need arises.

Design Calculations (Hydraulic Loading Alt #3)

Preliminary design of the dispersal system is based on a soil loading rate of 0.4 gallons per day per square foot. The result is an adsorption bed with a size of about 1.5 acres for current users and nearly 2.6 acres to accommodate new users within the existing system. Cell #2 is 3.79 ac. A maximum length for the laterals is 100 feet with a minimum spacing between laterals of 5 feet.

A preliminary tabulation of the dispersal system parameters is noted below:

Table 8—Design Calculation for Dispersal System

Subsurface Dispersal System Design Parameters and Features				
Spring Creek Sanitary District				
Design Parameter		Units	Current Design	Future Design
Avg Day Design Flow Rate			25,250	41,070
Number of Adsorption Beds			12.0	16.0
Multiplier			90%	90%
Soil Loading Rate or Application Rate		gpd/SF	0.45	0.45
Percolation Rate		minutes per inch	24	24
Adsorption Bed Area Required (based on 24 minutes /inch for a percolation rate)				
		sq. ft.	50,500	82,140
		acres	1.16	1.89
Total with Borders +20%			1.28	2.26
Gravel/Sand and Length of Laterals Required				
Estimated Width of Adsorption Bed (110' in length')			38.26	46.67
No. of 110' Laterals Required			108.0	160.0
Total Length of Laterals		LF.	10,800	16,000
Width of Beds		ft.	540	800
Width of Individual Beds		ft.	45	50
Gravel required		cu ft.	3,000	4,444

7 - OPINION OF PROBABLE PROJECT COST

The following estimates of probable cost are provided for the proposed improvements. Costs are developed from previous bids, discussion with contractors and equipment suppliers, and work experience on similar types of projects. Actual competitive bid prices at the time of construction may vary higher or lower depending on local contractor's workload, material prices, and other variables such as the cost of fuel and funding agency requirements.

The current bidding environment is highly variable with labor shortages and prices for construction materials such as PVC, Ductile Iron and steel have risen sharply in the past 6 months. Suppliers are hesitant to lock in material prices and, as a result, contractors are raising prices to reflect the risk they are forced to take when bidding long-range projects.

These project costs are reflective of the present inflationary environment and difficulty when bidding project. In addition to construction costs, the project cost includes legal, administration, engineering, and other costs along with a contingency cost for unknown factors. The costs do not include pricing for specialty items and land purchase. All three alternatives include the use of the existing site with the estimate based on not needing to purchase additional land.

The table below details the opinion of probable costs for the three alternatives at the existing lagoon site.

A fourth alternative was considered which included constructing a new primary treatment cell and wetland at a green field site within two to three miles from the existing location.

Table 9—Alternative Opinion of Probable Cost

Lagoon Rehab Alternative Opinion of Probable Cost					
Spring Creek Sanitary District					
ITEM NO.	DESCRIPTION OF ITEM	Alt. #1 Rehab Liners	Alt. #2 Wetland	Alt. #3 Dispersal	Alt. #4 New Lagoon
1	Mobilization, Bonds, Insurance, permit and Misc.	\$100,000	\$75,000	\$125,000	\$150,000
Rehab Existing Pond Cells #1 and #3					
2	Clearing and Grubbing	\$20,000	\$20,000	\$20,000	
3	Excavation and Clearing Prep for Liner	\$50,000	\$50,000	\$50,000	
4	Lagoon Poly Liner (Material Only)	\$150,000	\$150,000	\$150,000	\$150,000
5	Placement and Anchoring Liner	\$70,000	\$70,000	\$70,000	\$70,000
6	Remove and Reset Riprap with Filter Fabric	\$145,600	\$145,600	\$145,600	
7	Rip Rap with Filter Fabric (Min. 6" Diameter)	\$18,000	\$18,000	\$18,000	\$18,000
Rehab Existing Pond Cells #2					
8	Clearing and Grubbing	\$20,000	\$20,000	\$20,000	
9	Excavation, Grading	\$50,000	\$50,000	\$50,000	
10	Bentonite Material for Liner	\$65,000			
11	Placement and Compaction of Bentonite	\$70,000			
12	Remove and Reset Riprap with Filter Fabric	\$174,720			
13	Rip Rap with Filter Fabric (Min. 6" Diameter)	\$18,000			
14	Wetland Seed Bed Prep and Seeding/Fertilizer		\$40,000		\$40,000
15	Splitter Boxes			\$72,000	
16	Headers and Laterals		\$45,000	\$300,000	\$45,000
17	Gravel/Sand Bedding			\$36,000	
18	Top Soil & Seeding			\$25,000	
New Lagoon Cells					
19	Land Purchase (15 acres)				\$150,000
20	Clearing and Grubbing & Site Grading				\$100,000
21	Excavation & Compaction of Primary Cell				\$360,000
22	Excavation of Wetland Cell				\$261,000
23	Force Main Extension, (aprox 2.5 miles)				\$795,000
24	Rehab of Primary Lift Station				\$75,000
Piping and Misc. Improvements					
25	Manholes, 48" Diameter	\$15,000	\$15,000	\$15,000	\$45,000
26	8" SDR 26 PVC Influent Piping	\$87,500	\$87,500	\$87,500	\$87,500
27	Inlet Structure/ Splitter Box	\$15,000	\$15,000	\$15,000	\$15,000
28	temporary Erosion Control	\$5,000	\$5,000	\$5,000	\$5,000
29	lagoon Transfer Pumping	\$10,000	\$10,000	\$10,000	\$0
30	Pre-fill and Maintain with Potable Water	\$30,000	\$15,000	\$15,000	\$15,000
31	Perimeter Chainlink Fence	\$65,000	\$65,000	\$65,000	\$65,000
	SUBTOTAL	\$1,178,820	\$896,100	\$1,294,100	\$2,446,500
Other Project Costs					
	Engineering Design - 10%	\$117,880	\$89,610	\$129,410	\$244,650
	Engineering Administration -6%	\$70,730	\$53,770	\$77,650	\$146,790
	Construction Observation - 6%	\$70,730	\$53,770	\$77,650	\$146,790
	Legal & Financial Admin / Grant Admin	\$45,000	\$45,000	\$45,000	\$45,000
	Cultural Resources / Environmental	\$5,000	\$5,000	\$5,000	\$5,000
	Construction Contingencies--10%	\$117,882	\$89,610	\$129,410	\$244,650
	TOTAL	\$1,606,042	\$1,232,860	\$1,758,220	\$3,279,380

8 – COMPARISON OF IMPROVEMENTS, RECOMMENDATIONS, WITH SCHEDULE

Comparison of Performance

A summary of the three alternatives with associated probable costs and benefits of each are described below in Table 10.

Table 10--Summary of Alternatives & Probable Costs

Alternative and Basis of Design	Opinion of Probable Costs	Summary of Pros & Cons
1) Rehab all three pond cells with new liners. Design per SD Recommended Design Criteria Manual Chapter 4, Recommended Design Criteria for Wastewater Stabilization and Pollution Control Ponds	\$1,606,000	The benefits are: • Non-discharge system with no stated pretreatment requirements • With the rehab of all three cells the system is capable of meeting current design flows Disadvantages: • The liners will need to continue to meet DANR seepage limits • Maintenance of liners to prevent cracking during dry years • Limited seepage in all cells may result in trouble meeting future design flows during wet years
2) Convert to a Wetland with Pretreatment Design per SD Recommended Design Criteria Manual Chapter 4, Recommended Design Criteria for Wastewater Stabilization and Pollution Control Ponds Chapter 16, Design Criteria for Artificial Wetland Systems	\$1,232,000	The benefits are: • Lower project costs • No seepage limit for the largest cell if this portion of the lagoon is converted to wetland • Little system maintenance • With the addition of the wetland, the system is capable of meeting current and future design flows Disadvantages: • Pretreatment is needed prior to discharging to the wetland • Wastewater storage required during winter months unless transfer pipes and inlet headers are protected from freezing • Deep water sections required to minimize odors and mosquitos

3) Convert to a Subsurface Dispersal System with Pretreatment Design is based on permeability and loading rate of soils SD Recommended Design Criteria Manual Chapter 4, Recommended Design Criteria for Wastewater Stabilization and Pollution Control Ponds	\$1,758,000	The benefits are: • No seepage limit with the dispersal system • Odors and mosquitos are less likely • With the addition of the dispersal system, the system is capable of meeting current and future design flows Disadvantages: • Regulated by EPA in Denver and not SD DANR • Pretreatment is needed prior to discharging to subsurface dispersal system • Wastewater storage required during winter months • Long term maintenance of buried laterals • Dependent on testing of soil loading rate & permeability
4) Develop a New Lagoon System with a Wetland SD Recommended Design Criteria Manual Chapter 4, Recommended Design Criteria for Wastewater Stabilization and Pollution Control Ponds. Chapter 16, Design Criteria for Artificial Wetland Systems.	\$3,300,000	The benefits are: • New location offers distant from current residential and commercial areas. • Odors and mosquitos are less likely an issue in a more rural setting. • Additional land area can be purchased for future capacity. Disadvantages: • Added cost for purchasing land, extending existing force mains and building new lagoon infrastructure. • Soils are likely similar as the existing site, requiring similar approach. • Delay in project due to time needed to identify and purchase new project site.

Recommendations

The recommendation is to proceed with the construction of Alternative #2 and convert the system to operate as a wetland. It offers the low-cost solution and will require the least amount of maintenance an ongoing upkeep. Long term it is also able to meet the future design flow requirements based on the design flow as determined previously in the report.

It is recommended that no additional development be served from this facility, then the ongoing improvements on platted lots within the existing developments. This 1) allows for the variability of the type of users adding within the system, 2) provides some capacity as users

revise their status from seasonal to permanent, and 3) accommodate some future growth of existing commercial users. Note all recommendations and capacity determinations are subject to DANR review and approval.

Implementation Schedule

The table below outlines the implementation schedule for the project.

Table 11 – Recommended Plan Implementation Schedule

Task	Date
State Water Plan Application	Oct 1, 2021
Public Hearing (this updated plan)	June 2022
SDDANR Finance Application	June 2022
SDDANR Approval for SRF Loan/Grant	Aug. 2022
Notice to Proceed with Design of Improvements	July 2022
Submittal of Plans and Specifications for DANR Review (1 month)	Aug-Sept. 2022
Construction Contract Bid Advertisement	Nov-Dec. 2022
Construction Contract Bid Opening	January 2023
Start of Construction	April 2023
Complete Construction of Improvements	Aug. 2023
Complete One Year Warranty Period	Sept. 2024

Summary of System Users and Design Capacity

A summary of the current design population and flows within the existing sewer system is tabulated below. The maximum population and design flow for the lagoon when converted to a wetland is also noted. These are as determined from historical information and the design criteria and parameters described in the report.

Existing System --116 permanent homes --93 seasonal homes --652 seasonal RV units --12 commercial connections	--Existing Design Population = 633 --Existing Annual Avg Day Design Flow = 25,250 gpd
Current Ongoing Development --110 permanent homes --80 seasonal homes --200 RV units	--Estimate Design Population = 373 --Combined Design Population = 1,006 --Combined Annual Avg Day Design Flow = 41,000 gpd
Maximum Lagoon Capacity --lagoon to be modified as a wetland with poly-lined pretreatment in cells #1 and #3	--Maximum Design Population = 1,100 --Maximum Annual Avg Day Design Flow = 44,000 gpd

9 – FINANCING OPTIONS

Below is a summary of two options the Sanitary District can use to finance the improvements noted in the report. There are possible federal and state programs for consideration as well as commercial options. Applicants are expected to contact funding agencies prior to submittal to review funding options and submit a proposal requesting funds from the agency or agencies that fits their needs.

A summary comparison of the two funding sources is shown in Table 12 below.

Table 12--Summary of Funding Sources and Conditions

SOURCE	TYPE	TERMS	CONDITIONS
State Revolving Loan (SRF)	Loan	1.5-2.0% / 20 years	Secured by Bonds
State Revolving Loan (SRF)	Grant	Need based	Availability of Funds
Lease Purchase	Loan	aprox. 3% / 20 years	Secured by Assets

Drinking Water State Revolving Fund (DWSRF)

State revolving funds are administered by the Department of Agriculture and Natural Resources (DANR) and are made available to applicants based on a priority point system. Interest rates at the time of the loan closing are 30% of the current market rate. For loans associated with clean water improvements the department includes an administration fee of about 0.5%. The latest published (April 2020) interest rate is approximately 1.5% and when including the administration fee, is estimated at about 2.0%. The loan term is either 20 or up to 30 years (if approved and at a slightly higher rate of interest).

The borrower to be eligible for the program must have an acceptable debt instrument such as a voter approved bonding capacity (or outline their intention to put the issue on a future ballot) and completed a Facility Plan with an engineer discussing the options and need for improvements. Projects funded with SRF financing must meet federal wage rate requirements and all iron and steel products used in the project must be produced in the US. Depending on the type of project this may add additional costs to the project. There is also the cost of bond counsel (approximately \$15,000) and the loan closing cost of 0.6% for the Master Trust. For smaller loans these disadvantages must be weighed against the cost of a commercial loan available to utilities.

Both municipalities and non-profit community water/sewer systems are eligible for the program. Applications are received year around and if funds are available the applicant will be placed on the Intended Use Plan. If there are insufficient funds, priority will be given to systems that meet the due date of October 1st for Wastewater applications. Once a priority list of applicants is determined this is published for review with the process taking 12-18 months.

Lease Purchase or Private Funding

Funding can be acquired through a lease purchase arrangement through municipal bonding agencies. This simply requires a vote of the board to approve the financing. The project infrastructure is used as the collateral for securing the funding and no bond election is required. This type of funding can be used to purchase equipment such as a backhoe or truck or can be used to finance an infrastructure project such as plant improvements or a water tower or pump station.

Loan terms are typically 20-25 years, similar to the SRF program. The interest rates are very competitive market rates and sold on the bond market. In some case's the bond agency will go directly to private investors or private banks and sell the bonds.

This funding mechanism is the fastest and sometimes the most economical process, as it can be accomplished in 60 days or less. The interest rate is slightly higher than can be acquired from the SRF or other government loan process.

Summary Comparison of Project Costs and Debt Service

Given the various funding options, the following Table has been developed to compare funding scenarios for the Project. With an estimated Project Cost of \$1,232,000 the loan options have been compared to determine the lowest Annual Principal and Interest (Annual P/I) payment, which will affect the projected monthly water rates.

The monthly debt service is calculated and shown below assuming a total of 225, 325, and 425 metered connections. Note the debt service per user will lower as more users come on board to help pay for the improvements.

Table 13--Funding Options with Monthly Debt Service, 225 Users

Funding Options and Estimated Monthly Debt Service per Connection						
Spring Creek Sanitary District						
Funding Source	Financed Amount	Annual P/I	Monthly Debt Service/User	Total Paid Per User	Principal Paid Per User	Interest Paid per User
SRF 100% Loan	\$1,233,000	\$75,406	\$27.93	\$6,703	\$5,480	\$1,223
SRF--80% Loan & 20% Grant	\$986,400	\$60,325	\$22.34	\$5,362	\$4,384	\$978
Lease Purchase	\$1,233,000	\$82,877	\$30.70	\$7,367	\$5,480	\$1,887
Notes:						
1	Total Project Costs		\$ 1,233,000			
2	Number of Households / Connections		225			
3	SRF Interest Rate and Admin Fee is estimated to be 2.0% for 20 years.					
4	Lease Purchase Interest Rate and Loan term is estimated to be 3.00% for 20 years.					

Table 14--Funding Options with Monthly Debt Service, 325 Users

Funding Options and Estimated Monthly Debt Service per Connection						
Spring Creek Sanitary District						
Funding Source	Financed Amount	Annual P/I	Monthly Debt Service/User	Total Paid Per User	Principal Paid Per User	Interest Paid per User
SRF 100% Loan	\$1,233,000	\$75,406	\$19.33	\$4,640	\$3,794	\$847
SRF--80% Loan & 20% Grant	\$986,400	\$60,325	\$15.47	\$3,712	\$3,035	\$677
Lease Purchase	\$1,233,000	\$82,877	\$21.25	\$5,100	\$3,794	\$1,306
Notes:						
1	Total Project Costs		\$ 1,233,000			
2	Number of Households / Connections		325			
3	SRF Interest Rate and Admin Fee is estimated to be 2.0% for 20 years.					
4	Lease Purchase Interest Rate and Loan term is estimated to be 3.00% for 20 years.					

Table 15--Funding Options with Monthly Debt Service, 425 Users

Funding Options and Estimated Monthly Debt Service per Connection						
Spring Creek Sanitary District						
Funding Source	Financed Amount	Annual P/I	Monthly Debt Service/User	Total Paid Per User	Principal Paid Per User	Interest Paid per User
SRF 100% Loan	\$1,233,000	\$75,406	\$14.79	\$3,549	\$2,901	\$647
SRF--80% Loan & 20% Grant	\$986,400	\$60,325	\$11.83	\$2,839	\$2,321	\$518
Lease Purchase	\$1,233,000	\$82,877	\$16.25	\$3,900	\$2,901	\$999
Notes:						
1	Total Project Costs		\$ 1,233,000			
2	Number of Households / Connections		425			
3	SRF Interest Rate and Admin Fee is estimated to be 2.0% for 20 years.					
4	Lease Purchase Interest Rate and Loan term is estimated to be 3.00% for 20 years.					

APPENDIX

- Surface Water Discharge Permit
- Inspection Report from 2019
- Map of the Project Area
- Layout Drawings of the Described Alternatives
- Permeability Testing done at the Site
- EPA Letter “authorized by rule” for a dispersal System