CITY OF HARRISBURG
SOUTH DAKOTA

Wastewater Value Engineering Study

Harrisburg, SD

Submitted by

Banner Associates, Inc.
www.bannerassociates.com
BAI 22641.00.00

BANNER
engineering a better community

CITY OF HARRISBURG
SOUTH DAKOTA

Wastewater Value Engineering Study Harrisburg, SD

Submitted by

Banner Associates, Inc.
www.bannerassociates.com
BAI 22641.00.00

BANNER
engineering a better community

REGISTERED PROFESSIONAL ENGINEER
REG NO. 8326
TANYA L. MILLER
SOUTH DAKOTA

Tanya L. Miller
11/21/17

Tanya Miller

Digitally signed by Tanya Miller
DN: C=US,
E=tanyam@bannerassociates.com,
O="Banner Associates, Inc.", CN=Tanya
Miller
Date: 2017.11.21 10:22:24-06'00'

CITY OF HARRISBURG, SOUTH DAKOTA

WASTEWATER VALUE ENGINEERING STUDY

TABLE OF CONTENTS

BANNER
engineering a better community

APPENDICES

LIST OF FIGURES AND GRAPHS

LIST OF TABLES

BANNER
engineering a better community

SECTION 1: INTRODUCTION, AUTHORIZATION, PURPOSE, AND ORGANIZATION OF THE REPORT

1.1. INTRODUCTION AND PURPOSE

The City of Harrisburg is preparing to make a significant investment in its wastewater infrastructure to support growth and address future needs. Due to the significance of this investment, the City is seeking verification that the alternative recommended in the 2016 Wastewater Facilities Plan Amendment recently completed by Stockwell Engineers provides the City with the lowest cost option over the life of the facility.

A value engineering study offers an independent review of alternatives considered, capital construction costs, operations and maintenance costs, and feasibility for a proposed project. It considers the desired goals of the project, the proposed means to meet those goals, and identifies cost saving measures that can be achieved through design modifications and improved efficiency. Typically, it is best performed prior to design when a City wants to verify it is selecting the best, lowest-cost alternative, the very stage the City of Harrisburg is at right now.

1.2. AUTHORIZATION AND BASIS OF STUDY

Preparation of the Value Engineering Study was authorized by the City of Harrisburg in an Employment Agreement for Engineering Services dated June 19, 2017 with Banner Associates, Inc.

To understand the wastewater alternatives under consideration, the 2014 Wastewater Facilities Plan and the 2016 Wastewater Facilities Plan Amendment will be reviewed. Projected 2036 flows and loads will be obtained from these reports. The City of Harrisburg provided the anticipated permit limits and future nutrient removal requirements for BOD, TSS, ammonia, dissolved oxygen, pH, and E.coli as well as anticipated future nitrogen and phosphorus limits for the wastewater discharge. The Facility Plan's estimated construction costs and the projected operation/maintenance costs will be reviewed for the following treatment alternatives:

- Treatment Alternative 2.1: Sequencing Batch Reactor

- Treatment Alternative 2.2: Oxidation Ditch
- Treatment Alternative 2.3: SEQUOX® by Aeromod, Inc.
- Treatment Alternative 3.1: Partial Pumping to Sioux Falls
- Treatment Alternative 3.2: Complete Pumping to Sioux Falls
- Up to two (2) treatment alternatives not considered in the 2016 Wastewater Facilities Plan Amendment

1.3. ORGANIZATION OF THE REPORT

This report is organized into a total of four sections. The topics covered in each of the sections are summarized as follows:

Section 1 Introduction, Authorization, Purpose, and Organization of the Report

Section 2 Basis of Design

Section 3 Alternative Analysis

Section 4 Evaluation and Recommendation

END OF SECTION 1

SECTION 2: BASIS OF DESIGN

2.1 GENERAL

Wastewater design and equipment sizing is based the projected flows and organic loadings for a community. Therefore, the 2014 Wastewater Facilities Plan and 2016 Wastewater Facilities Plan Amendment prepared for the City of Harrisburg by Stockwell Engineers was reviewed to understand the basis for design and determine whether cost saving opportunities could be found through adjustments to flow and loading projections. The information summarized in this section was gathered from those reports unless otherwise noted.

When determining design parameters for a wastewater treatment facility, it is important to review historical data to project population growth, wastewater flows, and organic loadings. Ideally, five years of past flow and loading records should be reviewed to determine trends and minimize the influence of extreme weather conditions; very wet or very dry years.

2.2 PLANNING PERIOD

The South Dakota Department of Environment and Natural Resources (SD DENR) requires that a 20-year planning period be used in Facility Planning when State Revolving Funds dollars are requested to help fund a project. The intent is that the life of the project will coincide with the 20-year loan term. Because new treatment facilities take so long to site and construct, it is more typical to use a 25 year planning window for new facilities. The 2016 Wastewater Facilities Plan Amendment uses a 20-year planning period, projecting flows, loads, and costs to 2036. If SRF funds are used to construct a new treatment facility, Banner would recommend they be sized for a 25 year planning period to accommodate the time require to site and construct the new facility.

2.3 PROJECTED POPULATION

The 2016 Wastewater Facilities Plan Amendment indicates a 2016 initial population of 5,698 (per a 2016 special census) with a 4% growth rate resulting in a 2036 population of 12,485.

2.4 PROJECTED WASTEWATER FLOWS

The 2016 Wastewater Facilities Plan Amendment indicates that projecting wastewater flows for Harrisburg was challenging. Frequently, high pond levels resulted in less than 3 feet of freeboard, flooding the upstream Parshall flume at the influent to the ponds and creating erroneous flow readings.

Because of the erroneous readings, the 2016 Wastewater Facilities Plan Amendment compared influent wastewater flow readings from 2011-2013 with metered water purchases from 2010-2015 and determined that average day flows ranged from 50 to 55 gallons per capita per day (gpcd). The SD DENR requires wastewater treatment systems be designed for a minimum of 60 gpcd. Therefore, the 2016 Facility Plan projected wastewater flows based upon 65 gpcd to allow for additional inflow and infiltration. This results in a 2016 average day flow of 370,370 gallons per day (gpd) for a population of 5,698 and a 2036 average day flow of 811,525 gpd.

As will be discussed further in the next section, the 2016 Wastewater Facilities Plan Amendment evaluated several treatment alternatives, including mechanical treatment systems. The processes in a mechanical treatment system have short hydraulic detention times and must be designed to handle maximum day or even peak hour flows, depending on the process. For example, influent screens and clarifiers are designed based upon peak hour flow.

Documentation of the projected 2036 maximum day and peak hours flows used as the basis of design for the mechanical alternatives could not be found in the 2014 Wastewater Facilities Plan and 2016 Wastewater Facilities Plan Amendment. The following historical flows were inferred from pond influent measurements as stated in the first paragraph on page 11 of the 2016 Report. The data results in an average day to maximum day ratio of 6.0, which is exceptionally high and would indicate significant inflow and infiltration in the collection system.

- 2011 -2013 Historical Average Day Flow: 208,416 gpd
- 2011-2013 Maximum Day Flow: 1,458,000 gpd

In an effort to verify this data, the influent flow records used in the study for years 2011 through 2013 were obtained from Stockwell Engineers. The City of Harrisburg has recently worked to reduce pond levels so that influent Parshall flume flow readings are more accurate. Influent flow data from April 2017 (when pond levels were lowered) to August 2017 was obtained from the City. The average day, peak month, peak week and peak day flows were calculated for 2011, 2012, 2013, and 2017 with the available data with the results provided in Table 2.1.

Table 2.1 – Historical Influent Flume Wastewater Flows for Selected Years, Harrisburg, SD

	2011	2012	2013	2017	Combining 2011 and 2017 Data
Average Day (gpd)	245,879	153,857	237,608	230,788	241,420
Peak Month (gpd)	295,633	178,333	635,967	262,700	295,633
Peak Week (gpd)	344,714	264,429	886,286	302,286	344,714
Peak Day (gpd)	418,000	401,000	1,458,000	577,000	577,000
Peak Month to Average Day Ratio	1.20	1.16	2.68	1.14	1.22
Peak Week to Average Day Ratio	1.40	1.72	3.73	1.31	1.43
Peak Day to Average Day Ratio	1.70	2.61	6.14	2.50	2.39
Total Annual Precipitation* (inches)	22.23	11.53	22.77		
Maximum Precipitation Day* (inches)	4.16	1.15	4.8	2.2	
Total Annual Precipitation (inches)**	22.45	17.08	27.09		
Maximum Precipitation Day (inches)**	2.5	1.41	2.27	2.2	

**Data obtained from weather station Harrisburg 2.5 NW, SD*

***Data obtained from Stockwell 2016 Facility Plan Amendment*

Measured total annual and maximum day precipitation data from the nearest weather station (Harrisburg 2.5 NW, SD) and precipitation data provided by Stockwell are both included in Table 2.1. It is not known where Stockwell obtained their precipitation data, however it appears to be inconsistent with local weather events. For example, in late May of 2013 the Harrisburg area received record rainfall with reports of 8 to 10 inches over a two day period and Liberty Elementary flooded. The Harrisburg 2.5 NW, SD station recorded a total of 7.12 inches over the two day period. The data provided by Stockwell for this same period shows 2.13 inches of rain.

BANNER
engineering a better community

Wet and dry weather conditions impact wastewater flows. Normal precipitation for Harrisburg is 23.5 inches/year per Table 7 on page 21 of the 2016 Wastewater Facilities Plan Amendment. The *Harrisburg 2.5 NW, SD* station data indicates that 2012 was an extreme dry year with only 11.53 inches of annual precipitation. While 2013 shows normal annual rainfall, much occurred within a few months as 14.26 inches of precipitation occurred between May 1st and June 20th of that year. It is thought that the influent Parshall flume flooded in 2013 and caused erroneous readings. If flow readings are accurate, it would indicate significant infiltration and inflow in the collection system. In trying to determine peaking factors, 2011 and 2017 wastewater flows seem more typical and less likely to be impacted by flooding at the Parshall flume. As a result, this data will be used to review equipment sizing and costs in the VE Study. The combination of flows for 2011 and 2017 are shown in the far right column of Table 2.1.

For peak hour flows, the SD DENR Wastewater Design Manual calculation based upon population was used since historical flow information was not available:

Peak Hour Flow = Average Day Flow x (18+√(Population in Thousands))/ (4+√(Population in Thousands))

The above equation results in a peak hour flow ratio of 2.86, resulting in a projected 2016 peak hour flow of 1.182 mgd and a 2036 peak hour flow of 2.32 mgd.

Banner prepared Table 2.2 to document the projected annual population increase and related flows that will be used in this Value Engineering Study.

Table 2.2: Projected Flows for the City of Harrisburg, SD

Year	Population	AVERAGE DAILY FLOW (mgd)	PEAK MONTH FLOW (mgd)	PEAK WEEK FLOW (mgd)	MAXIMUM DAY FLOW (mgd)	PEAK HOUR FLOW (mgd)
2016	5,698	0.370	0.452	0.530	0.885	1.182
2017	5,926	0.385	0.470	0.551	0.921	1.223
2018	6,163	0.401	0.489	0.573	0.957	1.266
2019	6,409	0.417	0.508	0.596	0.996	1.310
2020	6,666	0.433	0.529	0.620	1.036	1.355
2021	6,932	0.451	0.550	0.644	1.077	1.402
2022	7,210	0.469	0.572	0.670	1.120	1.450
2023	7,498	0.487	0.595	0.697	1.165	1.500
2024	7,798	0.507	0.618	0.725	1.211	1.552
2025	8,110	0.527	0.643	0.754	1.260	1.605
2026	8,434	0.548	0.669	0.784	1.310	1.660
2027	8,772	0.570	0.696	0.815	1.363	1.717
2028	9,123	0.593	0.723	0.848	1.417	1.775
2029	9,488	0.617	0.752	0.882	1.474	1.836
2030	9,867	0.641	0.782	0.917	1.533	1.899
2031	10,262	0.667	0.814	0.954	1.594	1.963
2032	10,672	0.694	0.846	0.992	1.658	2.030
2033	11,099	0.721	0.880	1.032	1.724	2.099
2034	11,543	0.750	0.915	1.073	1.793	2.170
2035	12,005	0.780	0.952	1.116	1.865	2.244
2036	12,485	0.812	0.990	1.160	1.940	2.320

A more in depth analysis should be completed reviewing influent flow data for years prior to 2011 and subsequent to 2013 as part of preliminary design to verify peaking ratios and accurate sizing of treatment plant equipment. Lift station pump run times on maximum days should also be reviewed and compared to influent flows for data verification.

2.5 PROJECTED LOADING

In communities with average daily flows above 1.0 MGD, SD DENR standards for domestic wastewater indicate organic and inorganic loadings are typically 0.17 lbs./capita/day for biological oxygen demand

(BOD) and 0.20 lbs./capita/day for total suspended solids (TSS). However, when garbage disposals are utilized, the SD DENR indicates BOD loadings should be increased to 0.22 lbs./capita/day. While Harrisburg's flows are not over 1.0 MGD, this is still a reasonable reference for typical BOD and TSS concentrations.

The 2016 Wastewater Facilities Plan Amendment indicated influent wastewater sampling completed in April 2014 resulted in an average composite BOD of 427 mg/l, or 534 lbs./day and a per capita loading of 0.19 lbs./capita/day. While the loading is within SD DENR guidelines, the BOD concentration is high for the volume of wastewater generated, and Banner had concerns with its accuracy. Banner requested the test results used to develop the 427 mg/l BOD reading and determined it is based on only three samples collected during a one week period between April 10 and 16, 2014. Despite the limited sampling, this BOD parameter was used in the 2014 Facility Plan and 2016 Facility Plan Amendment to develop the average influent loadings. Typically, weekly or monthly samples collected over several months would be used to establish design parameters as BOD can vary seasonally, especially during spring and summer periods when inflow and infiltration can dilute the wastewater. It is quite risky to design a treatment facility with such limited data and additional influent testing is strongly recommended prior to preliminary design.

The Facility Plans also appear to have calculated the 0.19 lbs./capita/day BOD loading rate incorrectly. Dividing 534 lbs./day BOD loading in the Facility Plans by the 427 mg/l concentration and a conversion factor of 8.34 results in a flow rate of 149,950 gpd. Influent flow records indicate flows during April 10, 11, and 16, 2014 averaged 243,678 gpd. Based on the estimated 2014 population of 5,162 from Stockwell's projections (interpolating between the 2010 population of 4,089 and the 2016 population of 5,698.) and actual flow readings from the testing dates, the average loading rate is 0.17 lbs./capita/day.

The Facility Plans do not include discussion on the TSS loading parameters used for the basis of design. The April 2014 testing indicates an average loading rate of 0.09 lbs./capita/day, however with highly variable data.

The revised BOD and TSS calculations prepared for this Value Engineering Study, showing the influent test data and corrected BOD per capita loadings are provided in Table 2.3. Banner recommends additional influent testing be completed to verify BOD, TSS, ammonia, total nitrogen and phosphorus concentrations prior to preliminary design if a new treatment facility is recommended.

Table 2.3: Influent BOD and TSS Concentrations from April 2014 Testing

Sample Date	4/10/2014	4/11/2014	4/16/2014
Influent Flow (gpd)	244,333	242,933	243,767
Population*	5,162		
BOD (mg/l)	410	430	440
BOD (lbs./day)	835	871	895
BOD (lbs./capita/day)	0.162	0.169	0.173
TSS (mg/l)	350	240	120
TSS (lbs./day)	713	486	244
TSS (lbs./capita/day)	0.14	0.09	0.05

**Based on interpolated population. 2010 population of 4,089 and 2016 population of 5,698.*

Banner has prepared Table 2.4 to document the projected annual organic loads that will be used in this Value Engineering Study. For now, loading projections were based off 0.17 lbs./capita/day for BOD. For TSS, an industry accepted loading of 0.22 lbs./capita/day was used due to the variability in the sampling data and the limited number of samples. In the future, should additional testing confirm that TSS loads are lower, this is an area where cost savings could be found through reduced equipment sizing to treat the lower TSS loading.

Table 2.4: Projected Flows and Loading for the City of Harrisburg, SD

Year	Population	Average Daily Flow (mgd)	Average Day BOD Loading (lbs./day)	Average Day BOD Loading (mg/l)	Average Day TSS Loading (lbs./day)	Average Day TSS Loading (mg/l)
2016	5,698	0.370	969	314	1,254	406
2017	5,926	0.385	1,007	314	1,304	406
2018	6,163	0.401	1,048	314	1,356	406
2019	6,409	0.417	1,090	314	1,410	406
2020	6,666	0.433	1,133	314	1,466	406
2021	6,932	0.451	1,179	314	1,525	406
2022	7,210	0.469	1,226	314	1,586	406
2023	7,498	0.487	1,275	314	1,650	406
2024	7,798	0.507	1,326	314	1,716	406
2025	8,110	0.527	1,379	314	1,784	406
2026	8,434	0.548	1,434	314	1,856	406
2027	8,772	0.570	1,491	314	1,930	406
2028	9,123	0.593	1,551	314	2,007	406
2029	9,488	0.617	1,613	314	2,087	406
2030	9,867	0.641	1,677	314	2,171	406
2031	10,262	0.667	1,745	314	2,258	406
2032	10,672	0.694	1,814	314	2,348	406
2033	11,099	0.721	1,887	314	2,442	406
2034	11,543	0.750	1,962	314	2,539	406
2035	12,005	0.780	2,041	314	2,641	406
2036	12,485	0.812	2,122	314	2,747	406

2.6 ANTICIPATED DISCHARGE LIMITS

The creeks and tributaries near Harrisburg are not viable receiving streams for treated wastewater effluent due to protected waterway classifications or stringent discharge limits. As a result, the Big Sioux River east of Harrisburg is considered the only viable discharge location. Table 25 on page 47 of the 2016 Wastewater Facilities Plan Amendment references the effluent limits for the Big Sioux and is provided below in Table 2.5. The data shown in this table was obtained from November 9, 2015 correspondence between Banner Associates and the SDDENR as documented in the Wastewater Regionalization Study completed by Banner Associates in 2016. A copy of the letter is provided in Appendix A. The SD DENR considered antidegradation in developing the potential limits because the facility would be considered a new discharger.

The SD DENR has begun to require wastewater facilities to monitor nitrogen and phosphorus levels in anticipation of future nitrogen and phosphorus limits. The SD DENR has indicated that future limits will likely be less than 10 mg/l for nitrogen and less than 1 mg/l for phosphorus. As a result, the recommended treatment process should include provisions for future removal of nitrogen and phosphorus.

Table 2.5 Predicted Effluent Limits for Big Sioux River east of Harrisburg based on Flows Developed for the Regional Wastewater Study for the Communities of Harrisburg, Tea, and Worthing

Predicted Effluent Flows		2015	2020	2025	2030	2035	2040
Average Day Flow, gpd		1,277,336	1,615,672	2,026,298	2,488,490	3,013,578	3,613,695
PARAMETER	**BASIS**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Ammonia (mg/l)	Daily Max	6.6	2.5	2.2	2.1	2.5	2.2
	30-day Ave	1	0.5	0.4	0.5	0.6	0.5
TSS (mg/l)	Max 7-Day Ave	45	Based on Secondary Treatment Standards.				
	30-day Ave	30	Based on Secondary Treatment Standards.				
BOD (mg/l)	Max 7-Day Ave	45	Based on Secondary Treatment Standards.				
	30-day Ave	30	Based on Secondary Treatment Standards.				
pH	Daily Max	9	Based on warmwater marginal fish life propagation waters.				
	Daily Min	6.5	Based on warmwater marginal fish life propagation waters.				
***E. coli.* (#/100 mL)**	Daily Max	235	Effective May-September, limit based on limited contact recreation waters classification.				
	30-day Geo Mean	119	Effective May-September, limit based on antidegredation.				
DO (mg/l)	Daily Min	5	Effective May-September, limit based on warmwater marginal fish life propagation waters				
Temp. (°C)	Daily Max	32.2	Based on warmwater semi-permanent fish life propagation waters classification.				
	30-Day Ave	Monitor					
Nitrate (mg/l)	Daily Max	Monitor					
	30-Day Ave	Monitor					
Total P (mg/l)	Daily Max	Monitor					
	30-Day Ave	Monitor					

BANNER
engineering a better community

The values presented in Table 2.5 cannot be directly applied to Harrisburg. The flows used to develop the permit limits were for the recently completed regional study and Harrisburg's projected flows are much less. Updated discharge limits for the Big Sioux River were requested from the SD DENR for the revised flows and are presented in Table 2.6.

Table 2.6 Revised Effluent Limits for Big Sioux River east of Harrisburg based on Flows Developed in the Value Engineering Study

Predicted Effluent Flows		2017	2020	2025	2030	2035	2040
Average Day Flow, gpd		385,000	433,000	527,000	641,000	780,000	
PARAMETER	**BASIS**	**2017**	**2020**	**2025**	**2030**	**2035**	**2040**
Ammonia (mg/l)	Daily Max	16.4	6.6	5.6	4.8	4.1	--
	30-day Ave	3.9	1.3	1.1	1.0	0.8	--
TSS (mg/l)	Max 7-Day Ave	45	Based on Secondary Treatment Standards.				
	30-day Ave	30	Based on Secondary Treatment Standards.				
BOD (mg/l)	Max 7-Day Ave	45	Based on Secondary Treatment Standards.				
	30-day Ave	30	Based on Secondary Treatment Standards.				
pH	Daily Max	9	Based on warmwater marginal fish life propagation waters.				
	Daily Min	6.5	Based on warmwater marginal fish life propagation waters.				
***E. coli.* (#/100 mL)**	Daily Max	235	Effective May-September, limit based on limited contact recreation waters classification.				
	30-day Geo Mean	119	Effective May-September, limit based on antidegredation.				
DO (mg/l)	Daily Min	5	Effective May-September, limit based on warmwater marginal fish life propagation waters				
Temp. (°C)	Daily Max	32.2	Based on warmwater semi-permanent fish life propagation waters classification.				
	30-Day Ave	Monitor					
Nitrate (mg/l)	Daily Max	Monitor					
	30-Day Ave	Monitor					
Total P (mg/l)	Daily Max	Monitor					
	30-Day Ave	Monitor					

END OF SECTION 2

SECTION 3: ALTERNATIVE ANALYSIS

3.1 BASIS OF ANALYSIS

The feasibility and costs of the most viable alternatives from the 2016 Wastewater Facilities Plan Amendment, as well as two additional alternatives recommended by Banner Associates, were examined in this Value Engineering (VE) Study. The costs as well as the advantages, disadvantages, and key considerations for each alternative listed below are presented in this section of the report.

- Treatment Alternative 2.1: Sequencing Batch Reactor (SBR)
- Treatment Alternative 2.2: Oxidation Ditch
    - *Initially dismissed during the Facility Planning process, but reconsidered by Banner*
- Treatment Alternative 2.3: SEQUOX® by Aeromod, Inc.
- Treatment Alternative 3.1: Partial Pumping to Sioux Falls
- Treatment Alternative 3.2: Complete Pumping to Sioux Falls
- Treatment Alternative A: Integrated Fixed Film Activated Sludge (IFAS)
    - *Additional alternative offered by Banner*

3.1.1 Review of Capital Construction Costs

The capital construction costs for each alternative from the 2016 Wastewater Facilities Plan Amendment were reviewed with adjustments made and documented where savings could be found or costs appeared insufficient. This documentation can be found in Sections 3.2 through 3.5. For ease of comparison and consistency, the cost estimate format followed that of the 2016 Wastewater Facilities Plan Amendment. Capital construction costs were also developed for Treatment Alternative A: Integrated Fixed Film Activated Sludge (IFAS).

Note that a 0.5 mile extension of the existing 16-inch force main that conveys wastewater to Sioux Falls for treatment will be required in the summer of 2018 to address capacity issues in the receiving sewer and get ahead of development. If Harrisburg chooses to construct their own treatment plant, it will not be on-line prior to 2018. Therefore, this extension has been included in the cost of all alternatives.

Land purchase is priced at $1,250,000 in the 2016 Wastewater Facilities Plan Amendment. This dollar amount appeared high as only 30 acres would likely be required for a new treatment facility sized to meet the current and future needs of the City. At $25,000 per acre this would require approximately $750,000. However, Harrisburg indicated that buffer space would also be required and requested that the cost of land purchase not be adjusted in the VE Study. As a result, the cost for land purchase is $1,250,000 for all options involving Harrisburg constructing their own treatment facility.

For the alternatives that involve Harrisburg building their own treatment facility, the siting, design, and construction is anticipated to take at least four years. During that time, Harrisburg will continue pumping wastewater to Sioux Falls for treatment. The City of Sioux Falls requires Harrisburg pay a 2.0 multiplier on their regional wastewater rate because they have not paid the System Development Charges (SDCs) to connect to the regional system. For the alternatives where Harrisburg would become part of the regional system, Sioux Falls will reduce the initial SDC by the multiplier amount paid since 2009. If Harrisburg builds a new treatment plant, this money is lost. The loss of the multiplier money paid during the four years required to construct a new treatment facility needs to be accounted for in the VE Study. As a result, the present worth cost of the multiplier for years 2018-2021 is included the treatment alternatives. It is referred to as the "Present Worth of Lost Multiplier Credit" in the opinion of probably capital construction costs. It is listed near the bottom of the table, near the engineering and land purchase costs, as engineering fees and a contingency would not apply to it. The multiplier is calculated as the volume rate less the credit for equalization and treatment, if applicable. It is unlikely that Harrisburg would receive treatment credit over the 4-year period, so only the equalization credit has been included. A more detailed explanation of the regional rates, multiplier, and why Harrisburg will likely not be able to achieve treatment credit is provided in Section 3.5.

3.1.2 Nitrogen and Phosphorus Removal Considerations

While nitrogen and phosphorus limits will not be part of the initial permit, limits of less than 10 mg/l for nitrogen and 1 mg/l for phosphorus are expected in future as stated throughout the report. The alternative selected either needs to be able to meet these limits, or be easily modified so that it can meet these limits.

In regards to the nitrogen and phosphorus removal capabilities of the alternatives considered, the 2016 Wastewater Facilities Plan Amendment is inconsistent. Page 47 of the 2016 Report states, “These removal processes are not included in the estimates but the city should be aware of the future requirements.” However, in regards to mechanical treatment options, page 48 of the 2016 Wastewater Facilities Plan Amendment states, “With proper operational settings, (mechanical) plants are capable of biologically removing phosphorus down to 1 mg/L and total nitrogen below 10 mg/L.” This is true for all but one of the alternatives considered. The manufacturer for Treatment Alternative 2.1: SBR indicated it will only be able to reduce phosphorus to 2.0 mg/l.

In order to provide a fair comparison between the alternatives, treatment processes were added so that each alternative would be capable of meeting the anticipated effluent limit of 10 mg/l or less for total nitrogen and 1.0 mg/l or less for phosphorus. For Treatment Alternative 2.1: SBR this requires chemical addition (ferric chloride) followed by cloth disk filtration to precipitate and remove the phosphorus. The costs for this additional treatment process were included in the VE Study. Table 3.1 presents the projected effluent quality for the various treatment alternatives based on manufacturer information with this modification.

Table 3.1: Projected Effluent Quality for the Alternatives Considered

DESCRIPTION	BOD (mg/l)	TSS (mg/l)	Ammonia-N (mg/l)	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)
Alternative 2.1 Sequencing Batch Reactor*	30	30	0.6	10	1.0
Alternative 2.3 Sequox® process by Aeromod	10	10	1.0	5	1.0
Alternative 2.2 Oxidation Ditch	10	15	1.0	7.0	0.9
Alternative A IFAS System	<30	<30	<0.6	<10	<1
Alternative 3.1 Partial Pumping to Sioux Falls	Sioux Falls Water Reclamation will need to add processes to meet the future N and P limits. The future impact on rates for these improvements is not unknown.				
Alternative 3.2 Complete Pumping to Sioux Falls					

**Includes cloth disk filter and ferric chloride addition required to reach 1.0 mg/l of effluent phosphorus.*

3.1.3 Review of Operations and Maintenance (O&M) Costs

The 2016 Wastewater Facilities Plan Amendment developed O&M costs for each alternative based on annual equipment, solids handling, testing, utilities, and labor costs. These projected O&M costs were reviewed for accuracy with documentation provided in Sections 3.2 through 3.5.

The VE Study found that the O&M costs developed in the 2016 Wastewater Facilities Plan Amendment were inadequate compared to typical O&M costs of similar sized facilities in South Dakota. The VE Study revised the projected O&M costs based upon information from equipment suppliers and experience with similar sized treatment facilities. A 20% contingency has been applied to O&M costs to account for lighting, heating, operation of smaller equipment not accounted for in the Facility Plan, general maintenance needs and other miscellaneous costs. The revised O&M costs are summarized in Table 3.2, with a detailed breakdown of O&M costs provided in Appendix B. A description of each O&M area and the assumptions used to develop the costs is provided below.

Table 3.2: Operation and Maintenance (O&M) Costs Developed in the VE Study

	Annual Cost					
	Alt. 2.1: SBR	Alt. 2.2: Oxidation Ditch	Alt. 2.3: Sequox-Aeromod	Alt. 3.1: Partial Pumping to Sioux Falls	Alt. 3.2: Complete Pumping to Sioux Falls	Alt. A: IFAS
Labor	$547,040	$547,040	$547,040	$128,960	$64,480	$547,040
Utilities	$110,681	$112,719	$134,284	$87,740	$6,135	$127,913
Solids Handling	$28,893	$25,915	$25,915	$0	$0	$25,915
Testing	$12,000	$12,000	$12,000	$1,500	$1,500	$12,000
Equipment	$409,507	$437,261	$390,084	$151,722	$106,818	$386,966
Contingency (20%)	$221,624	$226,987	$221,865	$73,984	$35,787	$219,967
TOTAL =	**$1,329,746**	**$1,361,922**	**$1,331,188**	**$443,907**	**$214,719**	**$1,319,800**

3.1.3.1 Equipment Costs

Wastewater treatment facilities require a significant amount of equipment, such as motors, pumps, aerators, blowers, and a variety of moving parts that require regular maintenance to stay in good operating condition. For example, it is necessary to replace filters, oil, and seals regularly. In addition, equipment wears out and must be replaced. Therefore, it was assumed that 2.5% of the capital cost will be required on an annual basis to maintain and replace equipment.

3.1.3.2 Solids Handling Costs

Each treatment alternative proposed includes an aerobic digestion process for sludge treatment and to reduce the volume of sludge produced. Following aerobic digestion, solids handling is proposed with a belt filter press to reduce the volume and weight of the sludge that must be transported for disposal via land application on a nearby farm. Assuming the belt filter press produces a cake with 16% solids, the estimated sludge generated is 3.52 tons per day of dry cake.

Solids handling processes are costly to operate largely due to the amount of labor required. The greatest cost is in the loading, hauling, and land application of the sludge. In addition, chemical polymer addition is required ahead of the belt filter press to promote flocculation of solids, requiring a metering pump and mixing tank. Wash water is also required to clean the belts after the dewatering process. Chemical costs information was obtained from Hawkins Chemical in Sioux Falls, SD and a price of $2.00 per gallon for polymer is used in the O&M analysis.

While indirectly related to solids handling, the cost of ferric chloride addition ahead of the cloth disk filters to sequester and aid in phosphorus removal was included here for Alternative 2.1: SBR. The $1.70 per gallon price for ferric chloride was obtained from a local chemical supplier.

3.1.3.3 Testing

Regular testing is required at a wastewater treatment plant to verify the treated effluent is meeting discharge permit requirements and to monitor plant operations. Typical sampling locations and the tests performed at these locations are as follows.

- Influent: Biological oxygen demand (BOD), Total Suspended Solids (TSS), ammonia (NH3-N)
- Effluent: BOD, TSS, ammonia (NH3-N), pH, dissolved oxygen (DO), *e. coli*
- Aeration Mixed Liquor: Settleability, TSS, volatile suspended solids (VSS), DO
- Aerobic Digester: Settleability, TSS, VSS, % Solids
- Solids Handling: % Solids

Annual testing costs including purchasing the equipment and reagents to complete the testing, as well as gloves, eye protection, and other safety equipment. Testing of some parameters, such as heavy metals, cannot be completed in-house and must be sent out for analysis.

3.1.3.4 Utilities

Utility costs due to power consumption are incurred in equipment operations at a wastewater treatment plant. A significant number of motors are required to operate the mixers, blowers, pumps and other equipment. The number and size of motors was obtained from the proposals provided by equipment manufacturers. Utility costs were calculated assuming a $0.10 per kW-hour power cost.

3.1.3.5 Labor

Labor is the most significant cost in operating a wastewater treatment facility and proper O&M requires an adequate number of trained staff. The number of personnel and skill levels needed depends primarily on the size of the plant (wastewater flow treated) and the treatment processes involved (process and equipment complexity). An appropriately sized and trained staff will efficiently operate and maintain the plant to provide wastewater treatment producing an effluent that meets all applicable permit limits for many years. Overstaffing is expensive, but understaffing can result in poor morale among employees who are overworked and overwhelmed. Understaffing also leads to increased costs due to lack of necessary preventive maintenance, which may also lead to poor treatment performance. Poor treatment performance may result in permit violations and fines.

Harrisburg’s wastewater treatment plant would be staffed with a manager and a team of operators. In determining how many operations staff would be required, Banner reviewed the Pierre Wastewater Treatment Plant System Analysis completed by Banner in July 2014. The report included a staffing comparison at nine (9) South Dakota cities operating mechanical wastewater treatment plants. Plant designs vary as the municipality’s sizes and flows differ. Most of these plants operate aerobic or anaerobic digesters for biosolids treatment, providing a similar comparison since aerobic digesters are being considered for each alternative in this study. The findings are presented in Table 3.3.

Table 3.3: Summary of WWTP Staffing Comparison

CITY	ABERDEEN	BROOKINGS	HURON	MADISON	MILBANK	PIERRE	VERMILLION	WATERTOWN	YANKTON
Hours staffed	24/7	24/7	8 M-F, 5 Sat-Sun and holidays	8/day year round	8/day year round	8 M-F, 4 Sat-Sun and holidays	8 M-F, 4 Sat-Sun and holidays	8/day year round	8/day year round
Plant Design/Peak	4.5/8.0	3.0/6.0	2.3/2.3	2.0/4.0	1.5/3.5	2.2/4.4	2.0/4.0	4.0/NA	2.55/5.24
Superintendent/Fore	1/1	1/2	1/1	0/1	1/0	1/0	1/0	1/0	1/1
Assistant								.5[1]	
Pretreatment	.5[1]	1						.5[1]	
Pretreatment								1	
Lab Technician	.5[1]	0.6[2]				1	1	2	1
Lead Operator		1						1	
Operators	4	3.4[3]				1			
Maintenance	2	4							
Operator/Maintenanc			4	4	3[4]		3	4	3
Biosolids Operator	1					1			
Total	**10**	**9 + 4.0**	**6**	**5**	**4**	**4**	**5**	**10**	**6 + 2[5]**

[1] *One fulltime person holds the two listed positions in both Aberdeen and Watertown*
[2] *Lab technicians – 0.6 FTE filled by SDSU CEE students*
[3] *Plant is covered 24/7 – evening, overnight, weekend, holiday shifts all filled by 3.4 FTE SDSU CEE students*
[4] *O & M plant personnel also collection workers*
[5] *Two part time operators alternate weekends and holidays with one of the full time staff*

Seven (7) of the nine (9) plants have combined operation/maintenance personnel. Two (2) have personnel carrying either an operator or maintenance label only. The combined O&M personnel are cross-trained to cover operations and/or maintenance – providing flexibility to work where needed. Even personnel at the two plants with operator or maintenance only labels have some cross-training, mainly for maintenance personnel to act as backup operators. Eight (8) of the nine (9) cities surveyed have separate collection crews, with only Milbank having staff that also work on the collection system. The Milbank superintendent has indicated that he wishes they had more staff.

The six (6) wastewater plants not staffed 24/7 and Brookings keeps an on-call person available. Four (4) plants surveyed are short personnel during the week due to how they schedule and use comp/flex time with weekend operators.

Based on the size of the proposed Harrisburg wastewater treatment plant, it was assumed that the following additional full-time positions would be required for Alternatives 2.1, 2.2, 2.3, and A:

- 1 Superintendent – Wastewater Treatment
- 3 Wastewater Treatment Plant Operators

Staff would work a total of 40-hours per week with some of this time occurring on weekends and holidays on a rotating basis for operations staff. Operations staff were assumed to cost $62.00 per hour with wages and benefits. The office manager was assumed to cost $77.00 per hour with wages and benefits.

One full-time additional position would be required for Alternative 3.1: Partial Pumping to Sioux Falls to maintain and operate the bar screen and aeration system proposed in the first two cells. A half-time position would be required for Alternative 3.2: Complete Pumping to Sioux Falls due to the reduced maintenance and operational needs with pumping all the wastewater to Sioux Falls for treatment and only using the ponds for emergency storage.

3.1.4 Equivalent Uniform Annual Cost (EUAC) Analysis

The VE Study reviewed the equivalent uniform annual cost (EUAC) analysis completed in the 2016 Wastewater Facilities Plan Amendment. The EUAC evaluated the impact of capital construction and annual O&M costs for each of the alternatives. For the pumping to Sioux Falls alternatives, SDC charges and fees paid to the City of Sioux Falls for treatment were also included. The EUAC analysis was performed using a 20-year design period and a 3% inflation rate as an industry accepted standard. The EUAC developed for each alternative is the annual cost in today's dollars to fund each alternative if it could be paid for over a 20 year period. It is not a reflection of the actual annual cost, but a tool used to determine the lowest cost alternative over the planning period.

3.2 FACILITY PLAN TREATMENT ALTERNATIVE 2.1: SEQUENCING BATCH REACTOR

Sequencing Batch Reactors (SBRs) are an aerobic biological process used to convert organics into carbon dioxide, thus reducing BOD, and nitrifying ammonia into nitrate. If designed and operated properly, SBRs are also capable of denitrifying (converting nitrate into nitrogen gas) and biologically removing a portion of the phosphorus.

SBRs use batch treatment consisting of fill-react-settle-decant stages. In the fill stage, wastewater enters the tank for treatment. During the react stage, biological treatment occurs via aeration/mixing. During settling, aeration and mixing is turned off and the solids are allowed to settle. Clear water is decanted off the top for final treatment and discharge in last stage. Typically, biosolids are pumped and wasted from the sludge blanket at the bottom of the tank during the decant cycle. Multiple SBR tanks are required so that one tank can always be filling while the other tank(s) is settling. Figure 3.1 shows the layout of the SBR proposed for Harrisburg with two reactor tanks and one aerobic digester.

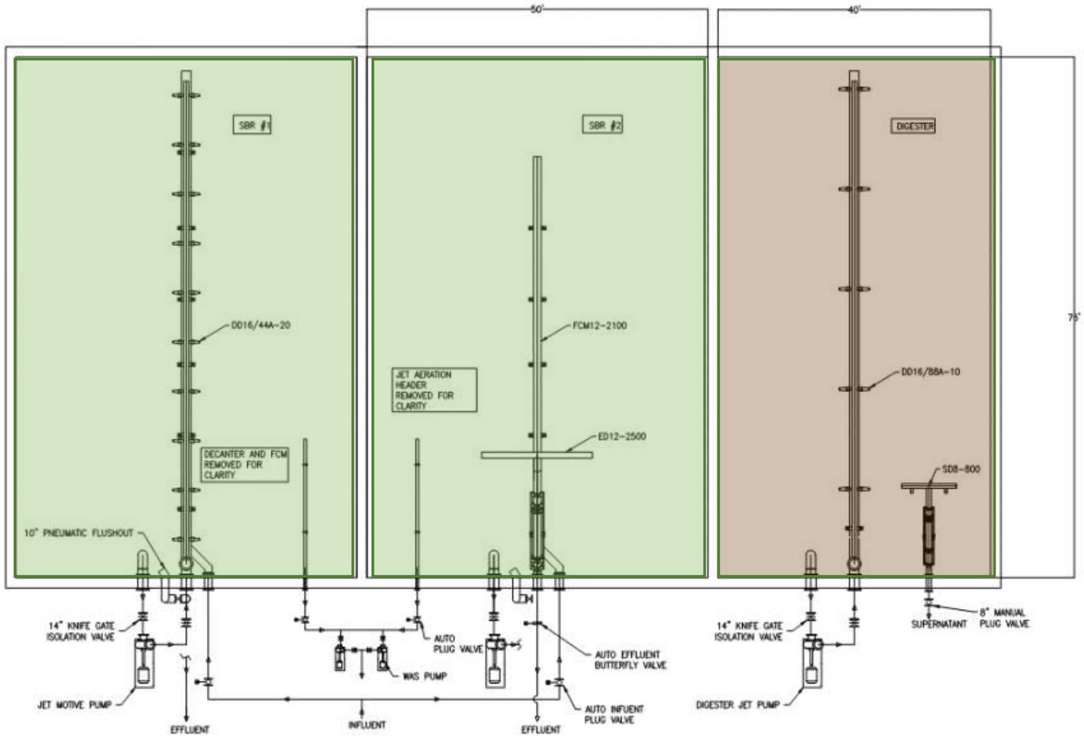


Figure 3.1: Sequencing Batch Rector (SBR) with Two Reactor Tanks and an Aerobic Digester

3.2.1 Process Feasibility

SBRs have an established track record for treating municipal wastewater. The City of Huron, SD has operated SBRs ahead of their ponds for organics removal since 1984. Other South Dakota communities using SBRs for treatment include Lennox, Box Elder, Summerset, and Hill City. The City of Del Rapids is in the design phase for a new mechanical wastewater treatment facility that will utilize SBRs.

SBRs offer the following advantages over other treatment processes:

- Compact footprint resulting in less tankage, reduced site work, reduced yard piping requirements (primary clarification, biological treatment, and secondary clarification performed in a single basin)
- React cycles can be adjusted to provide aerobic, anaerobic, and anoxic conditions to provide biological nutrient removal (nitrogen some phosphorus removal)

- Lower upfront capital cost
- Easily expandable
- Reduced power consumption due to smaller footprint and compact design

SBRs also have the following disadvantages compared to conventional activated sludge processes:

- Require a sophisticated level of timing units and controls
- Require knowledgeable operators with a higher degree of training
- Potential discharge of floating sludge during the decant phase
- Decant mechanisms tend to freeze-up during cold winter conditions
- Difficult to shut down operations to clean tanks with proposed two-tank system
- Difficulty meeting discharge requirements when phosphorus and nitrogen limits are very stringent. Chemical addition and cloth disk filtration is typically required to meet effluent phosphorus limits of 1.0 mg/l or less.

In addition to the SBR system, the 2016 Wastewater Facilities Plan Amendment also included the following equipment for Alternative 2.1:

- Influent pumps
- Influent bar screen for solids removal in an enclosed pretreatment building with odor control
- SBR basin effluent equalization
- UV disinfection (located outside)
- Effluent pumps
- Effluent aeration (located outside)
- Aerobic digestion for solids handling
- Belt press for solids dewatering
- Building for solids handling equipment and blowers
- Office and small lab

- Treated wastewater will be pumped to the Big Sioux River for discharge in a 16” force main
- Standby generator

The 2016 Wastewater Facilities Plan Amendment indicates that a cover for the SBRs will be evaluated during the design.

3.2.2 Value Engineering (VE) Capital Construction Cost Estimate Review and Modifications

The capital construction cost estimate for Alternative 2.1 SBR in the 2016 Wastewater Facilities Plan Amendment was reviewed to determine whether key components of the treatment system were missing, or if costs accurately reflected pricing obtained from manufacturers and observed in tabulations of recently bid projects. Table 3.4 provides a comparison of the opinion of probable costs for Alternative 2.1: SBR between the 2016 Wastewater Facilities Plan Amendment and the VE Study. The VE Study identified the following modifications that impacted the capital construction costs for Alternative 2.1.

Table 3.4: Construction Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.1: SBR

ITEM NO.	DESCRIPTION OF WORK AND MATERIALS	QTY	UNIT	FACILITY PLAN UNIT PRICE	FACILITY PLAN TOTAL		VE UNIT PRICE	VE TOTAL		Difference
1	Site Grading/Paving	1	LS	$200,000	$200,000		$326,000	$326,000		$126,000
2	Influent Pumps	1	LS	$150,000	$150,000		$0	$0		($150,000)
3	Effluent Pumps	1	LS	$150,000	$150,000		$0	$0		($150,000)
4	~~Bar Screen~~ Pretreatment Building	1	LS	$500,000	$500,000		$768,800	$768,800		$268,800
5	Bar Screen and Compactor (added Grit Removal)	1	LS	$200,000	$200,000		$362,700	$362,700		$162,700
6	Office, Lab and Final Effluent Pump Building (added area for cloth disk filtration)	1	LS	$600,000	$600,000		$735,200	$735,200		$135,200
7	Mechanical/Biosolids Dewatering Building	1	LS	$950,000	$950,000		$840,000	$840,000		($110,000)
8	Process Equipment (added cloth disk filters)	1	LS	$2,000,000	$2,000,000		$2,592,20	$2,592,200		$592,200
9	Odor Control	1	LS	$250,000	$250,000		$250,000	$250,000		$0
10	Power to Site	1	LS	$100,000	$100,000		$100,000	$100,000		$0
11	Standby Power/Generator	1	LS	$250,000	$250,000		$250,000	$250,000		$0
12	Instrumentation and Controls/SCADA	1	LS	$750,000	$750,000		$367,000	$367,000		($383,000)
13	Electrical Inside Plant	1	LS	$250,000	$250,000		$571,000	$571,000		$321,000
14	Concrete Work Influent Pumping	95	CuYd	$650	$61,750		$0	$0		($61,750)
15	Concrete Work Effluent Pumping*	85/127.5	CuYd	$650	$55,250		$650	$82,875		$27,625
16	Concrete Work Basins*	1200/1893	CuYd	$650	$780,000		$650	$1,230,378		$450,378
17	Concrete Work Disinfection/Post Aeration*	310/465	CuYd	$650	$201,500		$650	$302,250		$100,750
18	Effluent Equalization	1	LS	$500,000	$500,000		$500,000	$500,000		$0
19	~~Storm Water and~~ Bio Solids Holding Ponds	1	LS	$500,000	$500,000		$0	$0		($500,000)
20	Plant Piping	1	LS	$250,000	$250,000		$652,000	$652,000		$402,000
21	Mechanical Room Equipment	1	LS	$700,000	$700,000		$571,000	$571,000		($129,000)
22	Lift Station Pump and Piping Assembly	1	LS	$350,000	$350,000		$350,000	$350,000		$0
23	16" Force Main	36,000	FT	$70	$2,520,000		$70	$2,520,000		$0
24	16" Sanitary Bedding Material	36,000	FT	$6.00	$216,000		$6.00	$216,000		$0
25	0.5 Mile Force Main Extension	1	LS				$269,580	$269,580		$269,580
*First number references quantity used in the 2016 Wastewater Facilities Plan Amendment assuming 1 foot thick walls. It is more likely due to tank depth that 18-inch thick walls will be required. Second number references the increased concrete quantity used in the VE Study to account for this.				Contingencies (20%)	$12,484,500			$13,857,000		$1,372,500
				Subtotal	$2,496,900			$2,771,400		$274,500
				Total Estimated Construction Costs	**$14,981,400**			**$16,628,400**		**$1,647,000**
				ENGINEERING	$2,248,000			$2,660,600		$412,600
				LAND PURCHASE	$1,250,000			$1,250,000		$0
				PRESENT WORTH OF LOST MULTIPLIER CREDIT				$2,082,000		$2,082,000
				LEGAL, ADMINISTRATION & TESTING (4%)	$740,000			$665,200		($74,800)
				TOTAL ESTIMATED PROJECT COST	**$19,220,000**			**$23,286,000**		**$4,066,000**

3.2.2.1 Addition of Grit Removal Equipment

Grit removal equipment costs were not included in the 2016 Wastewater Facilities Plan Amendment, but should be implemented for mechanical treatment systems with downstream aerated basins. Without it, grit will build up in the basins potentially plugging the aeration equipment and damaging pumps. Accumulation of grit in downstream basins will require taking them out of service more frequently for cleaning. Grit removal equipment would consist of aerated or vortex grit chambers housed in the pretreatment building. The cost for grit removal equipment was included in line item 5, “Bar Screen and Compactor” for the VE costs.

3.2.2.2 Removal of Pumping Equipment and Facilities

The SBR cost estimates in the 2016 Wastewater Facilities Plan Amendment shows influent pumps, effluent pumps, and a lift station pump and piping assembly. This means that the wastewater would be pumped three times, in addition to being pumped one other time by Harrisburg’s existing lift station. Pumping wastewater four times is excessive as ideally wastewater is pumped only once, and at most, two times through a treatment process. As a result, Banner has removed the cost for the influent and effluent pumps as well as the concrete costs related to influent pumping.

3.2.2.3 Additional of Cloth Disk Filtration

Cloth disk filtration was not part of the 2016 Wastewater Facilities Plan Amendment, but is needed to meet the future effluent phosphorus limits of 1.0 mg/l. Ferric chloride chemical addition will be required ahead of the filters to facilitate the removal. The cost of the filter and chemical feed equipment was added to the “Process Equipment” cost in the VE Study. The size of the building in “Office, Lab and Final Effluent Pump Building” cost was increased in the VE Study to accommodate the cloth disk filters.

3.2.2.4 Odor Control

The 2016 Wastewater Facilities Plan Amendment included odor control, we assume at the pretreatment building. Odor control equipment may or may not be needed. If the treatment facility is constructed in town, it should be added to the pretreatment building. If it is constructed in more of a rural area, it may not be necessary. It is challenging to provide odor control at areas other than a pretreatment building in a wastewater treatment facility. Odor control will not stop the facility from having odors. It will only reduce the impact of the odors at the pretreatment building.

3.2.2.5 Additional Concrete Quantities

The concrete quantities used in the 2016 Wastewater Facilities Plan Amendment indicate that 1 foot thick walls were assumed for process tankage. Soil conditions for the depths of tanks that will be required often necessitate walls and floors thicknesses greater than 1 foot. Therefore, concrete quantities were increased to reflect 18-inch thick walls for the VE Study.

3.2.2.6 Removal of Bio-solids Holding Ponds

The 2016 Wastewater Facilities Plan Amendment costs for the SBR alternative includes storm water and bio-solids holding ponds. Based on the process equipment costs, an aerobic digester is provided to hold and aerate the solids until they can be sent to the belt filter press for solids processing. Therefore, bio-solids holding ponds are not required and this cost was removed. Banner has included storm water ponds in the site grading/paving costs instead.

3.2.2.7 Other Capital Construction Cost Modifications

Other adjustments to the capital construction costs used in the 2016 Wastewater Facilities Plan Amendment include:

- Mechanical/Biosolids Dewatering Building is anticipated to cost less based on the square footage required for the area needed and recent bid tabulations

- Instrumentation/SCADA costs appeared high, even for a fully automated plant compared to recent bid tabulations
- Electrical costs seemed very low based upon recent bid tabulations for new treatment facilities
- Plant piping costs seemed very low based upon recent bid tabulations for new treatment facilities
- Mechanical Room Equipment costs seemed high based upon recent bid tabulations for new treatment facilities
- Inclusion of the 0.5 mile force main extension for the connection to Sioux Falls in the cost as it will be required in 2018, before a new treatment plant could be constructed
- Inclusion of the Present Worth of Lost Multiplier Credit to account for the additional fees paid to the City of Sioux Falls for wastewater treatment during the approximately four years while a new plant is being constructed

3.2.3 Value Engineering (VE) Equivalent Uniform Annual Cost (EUAC) Estimate Review and Modifications

The Equivalent Uniform Annual Cost (EUAC) developed in the 2016 Wastewater Facilities Plan Amendment was also reviewed. Table 3.5 provides a comparison of the salvage values developed as part of the EUAC cost analysis for Alternative 2.1: SBR between the 2016 Wastewater Facilities Plan Amendment and the VE Study.

In the EUAC analysis, salvage values were examined for each item in the cost estimate. The 2016 Wastewater Facilities Plan Amendment set salvage value at the end of 20 years at either 0% or 60%, and assumes a 100% salvage value for all land purchased. The Amendment assigned a 60% salvage value to equipment.

The VE Study has modified several of the salvage values used. Typically, equipment reaches the end of its useful life after 20 years, and is at or nearing replacement. As a result, a salvage value of 0% has been used for equipment at the end of 20 years. A 60% salvage value was used in the

VE Study for buildings, concrete tankage, and buried piping as they have a typical life of 50 years. A 33% salvage value was used on bringing power to the site as it would have a typical life of 30 years. A 100% salvage value was used for land; however, land is unique in that it appreciates in value. For this analysis, land was assumed to appreciate at a 3% inflation rate. Finally, the salvage value for contingencies was based upon the overall percentage of the salvage value compared to the construction cost.

Next, the present worth of the salvage value was calculated using a 20 year period and 3% interest rate. It was then subtracted from the capital construction cost to determine the present net worth of the capital construction cost.

Table 3.5: Salvage Value Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.1: SBR

DESCRIPTION	FACILITY PLAN PRICE	FACILITY PLAN SALVAGE VALUE	FACILITY PLAN PRESENT WORTH OF SALVAGE VALUE	FACILITY PLAN PRESENT NET WORTH	VE PRICE	VE SALVAGE VALUE	VE PRESENT WORTH OF SALVAGE VALUE	VE PRESENT NET WORTH	DIFFERENCE	VE SALVAGE RATE
Site Grading/Paving	$200,000	$0	$0	$200,000	$326,000	$0	$0	$326,000	$126,000	0%
Influent Pumps	$150,000	$90,000	$49,831	$100,169	$0	$0	$0	$0	($100,169)	
Effluent Pumps	$150,000	$90,000	$49,831	$100,169	$0	$0	$0	$0	($100,169)	
Bar Screen Pretreatment Building	$500,000	$300,000	$166,103	$333,897	$768,800	$461,280	$255,400	$513,400	$179,503	60%
Bar Screen and Compactor (added Grit Removal)	$200,000	$120,000	$66,441	$133,559	$362,700	$0	$0	$362,700	$229,141	0%
Office, Lab and Final Effluent Pump Building	$600,000	$360,000	$199,323	$400,677	$735,200	$441,120	$244,237	$490,963	$90,286	60%
Mechanical/Biosolids Dewatering Building	$950,000	$570,000	$315,595	$634,405	$840,000	$504,000	$279,053	$560,947	($73,458)	60%
Process Equipment (added cloth disk filters)	$2,000,000	$1,200,000	$664,411	$1,335,589	$2,592,200	$0	$0	$2,592,200	$1,256,611	0%
Odor Control	$250,000	$150,000	$83,051	$166,949	$250,000	$0	$0	$250,000	$83,051	0%
Power to Site	$100,000	$0	$0	$100,000	$100,000	$33,333	$18,456	$81,544	($18,456)	33%
Standby Power/Generator	$250,000	$150,000	$83,051	$166,949	$250,000	$0	$0	$250,000	$83,051	0%
Instrumentation and Controls/SCADA	$750,000	$450,000	$249,154	$500,846	$367,000	$0	$0	$367,000	($133,846)	0%
Electrical Inside Plant	$250,000	$150,000	$83,051	$166,949	$571,000	$0	$0	$571,000	$404,051	0%
Concrete Work Influent Pumping	$61,750	$37,050	$20,514	$41,236	$0	$0	$0	$0	($41,236)	60%
Concrete Work Effluent Pumping	$55,250	$33,150	$18,354	$36,896	$82,875	$49,725	$27,532	$55,343	$18,447	60%
Concrete Work Basins	$780,000	$468,000	$259,120	$520,880	$1,230,378	$738,227	$408,738	$821,640	$300,760	60%
Concrete Work Disinfection/Post Aeration	$201,500	$120,900	$66,939	$134,561	$302,250	$181,350	$100,409	$201,841	$67,280	60%
Effluent Equalization	$500,000	$300,000	$166,103	$333,897	$500,000	$300,000	$166,103	$333,897	$0	60%
Storm Water and Bio Solids Holding Ponds	$500,000	$300,000	$166,103	$333,897	$0	$0	$0	$0	($333,897)	
Plant Piping	$250,000	$150,000	$83,051	$166,949	$652,000	$0	$0	$652,000	$485,051	0%
Mechanical Room Equipment	$700,000	$420,000	$232,544	$467,456	$571,000	$0	$0	$571,000	$103,544	0%
Lift Station Pump and Piping Assembly	$350,000	$210,000	$116,272	$233,728	$350,000	$0	$0	$350,000	$116,272	0%
16" Force Main	$2,520,000	$1,512,000	$837,158	$1,682,842	$2,520,000	$1,512,000	$837,158	$1,682,842	$0	60%
16" Sanitary Bedding Material	$216,000	$0	$0	$216,000	$216,000	$0	$0	$216,000	$0	0%
0.5 Mile Force Main Extension					$269,580	$161,748	$89,556	$180,024	$180,024	60%
Contingencies	$2,496,900	$0	$0	$2,496,900	$2,771,400	$998,399	$552,789	$2,218,611	($278,289)	36%
Present Worth of Lost Multiplier Credit					$2,081,848	$0	$0	$2,081,848	$2,081,848	0%
Engineering	$2,248,000	$0	$0	$2,248,000	$2,660,600	$0	$0	$2,660,600	$412,600	0%
Legal, Administration & Testing	$740,000	$0	$0	$740,000	$665,200	$0	$0	$665,200	($74,800)	0%
Land	$1,250,000	$1,250,000	$1,250,000	$0	$1,250,000	$2,257,639	$1,250,000	$0	$0	100%
Total	**$19,219,400**	**$8,431,100**	**$5,226,000**	**$13,993,400**	**$23,286,031**	**$7,638,821**	**$4,229,430**	**$19,056,601**	**$5,063,201**	

O&M costs were also part of the EUAC analysis to evaluate the impact of the cost over a 20 year period and are presented in Table 3.6. The O&M costs for Alternative 2.1: SBR were reviewed as part of the VE Study and appear insufficient for a facility of this size and complexity as documented below.

- Equipment: The annual amount allotted for equipment replacement in the 2016 Wastewater Facilities Plan Amendment is insufficient to maintain a plant of this magnitude.
- Solids Handling: The annual amount allotted for solids handling in the 2016 Wastewater Facilities Plan Amendment is high compared to that of area plants with similar mechanical solids handling equipment.
- Testing: The annual amount allotted for testing in the 2016 Wastewater Facilities Plan Amendment appears adequate.
- Utilities: The annual amount allotted for utilities in the 2016 Wastewater Facilities Plan Amendment is insufficient. An evaluation of the power consumption required for major equipment indicates utility costs will be much higher than the cost shown in the Amendment.
- Labor: The annual amount allotted for labor cost in the 2016 Wastewater Facilities Plan Amendment in not adequate. A survey of similar plants across the State indicates that four additional staff will be required for the successful operation of a facility of this size.

Table 3.6: Annual O&M Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.1: SBR

Description	Facility Plan EUAC	Facility Plan Net Present Worth		VE EUAC	VE Net Present Worth		Difference
Equipment	$53,000	$1,060,000		$491,409	$7,311,000		$6,395,400
Solids Handling	$75,000	$1,500,000		$34,672	$515,900		($984,100)
Testing	$15,000	$300,000		$14,400	$214,300		($85,700)
Utilities	$60,000	$1,200,000		$132,817	$1,976,000		$776,000
Labor	$164,000	$3,280,000		$656,448	$9,766,300		$6,486,300
Total	**$367,000**	**$7,340,000**		**$1,329,746**	**$19,783,500**		**$12,443,500**

In Table 3.6, annual O&M costs were converted to a net present worth cost using a 20 year period and 3% interest rate. It appears this calculation was incorrectly performed in the 2016 Wastewater Facilities Plan Amendment as the annual O&M costs were multiplied by 20 instead of performing a present worth calculation over the 20 year planning period.

Finally, the present worth of the capital construction costs was added to the net present worth of the O&M costs and used to develop the overall EUAC value as presented in Table 3.7.

Table 3.7: EUAC Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.1: SBR

	Facility Plan Analysis		VE Study Analysis
Construction Cost Net Present Worth (Less Salvage)	$13,993,400		$19,056,753
O&M Present Worth Cost	$7,340,000		$19,783,500
Total Net Present Worth	**$21,333,399**		**$38,840,253**
EUAC	**$1,433,940**		**$2,610,675**

3.3 TREATMENT ALTERNATIVE 2.2: OXIDATION DITCH

While the City of Harrisburg had eliminated the oxidation ditch alternative presented in the 2016 Wastewater Facilities Plan Amendment, Banner Associates recommends its reconsideration as part of the VE evaluation. An oxidation ditch is an oval shaped channel providing extended aeration wastewater treatment. Wastewater is mixed and aerated as it moves through the channel. The shape of the channel in combination with the aeration promotes mixing for long detention times. Basins can be added ahead of the ditch, creating anoxic and anaerobic zones for nitrogen and phosphorus removal. A final clarifier is provided at the end to settle out solids, with some of the solids recycled back to the head of the process and the remaining to an aerobic digester. An Ovivo single-train oxidation ditch layout is shown in Figure 3.2 with influent selector basins. Two trains are proposed for Harrisburg's wastewater system.

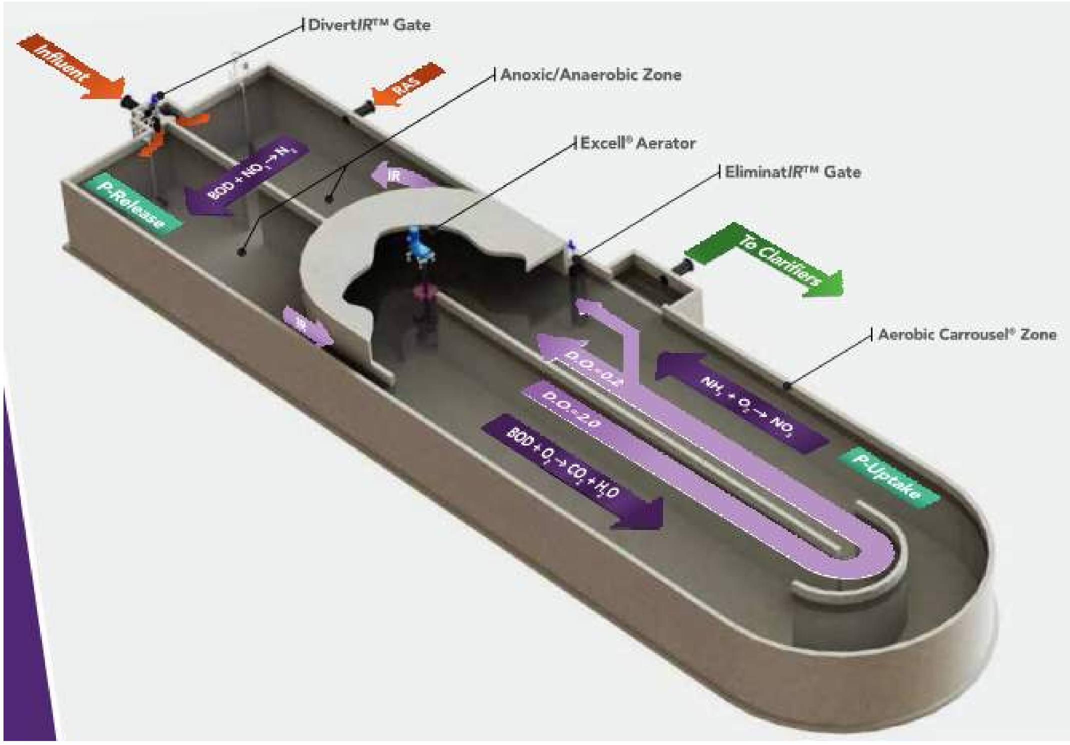


Figure 3.2: Carrousel® Oxidation Ditch by Ovivo

3.3.1 Process Feasibility

Oxidation ditches have a long history of successful municipal wastewater treatment with thousands of installations nationwide. Locally, they are used at Madison, Alcester, Clark, and Spearfish, SD, as well as Dawson and Luverne, MN.

The Alternative 2.2 Oxidation Ditch offers the following advantages:

- Easier to operate compared to the other treatment alternatives considered
- Offer a great deal of operational flexibility
- Resistant to plant upsets/shock loads due to long retention time
- Addition of selector tanks ahead of the ditch improve biological treatment
- One train can be easily shut down for maintenance
- Easily expandable

The Alternative 2.2 Oxidation Ditch has the following advantages:

- Less compact design results in higher capital cost
- Requires a sophisticated level of timing units and controls
- Require knowledgeable operators with a higher degree of training

In addition to the oxidation ditch, the 2016 Wastewater Facilities Plan Amendment also included the following equipment for Alternative 2.2:

- Influent pumps
- Influent bar screen for solids removal in an enclosed pretreatment building with odor control
- Final Clarification
- Equalization ahead of UV disinfection
- UV disinfection (located outside)
- Effluent Pumps
- Effluent aeration (located outside)
- Aerobic digestion for solids handling
- Belt press for solids dewatering
- Building for solids handling equipment and blowers
- Office and small lab
- Treated wastewater will be pumped to the Big Sioux River for discharge
- Standby generator

The 2016 Wastewater Facilities Plan Amendment indicates that a cover for the clarifiers will be evaluated during the design.

3.3.2 Value Engineering (VE) Capital Construction Cost Estimate Review and Modifications

The capital construction cost estimate for Alternative 2.2: Oxidation Ditch in the 2016 Wastewater Facilities Plan Amendment was reviewed to determine if key components of the treatment system were missing, if costs accurately reflected pricing obtained from manufacturers, and if pricing reflected tabulations of recently bid projects. Table 3.8 provides a comparison of the opinion of probable capital construction costs for Alternative 2.2: Oxidation Ditch between the 2016 Wastewater Facilities Plan Amendment and the VE Study.

The VE Study identified the following modifications that impacted the capital construction costs for Alternative 2.2: Oxidation Ditch:

- Addition of grit removal equipment (as presented in Section 3.2.2.1)
- Removal of pumping equipment and facilities (as presented in Section 3.2.2.2)
- Process equipment costs will likely be higher due to the inclusion of selector tanks ahead of the oxidation ditch process for nitrogen and phosphorus removal as well as aerobic digestion equipment
- Odor control (as presented in Section 3.2.2.4)
- Additional concrete quantities (as presented in Section 3.2.2.5)
- Removal of bio-solids holding ponds (as presented in Section 3.2.2.6)
- Mechanical/Biosolids Dewatering Building is anticipated to cost less based on the square footage required for the area needed and recent bid tabulations
- Instrumentation/SCADA costs appeared high, even for a fully automated plant compared to recent bid tabulations
- Electrical costs seemed very low based upon recent bid tabulations for new treatment facilities
- Effluent equalization is not needed with this flow through process with downstream clarification
- Plant piping costs seemed very low based upon recent bid tabulations for new treatment facilities
- Mechanical Room Equipment costs seemed high based upon recent bid tabulations for new treatment facilities
- The 0.5 mile force main extension for the connection to Sioux Falls has been included in the cost as will be required in 2018, before a new treatment plant could be constructed
- Inclusion of the Present Worth of Lost Multiplier Credit to account for the additional fees paid to the City of Sioux Falls for wastewater treatment during the approximately four years while a new plant is being constructed

Table 3.8: Construction Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.2: Oxidation Ditch

ITEM NO.	DESCRIPTION OF WORK AND MATERIALS	QTY	UNIT	FACILITY PLAN UNIT PRICE	FACILITY PLAN TOTAL		VE UNIT PRICE	VE TOTAL		Difference
1	Site Grading/Paving	1	LS	$200,000	$200,000		$348,500	$348,500		($148,500)
2	Influent Pumps	1	LS	$150,000	$150,000		$0	$0		$150,000
3	Effluent Pumps	1	LS	$150,000	$150,000		$0	$0		$150,000
4	~~Bar Screen~~ Pretreatment Building	1	LS	$500,000	$500,000		$768,800	$768,800		($268,800)
5	Bar Screen and Compactor (added Grit Removal)	1	LS	$200,000	$200,000		$362,700	$362,700		($162,700)
6	Office, Lab and Final Effluent Pump Building	1	LS	$600,000	$600,000		$615,200	$615,200		($15,200)
7	Mechanical/Biosolids Dewatering Building	1	LS	$950,000	$950,000		$840,000	$840,000		$110,000
8	Process Equipment	1	LS	$2,000,000	$2,000,000		$2,566,200	$2,566,200		($566,200)
9	Odor Control	1	LS	$250,000	$250,000		$250,000	$250,000		$0
10	Power to Site	1	LS	$100,000	$100,000		$100,000	$100,000		$0
11	Standby Power/Generator	1	LS	$250,000	$250,000		$250,000	$250,000		$0
12	Instrumentation and Controls/SCADA	1	LS	$750,000	$750,000		$392,000	$392,000		$358,000
13	Electrical Inside Plant	1	LS	$250,000	$250,000		$609,500	$609,500		($359,500)
14	Concrete Work Influent Pumping	95	CuYd	$650	$61,750		$0	$0		$61,750
15	Concrete Work Effluent Pumping*	85/127.5	CuYd	$650	$55,250		$650	$82,875		($27,625)
16	Concrete Work Basins*	2700/4050	CuYd	$650	$1,755,000		$650	$2,632,500		($877,500)
17	Concrete Work Disinfection/Post Aeration*	310/465	CuYd	$650	$201,500		$650	$302,250		($100,750)
18	Effluent Equalization	1	LS	$500,000	$500,000		$0	$0		$500,000
19	~~Storm Water and~~ Bio Solids Holding Ponds	1	LS	$500,000	$500,000		$0	$0		$500,000
20	Plant Piping	1	LS	$350,000	$350,000		$696,500	$696,500		($346,500)
21	Mechanical Room Equipment	1	LS	$700,000	$700,000		$609,500	$609,500		$90,500
22	Lift Station Pump and Piping Assembly	1	LS	$350,000	$350,000		$350,000	$350,000		$0
23	16" Force Main	36,000	FT	$70	$2,520,000		$70	$2,520,000		$0
24	16" Sanitary Bedding Material	36,000	FT	$6.00	$216,000		$6.00	$216,000		$0
25	0.5 Mile Force Main Extension	1	LS				$269,580	$269,580		$269,580
	First number references quantity used in the 2016 Wastewater Facilities Plan Amendment assuming 1 foot thick walls. It is more likely due to tank depth that 18-inch thick walls will be required. Second number references the increased concrete quantity used in the VE Study to account for this.			Contingencies (20%)	$13,559,500			$14,782,000		($684,000)
				Subtotal	$2,711,900			$2,956,400		$244,500
				Total Estimated Construction Costs	**$16,271,400**			**$17,738,400**		**$1,467,000**
				ENGINEERING	$2,441,000			$2,838,100		$397,100
				LAND PURCHASE	$1,250,000			$1,250,000		$0
				PRESENT WORTH OF LOST MULTIPLIER CREDIT				$2,082,000		$2,082,000
				LEGAL, ADMINISTRATION & TESTING (4%)	$740,000			$709,500		($89,500)
				TOTAL ESTIMATED PROJECT COST	**$20,761,400**			**$24,618,000**		**$3,856,600**

3.3.3 Value Engineering (VE) Equivalent Uniform Annual Cost (EUAC) Estimate Review and Modifications

The EUAC developed for Alternative 2.2 in the 2016 Wastewater Facilities Plan Amendment was also reviewed. Table 3.9 provides a comparison of the salvage values developed as part of the EUAC cost analysis for Alternative 2.2: Oxidation Ditch between the 2016 Wastewater Facilities Plan Amendment and the VE Study. Similar modifications were made to the salvage values as discussed in the EUAC cost analysis for the SBR alternative.

Table 3.9: Salvage Value Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.2: Oxidation Ditch

DESCRIPTION	FACILITY PLAN PRICE	FACILITY PLAN SALVAGE VALUE	FACILITY PLAN PRESENT WORTH OF SALVAGE VALUE	FACILITY PLAN PRESENT NET WORTH	VE PRICE	VE SALVAGE VALUE	VE PRESENT WORTH OF SALVAGE VALUE	VE PRESENT NET WORTH	DIFFERENCE	VE SALVAGE RATE
Site Grading/Paving	$200,000	$0	$0	$200,000	$348,500	$0	$0	$348,500	$148,500	0%
Influent Pumps	$150,000	$90,000	$49,831	$100,169	$0	$0	$0	$0	($100,169)	
Effluent Pumps	$150,000	$90,000	$49,831	$100,169	$0	$0	$0	$0	($100,169)	
Bar Screen Pretreatment Building	$500,000	$300,000	$166,103	$333,897	$768,800	$461,280	$255,400	$513,400	$179,503	60%
Bar Screen and Compactor (added Grit Removal)	$200,000	$120,000	$66,441	$133,559	$362,700	$0	$0	$362,700	$229,141	0%
Office, Lab and Final Effluent Pump Building	$600,000	$360,000	$199,323	$400,677	$615,200	$369,120	$204,373	$410,827	$10,150	60%
Mechanical/Biosolids Dewatering Building	$950,000	$570,000	$315,595	$634,405	$840,000	$504,000	$279,053	$560,947	($73,458)	60%
Process Equipment	$2,000,000	$1,200,000	$664,411	$1,335,589	$2,566,200	$0	$0	$2,566,200	$1,230,611	0%
Odor Control	$250,000	$150,000	$83,051	$166,949	$250,000	$0	$0	$250,000	$83,051	0%
Power to Site	$100,000	$0	$0	$100,000	$100,000	$33,333	$18,456	$81,544	($18,456)	33%
Standby Power/Generator	$250,000	$150,000	$83,051	$166,949	$250,000	$0	$0	$250,000	$83,051	0%
Instrumentation and Controls/SCADA	$750,000	$450,000	$249,154	$500,846	$392,000	$0	$0	$392,000	($108,846)	0%
Electrical Inside Plant	$250,000	$150,000	$83,051	$166,949	$609,500	$0	$0	$609,500	$442,551	0%
Concrete Work Influent Pumping	$61,750	$37,050	$20,514	$41,236	$0	$0	$0	$0	($41,236)	60%
Concrete Work Effluent Pumping	$55,250	$33,150	$18,354	$36,896	$82,875	$49,725	$27,532	$55,343	$18,447	60%
Concrete Work Basins	$1,755,000	$1,053,000	$583,021	$1,171,979	$2,632,500	$1,579,500	$874,531	$1,757,969	$585,990	60%
Concrete Work Disinfection/Post Aeration	$201,500	$120,900	$66,939	$134,561	$302,250	$181,350	$100,409	$201,841	$67,280	60%
Effluent Equalization	$500,000	$300,000	$166,103	$333,897	$0	$0	$0	$0	($333,897)	60%
Storm Water and Bio Solids Holding Ponds	$500,000	$300,000	$166,103	$333,897	$0	$0	$0	$0	($333,897)	
Plant Piping	$350,000	$210,000	$116,272	$233,728	$696,500	$0	$0	$696,500	$462,772	0%
Mechanical Room Equipment	$700,000	$420,000	$232,544	$467,456	$609,500	$0	$0	$609,500	$142,044	0%
Lift Station Pump and Piping Assembly	$350,000	$210,000	$116,272	$233,728	$350,000	$0	$0	$350,000	$116,272	0%
16" Force Main	$2,520,000	$1,512,000	$837,158	$1,682,842	$2,520,000	$1,512,000	$837,158	$1,682,842	$0	60%
16" Sanitary Bedding Material	$216,000	$0	$0	$216,000	$216,000	$0	$0	$216,000	$0	0%
0.5 Mile Force Main Extension					$269,580	$161,748	$89,556	$180,024	$180,024	60%
Contingencies	$2,711,900	$0	$0	$2,711,900	$2,956,400	$1,073,515	$594,379	$2,362,021	($349,879)	36%
Present Worth of Lost Multiplier Credit					$2,082,000	$0	$0	$2,082,000	$2,082,000	0%
Engineering	$2,441,000	$0	$0	$2,441,000	$2,838,100	$0	$0	$2,838,100	$397,100	0%
Legal, Administration & Testing	$799,000	$0	$0	$1,250,000	$709,500	$0	$0	$709,500	($540,500)	0%
Land	$1,250,000	$1,250,000	$1,250,000	$0	$1,250,000	$2,257,639	$1,250,000	$0	$0	100%
Total	**$20,761,400**	**$9,076,100**	**$5,583,122**	**$15,629,278**	**$24,618,000**	**$8,183,210**	**$4,530,845**	**$20,087,260**	**$4,457,982**	

O&M costs were also part of the EUAC analysis to evaluate the impact of the cost over a 20 year period and are presented in Table 3.10. The O&M costs for Alternative 2.2: Oxidation Ditch were reviewed as part of the VE Study and appear insufficient for a facility of this size and complexity as documented below.

- Equipment: The annual amount allotted for equipment replacement in the 2016 Wastewater Facilities Plan Amendment is insufficient to maintain a plant of this magnitude.
- Solids Handling: The annual amount allotted for solids handling in the 2016 Wastewater Facilities Plan Amendment is high compared to that of area plants with similar mechanical solids handling equipment.
- Testing: The annual amount allotted for testing in the 2016 Wastewater Facilities Plan Amendment appears adequate.
- Utilities: The annual amount allotted for utilities in the 2016 Wastewater Facilities Plan Amendment is insufficient. An evaluation of the power consumption required for major equipment indicates utility costs will be much higher than the cost shown in the Amendment.
- Labor: The annual amount allotted for labor cost in the 2016 Wastewater Facilities Plan Amendment in not adequate. A survey of similar plants across the State indicates that four additional staff will be required for the successful operation of a facility of this size.

Table 3.10: Annual O&M Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.2: Oxidation Ditch

Description	Facility Plan EUAC	Facility Plan Net Present Worth		VE EUAC	VE Net Present Worth		Difference
Equipment	$73,000	$1,460,000		$524,713	$7,806,300		$6,346,500
Solids Handling	$75,000	$1,500,000		$31,098	$462,700		($1,037,300)
Testing	$15,000	$300,000		$14,400	$214,300		($85,700)
Utilities	$80,000	$1,600,000		$135,263	$2,012,400		$412,400
Labor	$164,000	$3,280,000		$656,448	$9,766,300		$6,486,300
Total	**$407,000**	**$8,140,000**		**$1,361,922**	**$20,262,200**		**$12,122,200**

In Table 3.10, annual O&M costs were converted to a net present worth cost using a 20 year period and 3% interest rate. It appears this calculation was incorrectly performed in the 2016 Wastewater Facilities Plan Amendment as the annual O&M costs were multiplied by 20 instead of performing a present worth calculation over the 20 year planning period.

Finally, the present worth of the capital construction costs was added to the net present worth of the O&M costs and used to develop the overall EUAC value as presented in Table 3.11.

Table 3.11: EUAC Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.2: Oxidation Ditch

	Facility Plan Analysis		VE Study Analysis
Construction Cost Net Present Worth (Less Salvage)	**$15,629,278**		**$20,087,260**
O&M Present Worth Cost	**$8,140,000**		**$20,262,200**
Total Net Present Worth	**$23,769,278**		**$40,349,460**
EUAC	**$1,597,669**		**$2,712,118**

3.4 FACILITY PLAN TREATMENT ALTERNATIVE 2.3: SEQUOX® BY AEROMOD, INC.

The Sequox® process by Aeromod, Inc. is a packaged wastewater process that includes an influent selector, two stage aeration and mixing tank with final clarification. A surge tank is also provided for equalization during high flow periods. Separate tankage is used for each step allowing for a continuous flow-through process. Aerobic digestion is also provided for solids processing. Savings is achieved though common wall construction as shown in Figure 3.3.

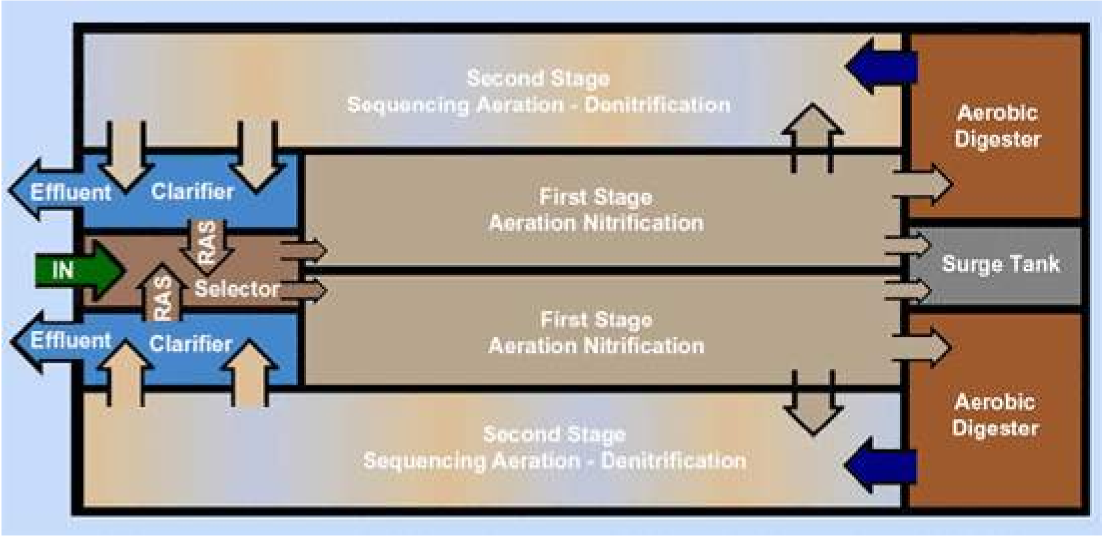


Figure 3.3: Typical SEQUOX® Biological Nutrient Removal Process Layout

3.4.1 Process Feasibility

The 2016 Wastewater Facilities Plan Amendment indicates Aeromod has constructed over 400 wastewater installations across the United States in the last 25 years. Aeromod, Inc. has 39 Sequox process installations in Iowa and Nebraska, but none in South Dakota yet.

The Sequox® process offers the following advantages:

- Compact footprint with common wall construction resulting in less tankage, reduced site work, and reduced yard piping requirements
- Selector tank for improved biological treatment
- First and second stage aeration basins can be adjusted to provide aerobic, anaerobic, and anoxic conditions to provide biological nutrient removal (nitrogen and some phosphorus removal). Chemical phosphorus removal is not anticipated.
- Easily expandable
- Reduced power consumption due to smaller footprint and compact design
- Less susceptible to shock loads than an SBR

The Sequox® process also has the following disadvantages:

- Because it is a proprietary process with no existing South Dakota installations, the SD DENR will likely need to complete a more in depth review prior to approval and may even require pilot testing
- Require a sophisticated level of timing units and controls
- No redundancy in selector tank making it very difficult to take out of service for maintenance
- Require knowledgeable operators with a higher degree of training
- Less competition when future expansion is required due to proprietary nature of process

In addition to the Sequox® system, the 2016 Wastewater Facilities Plan Amendment also included the following equipment for Alternative 2.3:

- Influent pumps
- Influent bar screen for solids removal in an enclosed pretreatment building with odor control
- Equalization ahead of UV disinfection
- UV disinfection (located outside)
- Effluent pumps
- Effluent aeration (located outside)
- Aerobic digestion for solids handling
- Belt press for solids dewatering
- Building for solids handling equipment and blowers
- Office and small lab
- Standby generator

The 2016 Wastewater Facilities Plan Amendment indicates that a cover for the clarifiers will be evaluated during the design.

3.4.2 Value Engineering (VE) Capital Construction Cost Estimate Review and Modifications

The capital construction cost estimate for Alternative 2.3: Sequox by Aeromod, Inc. in the 2016 Wastewater Facilities Plan Amendment was reviewed to determine if key components of the treatment system were missing, if costs accurately reflected pricing obtained from manufacturers, and if pricing reflected tabulations of recently bid projects. Table 3.12 provides a comparison of the opinion of probable capital construction costs for Alternative 2.3: Sequox by Aeromod, Inc. between the 2016 Wastewater Facilities Plan Amendment and the VE Study.

The VE Study identified the following modifications that impacted the capital construction costs for Alternative 2.3: Sequox by Aeromod:

- Addition of grit removal equipment (as presented in Section 3.2.2.1)
- Removal of pumping equipment and facilities (as presented in Section 3.2.2.2)
- Odor control (as presented in Section 3.2.2.4)
- Additional concrete quantities (as presented in Section 3.2.2.5)
- Removal of bio-solids holding ponds (as presented in Section 3.2.2.6)
- Mechanical/Biosolids Dewatering Building is anticipated to cost less based on the square footage required for the area needed and recent bid tabulations
- Instrumentation/SCADA costs appeared high, even for a fully automated plant compared to recent bid tabulations
- Electrical costs seemed very low based upon recent bid tabulations for new treatment facilities
- Effluent equalization is not needed since the Sequox process provides includes a small surge tank
- Plant piping costs seemed very low based upon recent bid tabulations for new treatment facilities
- Mechanical Room Equipment costs seemed high based upon recent bid tabulations for new treatment facilities
- The 0.5 mile force main extension for the connection to Sioux Falls has been included in the cost as will be required in 2018, before a new treatment plant could be constructed

- Inclusion of the Present Worth of Lost Multiplier Credit to account for the additional fees paid to the City of Sioux Falls for wastewater treatment during the approximately four years while a new plant is being constructed

Table 3.12: Construction Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.3: Sequox by Aeromod, Inc.

ITEM NO.	DESCRIPTION OF WORK AND MATERIALS	QTY	UNIT	FACILITY PLAN UNIT PRICE	FACILITY PLAN TOTAL		VE UNIT PRICE	VE TOTAL		Difference
1	Site Grading/Paving	1	LS	$200,000	$200,000		$310,000	$310,000		$110,000
2	Influent Pumps	1	LS	$150,000	$150,000		$0	$0		($150,000)
3	Effluent Pumps	1	LS	$150,000	$150,000		$0	$0		($150,000)
4	~~Bar Screen~~ Pretreatment Building	1	LS	$500,000	$500,000		$768,800	$768,800		$268,800
5	Bar Screen and Compactor (added Grit Removal)	1	LS	$200,000	$200,000		$362,700	$362,700		$162,700
6	Office, Lab and Final Effluent Pump Building	1	LS	$600,000	$600,000		$615,200	$615,200		$15,200
7	Mechanical/Biosolids Dewatering Building	1	LS	$950,000	$950,000		$840,000	$840,000		($110,000)
8	Process Equipment	1	LS	$2,000,000	$2,000,000		$2,244,90	$2,244,900		$244,900
9	Odor Control	1	LS	$250,000	$250,000		$250,000	$250,000		$0
10	Power to Site	1	LS	$100,000	$100,000		$100,000	$100,000		$0
11	Standby Power/Generator	1	LS	$250,000	$250,000		$250,000	$250,000		$0
12	Instrumentation and Controls/SCADA	1	LS	$750,000	$750,000		$310,000	$310,000		($440,000)
13	Electrical Inside Plant	1	LS	$250,000	$250,000		$545,000	$545,000		$295,000
14	Concrete Work Influent Pumping	95	CuYd	$650	$61,750		$0	$0		($61,750)
15	Concrete Work Effluent Pumping*	85/127.5	CuYd	$650	$55,250		$650	$82,875		$27,625
16	Concrete Work Basins*	1750/2625	CuYd	$650	$1,137,500		$650	$1,706,250		$568,750
17	Concrete Work Disinfection/Post Aeration*	310/465	CuYd	$650	$201,500		$650	$302,250		$100,750
18	Effluent Equalization	1	LS	$500,000	$500,000		$0	$0		($500,000)
19	~~Storm Water and~~ Bio Solids Holding Ponds	1	LS	$500,000	$500,000		$0	$0		($500,000)
20	Plant Piping	1	LS	$250,000	$250,000		$621,000	$621,000		$371,000
21	Mechanical Room Equipment	1	LS	$750,000	$750,000		$545,000	$545,000		($205,000)
22	Lift Station Pump and Piping Assembly	1	LS	$350,000	$350,000		$350,000	$350,000		$0
23	16" Force Main	36,000	FT	$70	$2,520,000		$70	$2,520,000		$0
24	16" Sanitary Bedding Material	36,000	FT	$6.00	$216,000		$6.00	$216,000		$0
25	0.5 Mile Force Main Extension	1	LS				$269,580	$269,580		$269,580
				Contingencies (20%)	$12,892,000			$13,209,555		$317,555
				Subtotal	$2,578,400			$2,642,000		$63,600
				Total Estimated Construction Costs	**$15,470,400**			**$15,851,555**		**$381,155**
				ENGINEERING	$2,321,000			$2,377,800		$56,800
				LAND PURCHASE	$1,250,000			$1,250,000		$0
				PRESENT WORTH OF LOST MULTIPLIER CREDIT				$2,082,000		$2,082,000
				LEGAL, ADMINISTRATION & TESTING (4%)	$762,000			$634,100		($127,900)
				TOTAL ESTIMATED PROJECT COST	**$19,803,400**			**$22,195,455**		**$2,392,055**

**First number references quantity used in the 2016 Wastewater Facilities Plan Amendment assuming 1 foot thick walls. It is more likely due to tank depth that 18-inch thick walls will be required. Second number references the increased concrete quantity used in the VE Study to account for this.*

3.4.3 Value Engineering (VE) Equivalent Uniform Annual Cost (EUAC) Estimate Review and Modifications

The EUAC developed in the 2016 Wastewater Facilities Plan Amendment for Alternative 2.3 was also reviewed. Table 3.13 provides a comparison of the salvage values developed as part of the EUAC cost analysis for Alternative 2.3: Sequox by Aeromod, Inc. between the 2016 Wastewater Facilities Plan Amendment and the VE Study. Similar modifications were made to the salvage values as discussed in the EUAC cost analysis for the SBR alternative.

Table 3.13: Salvage Value Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.3: Sequox by Aeromod, Inc.

DESCRIPTION	FACILITY PLAN PRICE	FACILITY PLAN SALVAGE VALUE	FACILITY PLAN PRESENT WORTH OF SALVAGE VALUE	FACILITY PLAN PRESENT NET WORTH	VE PRICE	VE SALVAGE VALUE	VE PRESENT WORTH OF SALVAGE VALUE	VE PRESENT NET WORTH	DIFFERENCE	VE SALVAGE RATE
Site Grading/Paving	$200,000	$0	$0	$200,000	$310,000	$0	$0	$310,000	$110,000	0%
Influent Pumps	$150,000	$90,000	$49,831	$100,169	$0	$0	$0	$0	($100,169)	
Effluent Pumps	$150,000	$90,000	$49,831	$100,169	$0	$0	$0	$0	($100,169)	
Bar Screen Pretreatment Building	$500,000	$300,000	$166,103	$333,897	$768,800	$461,280	$255,400	$513,400	$179,503	60%
Bar Screen and Compactor (added Grit Removal)	$200,000	$120,000	$66,441	$133,559	$362,700	$0	$0	$362,700	$229,141	0%
Office, Lab and Final Effluent Pump Building	$600,000	$360,000	$199,323	$400,677	$615,200	$369,120	$204,373	$410,827	$10,150	60%
Mechanical/Biosolids Dewatering Building	$950,000	$570,000	$315,595	$634,405	$840,000	$504,000	$279,053	$560,947	($73,458)	60%
Process Equipment	$2,000,000	$1,200,000	$664,411	$1,335,589	$2,244,900	$0	$0	$2,244,900	$909,311	0%
Odor Control	$250,000	$150,000	$83,051	$166,949	$250,000	$0	$0	$250,000	$83,051	0%
Power to Site	$100,000	$0	$0	$100,000	$100,000	$33,333	$18,456	$81,544	($18,456)	33%
Standby Power/Generator	$250,000	$150,000	$83,051	$166,949	$250,000	$0	$0	$250,000	$83,051	0%
Instrumentation and Controls/SCADA	$750,000	$450,000	$249,154	$500,846	$310,000	$0	$0	$310,000	($190,846)	0%
Electrical Inside Plant	$250,000	$150,000	$83,051	$166,949	$545,000	$0	$0	$545,000	$378,051	0%
Concrete Work Influent Pumping	$61,750	$37,050	$20,514	$41,236	$0	$0	$0	$0	($41,236)	60%
Concrete Work Effluent Pumping	$55,250	$33,150	$18,354	$36,896	$82,875	$49,725	$27,532	$55,343	$18,447	60%
Concrete Work Basins	$1,137,500	$682,500	$377,884	$759,616	$1,706,250	$1,023,750	$566,826	$1,139,424	$379,808	60%
Concrete Work Disinfection/Post Aeration	$201,500	$120,900	$66,939	$134,561	$302,250	$181,350	$100,409	$201,841	$67,280	60%
Effluent Equalization	$500,000	$300,000	$166,103	$333,897	$0	$0	$0	$0	($333,897)	60%
Storm Water and Bio Solids Holding Ponds	$500,000	$300,000	$166,103	$333,897	$0	$0	$0	$0	($333,897)	
Plant Piping	$250,000	$150,000	$83,051	$166,949	$621,000	$0	$0	$621,000	$454,051	0%
Mechanical Room Equipment	$750,000	$450,000	$249,154	$500,846	$545,000	$0	$0	$545,000	$44,154	0%
Lift Station Pump and Piping Assembly	$350,000	$210,000	$116,272	$233,728	$350,000	$0	$0	$350,000	$116,272	0%
16" Force Main	$2,520,000	$1,512,000	$837,158	$1,682,842	$2,520,000	$1,512,000	$837,158	$1,682,842	$0	60%
16" Sanitary Bedding Material	$216,000	$0	$0	$216,000	$216,000	$0	$0	$216,000	$0	0%
0.5 Mile Force Main Extension					$269,580	$161,748	$89,556	$180,024	$180,024	60%
Contingencies	$2,578,400	$0	$0	$2,578,400	$2,642,000	$981,764	$543,579	$2,098,421	($479,979)	37%
Present Worth of Lost Multiplier Credit					$2,082,000	$0	$0	$2,082,000	$2,082,000	0%
Engineering	$2,321,000	$0	$0	$2,321,000	$2,377,800	$0	$0	$2,377,800	$56,800	0%
Legal, Administration & Testing	$762,000	$0	$0	$762,000	$634,100	$0	$0	$634,100	($127,900)	0%
Land	$1,250,000	$1,250,000	$1,250,000	$0	$1,250,000	$2,257,639	$1,250,000	$0	$0	100%
Total	**$19,803,400**	**$8,675,600**	**$5,361,374**	**$14,442,026**	**$22,195,455**	**$7,535,710**	**$4,172,340**	**$18,023,115**	**$3,581,089**	

O&M costs were also part of the EUAC analysis to evaluate the impact of the cost over a 20 year period and are presented in Table 3.14. The O&M costs for Alternative 2.3: Sequox by Aeromod, Inc. were reviewed as part of the VE Study and appear insufficient for a facility of this size and complexity as documented below.

- Equipment: The annual amount allotted for equipment replacement in the 2016 Wastewater Facilities Plan Amendment is insufficient to maintain a plant of this magnitude.
- Solids Handling: The annual amount allotted for solids handling in the 2016 Wastewater Facilities Plan Amendment is high compared to that of area plants with similar mechanical solids handling equipment.
- Testing: The annual amount allotted for testing in the 2016 Wastewater Facilities Plan Amendment appears adequate.
- Utilities: The annual amount allotted for utilities in the 2016 Wastewater Facilities Plan Amendment is insufficient. An evaluation of the power consumption required for major equipment indicates utility costs will be much higher than the cost shown in the Amendment.
- Labor: The annual amount allotted for labor cost in the 2016 Wastewater Facilities Plan Amendment in not adequate. A survey of similar plants across the State indicates that four additional staff will be required for the successful operation of a facility of this size.

Table 3.14: Annual O&M Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.3: Sequox by Aeromod, Inc.

Description	Facility Plan EUAC	Facility Plan Net Present Worth		VE EUAC	VE Net Present Worth		Difference
Equipment	$33,000	$660,000		$468,101	$6,964,200		$6,304,200
Solids Handling	$75,000	$1,500,000		$31,098	$462,700		($1,037,300)
Testing	$15,000	$300,000		$14,400	$214,300		($85,700)
Utilities	$60,000	$1,200,000		$161,141	$2,397,400		$1,197,400
Labor	$164,000	$3,280,000		$656,448	$9,766,300		$6,486,300
Total	**$347,000**	**$6,940,000**		**$1,331,188**	**$19,804,900**		**$12,864,900**

In Table 3.14, annual O&M costs were converted to a net present worth cost using a 20 year period and 3% interest rate. It appears this calculation was incorrectly performed in the 2016 Wastewater Facilities Plan Amendment as the annual O&M costs were multiplied by 20 instead of performing a present worth calculation over the 20 year planning period.

Finally, the present worth of the capital construction costs was added to the net present worth of the O&M costs and used to develop the overall EUAC value as presented in Table 3.15.

Table 3.15: EUAC Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 2.3: Sequox by Aeromod, Inc.

	Facility Plan Analysis		VE Study Analysis
Construction Cost Net Present Worth (Less Salvage)	**$14,442,026**		**$18,023,115**
O&M Present Worth Cost	**$6,940,000**		**$19,804,900**
Total Net Present Worth	**$21,382,025**		**$37,828,015**
EUAC	**$1,437,208**		**$2,542,637**

3.5 FACILITY PLAN TREATMENT ALTERNATIVES 3.1 & 3.2: PUMPING TO SIOUX FALLS

Harrisburg began pumping wastewater to the City of Sioux Falls in 2010 through a lift station and 7.5 miles of 16" diameter force main from the City's lagoons to a receiving manhole in southeast Sioux Falls. Eventually, the City of Sioux Falls will require the City of Harrisburg to extend the force main to Pump Station #240. Recently, the City of Sioux Falls has indicated this extension can be completed in two phases. The first phase would be required in 2018 and is a 0.5 mile extension to the east into the trunk line near Highway 11. A second extension, approximately 3.0 miles in length, would be required 3 to 10 years later, from Highway 11 to Pump Station #240. The capital improvement costs for these extensions are included in Alternatives 3.1 and 3.2.

Regional Wastewater System Rates are presented in Table 3.16. The City of Sioux Falls approved 6% annual rate increases for 2017, 2018, and 2019 at their May 2, 2016 City Council meeting. The presentation at that meeting also indicated that rates increases are projected at 5% for 2020, 4% for

2021, and 3% for year 2022 and forward. However, the 2016 Wastewater Facilities Plan Amendment completed by Stockwell projected rate increases at 6% each year for 2017-2019, and 3% each year for 2020-2036. For purposes of this analysis, the rate increased projected in the rate presentation at the May 2, 2016 Sioux Falls City Council meeting for years 2017-2021 will be used in the cost projections. For years 2022-2036, a 3% annual rate increase will be assumed.

Equalization and treatment credit is offered to regional wastewater customers. Equalization credit is provided for maintaining a 30-day continuous storage volume based on the regional wastewater customer's average annual daily flow. Treatment credit is offered for regional customers whose treated, pumped wastewater has biological oxygen demand (BOD), total suspended solids (TSS), and total kjeldahl nitrogen (TKN) concentrations equal to or less than 20 mg/l, 45 mg/l, and 10 mg/l. The equalization and treatment credit is also shown in Table 3.16.

Table 3.16: Projected Sioux Falls Wastewater Fees

Year	Monthly Customer Charge ($/month)	Volume Rate ($/1,000 gallons)	Equalization Credit ($/1,000 gallons)	Treatment Credit ($/1,000 gallons)
2016	$16.23	$4.51	$0.50	$0.61
2017	$16.55	$4.78	$0.53	$0.65
2018	$16.89	$5.06	$0.56	$0.69
2019	$17.22	$5.37	$0.59	$0.73
2020	$18.08	$5.64	$0.62	$0.77
2021	$18.80	$5.86	$0.64	$0.80
2022	$19.37	$6.04	$0.66	$0.82
2023	$19.95	$6.22	$0.68	$0.85
2024	$20.55	$6.41	$0.70	$0.87
2025	$21.16	$6.60	$0.73	$0.90
2026	$21.80	$6.80	$0.75	$0.92
2027	$22.45	$7.00	$0.77	$0.95
2028	$23.13	$7.21	$0.79	$0.98
2029	$23.82	$7.43	$0.82	$1.01
2030	$24.54	$7.65	$0.84	$1.04
2031	$25.27	$7.88	$0.87	$1.07
2032	$26.03	$8.12	$0.89	$1.10
2033	$26.81	$8.36	$0.92	$1.14
2034	$27.61	$8.61	$0.95	$1.17
2035	$28.44	$8.87	$0.97	$1.21
2036	$29.30	$9.14	$1.00	$1.24

Harrisburg is currently required to pay a 2.0 multiplier on their Regional Wastewater rate for the wastewater pumped to the City of Sioux Falls for treatment. In other words, the 2017 volume rate is $9.02/1,000 gallons. Harrisburg has been receiving credit for both equalization and treatment, reducing their 2017 rate to $7.91/1,000 gallons.

Regional wastewater customers are required to pay System Development Charge (SDC) to connect to the regional system. Regional SDCs are intended to fund regional wastewater system capacity, including improvements to the City of Sioux Falls' Water Reclamation Plant and the large interceptors that convey wastewater to the plant. The current regional SDCs are shown in Table 3.17 and are based on water

BANNER
engineering a better community

meter size. SDCs have not increased for some time, but are projected to increase at 3% once the initial SDCs are paid (2018 and future years).

Table 3.17: Sioux Falls Regional Wastewater System Development Charges (SDCs)

WATER METER SIZE (INCH)	REGIONAL WASTEWATER SYSTEM DEVELOPMENT CHARGE (PER METER)
5/8” to 3/4”	$2,391
1”	$,5,978
1 ½”	$11,954
2”	$19,127
3”	$35,863
4”	$60,000

A participating regional community pays SDCs based on the number and size of water meters in that community at the time of connection to the Sioux Falls Regional Wastewater System. Harrisburg has not officially connected to the regional system and therefore has not paid the SDCs for existing customers. The 2.0 multiplier is applied to the volume rate until communities are connected and SDCs for existing customers paid.

At the time the 2016 Wastewater Facilities Plan Amendment was completed, Harrisburg had 1,780 metered customers. As of June 30, 2017, Harrisburg had 1,839 metered customers. The SDC connection fee as documented in the 2016 Wastewater Facilities Plan Amendment and per the VE Study, with the current number of metered customers, is provided in Table 3.18. The charge to connect to the Regional System as of June 30, 2017 was $5,076,297. Once the SDC connection charge is paid, the 2.0 multiplier on the rates will be removed. Sioux Falls will apply the excess fees Harrisburg has paid to date as a result of the 2.0 multiplier to the initial SDC connection charge. The City of Harrisburg indicated that as of June 30, 2017, this credit amount is $1,101,474, reducing the connection charge to $3,974,823.

Table 3.18: Harrisburg System Development Charges Connection Fee

WATER METER SIZE (INCH)	PER 2016 WASTEWATER FACILITIES PLAN AMENDMENT		PER VE STUDY		
	NUMBER OF METERS	REGIONAL WASTEWATER SYSTEM DEVELOPMENT CHARGE	NUMBER OF METERS	REGIONAL WASTEWATER SYSTEM DEVELOPMENT CHARGE	PROPORTION OF CONNECTIONS
5/8” to 3/4”	1,719	$4,110,129	1,778	$4,251,198	96.68%
1”	27	$161,406	28	$167,384	1.52%
1 ½”	9	$107,586	9	$107,586	0.49%
2”	21	$401,667	20	$382,540	1.09%
3”	3	$107,589	3	$107,589	0.16%
4”	1	$60,000	1	$60,000	0.05%
Total	**1,780**	**$4,948,377**	**1,839**	**$5,076,297**	**100%**
Average Cost per Meter		***$2,780***		***$2,760***	
Credit for Multiplier		*$680,000*		*$1,101,474*	

In subsequent years, annual payments would be made to the City of Sioux Falls based upon the number of new connections each year. It is difficult to accurately predict future annual SDCs, as the number and size of meters installed from year to year will vary. The 2016 Wastewater Facilities Plan Amendment used the 2016 average cost per meter of $2,780 multiplied by the number of meters added that year. For future projections, the cost per meter was increased 3% annually and multiplied by the number of new meters, assuming the total number of meters increased at 4% per year, same as the population.

Since 2016, several customers with 1 ½” meters have been added to the system increasing the average cost to $2,852 per meter. It is unknown if this trend will continue. The VE Study projects future SDC charges based on the $2,730 cost from the 2016 Wastewater Facilities Plan Amendment. Future annual SDC charges were estimated through the year 2036 and are shown in Table 3.19.

Table 3.19: VE Study Projected Annual SDC Charges

Year	Total Meters	Cost per Meter*	Annual SDC Charge
2016	1,780	$ 2,730	
2017	1,851	$ 2,812	$ 200,207
2018	1,925	$ 2,896	$ 214,462
2019	2,002	$ 2,983	$ 229,732
2020	2,082	$ 3,073	$ 246,089
2021	2,166	$ 3,165	$ 263,610
2022	2,252	$ 3,260	$ 282,379
2023	2,342	$ 3,358	$ 302,485
2024	2,436	$ 3,458	$ 324,021
2025	2,533	$ 3,562	$ 347,092
2026	2,635	$ 3,669	$ 371,805
2027	2,740	$ 3,779	$ 398,277
2028	2,850	$ 3,892	$ 426,635
2029	2,964	$ 4,009	$ 457,011
2030	3,082	$ 4,129	$ 489,550
2031	3,206	$ 4,253	$ 524,406
2032	3,334	$ 4,381	$ 561,744
2033	3,467	$ 4,512	$ 601,740
2034	3,606	$ 4,648	$ 644,584
2035	3,750	$ 4,787	$ 690,478
2036	3,900	$ 4,931	$ 739,640

Table 3.19 shows that the 2036 SDC will be approximately $739,640. In the 2016 Wastewater Facilities Plan Amendment, Table 33 on page 60 indicates the 2036 SDC charge would be $446,868. It appears an error was made in this calculation as the 2036 per meter cost is $4,931 assuming a 3% annual increase and dividing $446,868 in Table 33 by $4,931 results in only 90 new meters. Assuming a growth rate of 4%, the population increase from 2034 to 2035 is 480 people. Dividing 480 people by the current housing density of 3.2, indicates 150 new meters would be required. This error impacts the calculations for all 20 years and will increase the cost of connecting to the Sioux Falls Regional System above what was shown in the 2016 Wastewater Facilities Plan Amendment.

3.5.1 Alternative 3.1: Partial Pumping to Sioux Falls

The 2016 Wastewater Facilities Plan Amendment indicates that Harrisburg would only receive treatment credit approximately half of the time based on samples collected at the gravity lift station that pumps to Sioux Falls. The likelihood of meeting treatment limits would only decrease as influent flows and loads increase.

Alternative 3.1 makes use of Harrisburg's existing ponds to obtain as much treatment and equalization credit as possible. In this alternative, aeration is added to the two northern pond cells to provide increased BOD and organic treatment capacity allowing for partial treatment credit for 10 years and equalization treatment for the 20 year design period.

3.5.1.1 Process Feasibility

3.5.1.1.1 Ability to Meet Treatment Limits

When designing aerated ponds, both the required detention time and aeration needs must be considered. In order to achieve a 20 mg/l effluent BOD at 2026 average day design flows and influent BOD concentrations of 427 mg/l, a detention time of 88 days is required per the SD DENR Wastewater Design Manual. The first two pond cells have a detention time of only 63 days at 2026 flows. In fact, the first two ponds can only achieve an effluent BOD of 20 mg/l through 2017. Aerated ponds will not reduce BOD concentrations enough to receive treatment credit at influent BOD concentrations of 427 mg/l. However, if influent BOD concentrations are lower, aeration may be feasible to meet the limits required for treatment credit for the first 5 to 10 years of operation. Additional testing should be completed to determine influent BOD concentrations, and the concentrations of similar eastern South Dakota communities is much lower.

3.5.1.1.2 Equalization Feasibility

The primary objective of keeping the ponds in service is to meet the equalization credit requirement by providing 30 days of emergency storage.

The projected 2036 average day flow is estimated to be 811,526 gpd, requiring 24.35 million gallons of storage. The capacity of the existing ponds is estimated to be 59.1 million gallons, with the third cell having 36.8 million gallons of storage between the 2 foot and 8 foot levels. The City will have to reduce the level of the third cell over time to provide 30 days of available emergency storage. As shown in Table 3.20, the VE Study assumes the third cell will have to be operated at a depth of 6 feet from the pond bottom for years 2016-2018, 5 feet from the pond bottom for years 2019-2029, and 4 feet from the pond bottom for years 2030 to 2036 to provide 30 days of available emergency storage.

Table 3.20: Projected Annual SDC Charges

Liquid Depth in Third Cell-from pond bottom (feet)	Volume Available for Emergency Storage (million gallons)	Years Required at Operating Liquid Depth
8	0.0	
7	6.3	
6	12.6	2016-2018
5	18.8	2019-2029
4	24.8	2030-2036
3	30.8	
2	36.8	

The lift station that pumps wastewater to Sioux Falls for treatment has three 1,250 gpm pumps on variable frequency drives, giving it a firm pumping capacity of approximately 3,600,000 gpd with one pump out of service as required for redundancy. The pumps have capacity to lower pond levels after such an event.

Aeration will be required to reduce BOD and prevent significant odor issues. The ponds can provide enough detention time to reduce influent BOD concentrations of 427 mg/l at 812,000 gpd to 39 mg/l. An oxygen delivery rate of 294 lbs./hr will be required for these conditions.

3.5.1.1.3 Advantages & Disadvantages for Alternative 3.1: Partial Pumping to Sioux Falls

Alternative 3.1: Partial Pumping to Sioux Falls offers the following advantages:

- Makes use of Harrisburg's existing ponds to obtain as much treatment and equalization credit as possible

Alternative 3.1: Partial Pumping to Sioux Falls has the following disadvantages:

- Aerated ponds do not provide enough detention time to meet treatment limits per SD DENR requirements
- Highly unlikely that treatment credit could be obtained for the first 10 years as the 2016 Wastewater Facilities Plan Amendment indicates
- Cost of installing aeration equipment high for the benefit since treatment limits cannot be met

3.5.1.2 Value Engineering (VE) Capital Construction Cost Estimate Review and Modifications

The capital construction cost estimate for Alternative 3.1 Partial Pumping to the City of Sioux Falls in the 2016 Wastewater Facilities Plan Amendment was reviewed to determine if key components of the treatment system were missing, if costs accurately reflected pricing obtained from manufacturers and observed in tabulations of recently bid projects. Table 3.21 provides a comparison of the opinion of probable construction costs for Alternative 3.1: Partial Pumping to Sioux Falls between the 2016 Wastewater Facilities Plan Amendment and the VE Study.

Table 3.21: Construction Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 3.1: Partial Pumping to Sioux Falls

ITEM NO.	DESCRIPTION OF WORK AND MATERIALS	QTY	UNIT	FACILITY PLAN UNIT PRICE	FACILITY PLAN TOTAL	VE UNIT PRICE	VE TOTAL	Difference
1	Mobilization	1	LS	$455,000.00	$455,000	$355,000	$355,000	($100,000)
2	Clearing	1	LS	$10,500.00	$10,500	$10,500	$10,500	$0
3	Traffic Control	1	LS	$10,500.00	$10,500	$10,500	$10,500	$0
4	Gravel Surfacing	1,800	TON	$12.75	$22,950	$15.00	$27,000	$4,050
5	Unclassified Excavation	122,000	CY	$3.20	$390,400	$4.50	$549,000	$158,600
6	Salvage & Place Topsoil	6,000	CY	$5.25	$31,500	$5.25	$31,500	$0
7	Class B Rip Rap	10,000	TON	$37.00	$370,000	$37.00	$370,000	$0
8	Type B Drainage Fabric	13,800	SY	$2.65	$36,570	$3.00	$41,400	$4,830
9	16" Force Main	21,000	FT	$70.00	$1,470,000	$70.00	$1,470,000	$0
10	16" Sanitary Bedding Material	21,000	FT	$6.00	$126,000	$6.00	$126,000	$0
11	Bar Screen	1	LS	$200,000.00	$200,000	$169,000	$169,000	($31,000)
12	Bar Screen Building	1	LS	$300,000.00	$300,000	$320,000	$320,000	$20,000
13	Blower Building	1	LS	$300,000.00	$300,000	$300,000	$300,000	$0
14	Control & SCADA System	1	LS	$80,000.00	$80,000	$80,000	$80,000	$0
15	Electrical Service	1	LS	$27,500.00	$27,500	$27,500	$27,500	$0
16	Aeration System	1	LS	$530,000.00	$530,000	$530,000	$530,000	$0
17	Aeration Site Piping	1,500	LF	$32.00	$48,000	$32.00	$48,000	$0
18	Sludge Removal	15,000	CY	$32.00	$480,000	$32.00	$480,000	$0
19	Seeding, Fertilizing & Mulching	70,000	SY	$1.60	$112,000	$1.60	$112,000	$0
				Contingencies (20%)	$5,000,920		$5,057,400	$56,480
				Subtotal	$1,001,000		$1,011,480	$10,480
				Total Estimated Construction Costs	**$6,001,920**		**$6,068,880**	**$66,960**
				INITIAL SDC	$4,268,377		$3,974,823	($293,554)
				ENGINEERING	$901,000		$910,332	$9,332
				LEGAL, ADMINISTRATION & TESTING (4%)	$241,000		$242,755	$1,755
				TOTAL ESTIMATED PROJECT COST	**$11,413,000**		**$11,196,790**	**($216,210)**

The VE Study identified the following modifications that impacted the capital construction costs for Alternative 3.1.

- Mobilization costs were assumed at 7.5% of total construction costs which is representative of the amount see on recent bid tabulations
- Gravel Surfacing costs seemed low compared to what has been observed on recently completed bid tabulations. The cost was increased to $15.00/ton.
- Unclassified Excavation costs seemed low compared to what has been observed on recently completed bid tabulations. The cost was increased to $4.50/cubic yard.
- Type B Drainage Fabric costs seemed low compared to what has been observed on recently completed bid tabulations. The cost was increased to $3.00/square yard.
- The Bar Screen costs seem high for the cost of the equipment and was decreased.
- The Bar Screen Building cost seemed low for the size of building required and was increased.

3.5.1.3 Treatment Costs for Alternative 3.1: Partial Pumping to the City of Sioux Falls

The fees that would need to be paid to the City of Sioux Falls for treating the pumped wastewater make up a significant portion of the annual operational costs for Alternative 3.1: Partial Pumping to the City of Sioux Falls. Table 3.22 shows projected annual wastewater flows, annual requirements for 30-day storage, the volume pumped to Sioux Falls for treatment taking into account seepage and evaporation, the annual fees paid to Sioux Falls taking into account equalization credit, and the present worth value of the annual fees. The bolded numbers below the table show the present worth value totaled over the 20-year period and the resulting EUAC for Alternative 3.1.

Table 3.22: Projected EUAC and Present Worth Cost for Alternative 3.1: Partial Pumping to the City of Sioux Falls

Year	Average Wastewater Flow (gallons /day)	Partial Pumping Option			
		30 Day Storage Requirement (MGD)	Annual Wastewater Flow Less Seepage and Evaporation	Partial Pumping Annual Volume Charge with EQ Credit	Present Worth Value
2016	370,370	11.11	98,245,019	$394,157	$394,157
2017	385,185	11.56	103,652,421	$440,721	$427,885
2018	400,592	12.02	109,276,119	$491,945	$463,706
2019	416,616	12.50	115,124,765	$550,503	$503,788
2020	433,281	13.00	121,207,356	$608,557	$540,695
2021	450,612	13.52	127,533,252	$665,919	$574,427
2022	468,636	14.06	134,112,183	$721,267	$604,050
2023	487,382	14.62	140,954,272	$780,794	$634,857
2024	506,877	15.21	148,793,298	$848,930	$670,153
2025	527,152	15.81	156,193,701	$917,874	$703,474
2026	548,238	16.45	163,890,120	$991,982	$738,128
2027	570,168	17.11	171,894,396	$1,071,630	$774,168
2028	592,974	17.79	180,218,843	$1,157,219	$811,650
2029	616,693	18.50	188,876,268	$1,249,180	$850,631
2030	641,361	19.24	197,879,989	$1,347,976	$891,171
2031	667,015	20.01	207,243,860	$1,454,103	$933,333
2032	693,696	20.81	216,982,286	$1,568,089	$977,181
2033	721,444	21.64	227,110,248	$1,690,506	$1,022,784
2034	750,302	22.51	237,643,329	$1,821,961	$1,070,210
2035	780,314	23.41	248,597,733	$1,963,109	$1,119,533
2036	811,526	24.35	259,990,314	$2,114,649	$1,170,830

Present Worth Value	**$ 15,876,812**
Equivalent Uniform Annual Cost	**$ 1,067,171**

Evaporation and seepage within the ponds reduce the amount of wastewater that must be pumped to Sioux Falls in Alternative 3.1. A key difference in the projected pumping costs between the 2016 Wastewater Facilities Plan Amendment and the VE Study appears to be related to the assumed seepage rate in the ponds. Table 7 on page 21 of the 2016 Wastewater Facilities Plan Amendment uses 1/16 inch per day of seepage in the primary ponds and 1/8 inch per day of seepage in the secondary pond. The SD Wastewater Design Manual States, "The seepage rate for the primary cell(s) shall not exceed 1/16 inch per day. An allowable seepage rate of 1/8 inch per day for cells in series following the primary cell(s) may be considered on a case-by-case basis dependent upon underlying soil formations and proximity of water sources in the area." It is unusual to assume 1/8 inch per day of seepage unless there is data to support those findings and then it would only be allowed with authorization from the SD DENR. The VE Study assumes a seepage rate of 1/16 inch per day for all the ponds, increasing the volume of wastewater pumped to Sioux Falls for treatment.

3.5.1.4 Value Engineering (VE) Equivalent Uniform Annual Cost (EUAC) Estimate Review and Modifications

The EUAC developed in the 2016 Wastewater Facilities Plan Amendment for Alternative 3.1: Partial Pumping to Sioux Falls was also reviewed. Table 3.23 provides a comparison of the salvage values developed as part of the EUAC cost analysis for Alternative 3.1: Partial Pumping between the 2016 Wastewater Facilities Plan Amendment and the VE Study. Similar modifications were made to the salvage values as discussed in the EUAC cost analysis for the SBR alternative.

In addition, the 2016 Wastewater Facilities Plan Amendment omitted the cost of contingencies, engineering, and legal, administration and testing from the net present worth calculation. The credit on the amount paid on the 2.0 multiplier was also omitted. These items have been included in the VE Study calculation of the present net worth.

Table 3.23: Salvage Value Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 3.1: Partial Pumping to Sioux Falls

DESCRIPTION	FACILITY PLAN PRICE	FACILITY PLAN SALVAGE VALUE	FACILITY PLAN PRESENT WORTH OF SALVAGE VALUE	FACILITY PLAN PRESENT NET WORTH	VE PRICE	VE SALVAGE VALUE	VE PRESENT WORTH OF SALVAGE VALUE	VE PRESENT NET WORTH	DIFFERENCE	VE SALVAGE RATE
Mobilization	$455,000	$0	$0	$455,000	$355,000	$0	$0	$355,000	($100,000)	0%
Clearing	$10,500	$0	$0	$10,500	$10,500	$0	$0	$10,500	$0	0%
Traffic Control	$10,500	$0	$0	$10,500	$10,500	$0	$0	$10,500	$0	0%
Gravel Surfacing	$22,950	$0	$0	$22,950	$27,000	$0	$0	$27,000	$4,050	0%
Unclassified Excavation	$390,400	$0	$0	$390,400	$549,000	$0	$0	$549,000	$158,600	0%
Salvage & Place Topsoil	$31,500	$0	$0	$31,500	$31,500	$0	$0	$31,500	$0	0%
Class B Rip Rap	$370,000	$222,000	$122,916	$247,084	$370,000	$0	$0	$370,000	$122,916	0%
Type B Drainage Fabric	$36,570	$0	$0	$36,570	$41,400	$0	$0	$41,400	$4,830	0%
16" Force Main	$1,470,000	$882,000	$488,342	$981,658	$1,470,000	$882,000	$488,342	$981,658	($0)	60%
16" Sanitary Bedding Material	$126,000	$0	$0	$126,000	$126,000	$0	$0	$126,000	$0	0%
Bar Screen	$200,000	$120,000	$66,441	$133,559	$169,000	$0	$0	$169,000	$35,441	0%
Bar Screen Building	$300,000	$180,000	$99,662	$200,338	$320,000	$192,000	$106,306	$213,694	$13,356	60%
Blower Building	$300,000	$180,000	$99,662	$200,338	$300,000	$180,000	$99,662	$200,338	$0	60%
Control & SCADA System	$80,000	$48,000	$26,576	$53,424	$80,000	$0	$0	$80,000	$26,576	0%
Electrical Service	$27,500	$16,500	$9,136	$18,364	$27,500	$9,075	$5,025	$22,475	$4,111	33%
Aeration System	$530,000	$318,000	$176,069	$353,931	$530,000	$0	$0	$530,000	$176,069	0%
Aeration Site Piping	$48,000	$28,800	$15,946	$32,054	$48,000	$0	$0	$48,000	$15,946	0%
Sludge Removal	$480,000	$0	$0	$480,000	$480,000	$0	$0	$480,000	$0	0%
Seeding, Fertilizing & Mulching	$112,000	$0	$0	$112,000	$112,000	$0	$0	$112,000	$0	0%
Contingencies	$0			$0	$1,011,480	$125,433	$69,449	$942,031	$942,031	12%
Engineering	$0			$0	$910,332	$0	$0	$910,332	$910,332	0%
Legal, Administration & Testing	$0			$0	$242,755	$0	$0	$242,755	$242,755	0%
Remaining Capital Costs (Initial SDC)	$6,411,377	$0	$0	$6,411,377	$3,974,823	$0	$0	$3,974,823	($2,436,554)	0%
Total	**$11,412,297**	**$1,995,300**	**$1,104,749**	**$10,307,548**	**$11,196,790**	**$1,388,508**	**$768,783**	**$10,428,007**	**$120,460**	

O&M costs were also part of the EUAC analysis to evaluate the impact of the cost over a 20 year period and are presented in Table 3.24. The O&M costs for Alternative 3.1: Partial Pumping to Sioux Falls were reviewed as part of the VE Study and appear insufficient for a facility of this size and complexity as documented below.

- Equipment: The annual amount allotted for equipment replacement in the 2016 Wastewater Facilities Plan Amendment is insufficient.
- Testing: Minimal testing would be required as the treatment limits cannot be met.
- Utilities: The annual amount allotted for utilities in the 2016 Wastewater Facilities Plan Amendment is insufficient. An evaluation of the power consumption required for major equipment indicates utility costs will be much higher than the cost shown in the Amendment.
- Labor: The annual amount allotted for labor cost in the 2016 Wastewater Facilities Plan Amendment in not adequate. It will take additional staff time to maintain the blowers, aerators and aging pumps.
- Pumping Fees: The 2016 Wastewater Facilities Plan Amendment under projected pumping fees. Based on the discussion in Section 3.4.1.1, no treatment credit will be achieved through aeration, but equalization credit will be maintained for years 2016-2036. Sioux Falls rates have been adjusted to allow for a 5% increase in 2020, a 4% increase for 2021, and a 3% increase for year 2022 and forward.
- Annual SDC: The 2016 Wastewater Facilities Plan Amendment under projected Annual SDC costs.

Table 3.24: Annual O&M Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 3.1: Partial Pumping to Sioux Falls

Description	Facility Plan EUAC	Facility Plan Net Present Worth		VE EUAC	VE Net Present Worth		Difference
Equipment	$44,000	$880,000		$182,066	$2,708,700		$1,828,700
Testing	$5,000	$100,000		$1,800	$26,800		($73,200)
Utilities	$15,000	$300,000		$105,289	$1,566,500		$1,266,500
Labor	$17,000	$340,000		$154,752	$2,302,400		$1,962,400
Pumping Fees	$653,000	$13,061,000		$1,067,171	$15,876,900		$2,815,900
Annual SDC	$226,000	$4,525,000		$389,054	$5,788,200		$1,263,200
Total	**$960,000**	**$19,206,000**		**$1,900,132**	**$28,269,500**		**$9,063,500**

In Table 3.24, annual O&M costs were converted to a net present worth cost using a 20 year period and 3% interest rate. It appears this calculation was incorrectly performed in the 2016 Wastewater Facilities Plan Amendment as the annual O&M costs were multiplied by 20 instead of performing a present worth calculation over the 20 year planning period.

Finally, the present worth of the capital construction costs was added to the net present worth of the O&M costs and used to develop the overall EUAC value as presented in Table 3.25. The Total Net Present Worth calculation was incorrectly performed in the 2016 Wastewater Facilities Plan Amendment as $10,307,548 and $19,206,000 should total $29,513,548.

Table 3.25: EUAC Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 3.1: Partial Pumping to Sioux Falls

	Facility Plan Analysis		VE Study Analysis
Construction Cost Net Present Worth (Less Salvage)	**$10,307,548**		**$10,428,007**
O&M Present Worth Cost	**$19,206,000**		**$28,269,500**
Total Net Present Worth	**$23,368,548**		**$38,697,507**
EUAC	**$1,570,733**		**$2,601,080**

3.5.2 Alternative 3.2: Complete Pumping to Sioux Falls

Alternative 3.2, as proposed in the 2016 Wastewater Facilities Plan Amendment, eliminates the use of Harrisburg's existing ponds, continuously pumping raw wastewater to Sioux Falls for treatment. The two northern ponds would be abandoned and the southern pond kept for emergency storage. The 2016 Wastewater Facility Plan Amendment indicates flow would only be sent to it for brief periods when the City's lift station could not keep up.

3.5.2.1 Process Feasibility

This option would require pumping up to 2,340,000 gpd during peak hour 2036 conditions. As stated previously, the three lift station pumps have a 1,250 gpm pumps and are on variable frequency drives, providing a firm pumping capacity of approximately 3,600,000 gpd with one pump out of service. The lift station has capacity to meet these conditions. Having the third pond available for emergency storage (up to 21.5 million gallons) will increase operational flexibility during high flow conditions.

The third cell would provide 36.8 million gallons of emergency storage between the 2 foot and 8 foot levels. To maintain the integrity of the clay liner in the bottom of the pond, the City should maintain at least a two foot water depth in it to eliminate cattails and other vegetation from growing. Another option would be to place a layer of topsoil over the clay and plant grass (this option was added to the capital cost estimate in the VE Study). Should wastewater need to be directed into the pond, it is recommended that it be pumped out within 7 days to prevent significant odor and algae issues from developing.

Alternative 3.2: Complete Pumping to Sioux Falls offers the following advantages:

- Eliminates need for Pond 1 and 2 allowing them to be decommissioned and the land repurposed
- Lowest initial capital cost
- Capacity is available when it is needed
- Ponds will not have odors except when used for emergency storage

- City does not have to maintain a discharge permit
- City could use third cell to obtain equalization credit

Alternative 3.2: Complete Pumping to Sioux Falls has the following disadvantages:

- Local control of the wastewater facility is relinquished to Sioux Falls

3.5.2.2 Value Engineering (VE) Capital Construction Cost Estimate Review and Modifications

The capital construction cost estimate for Alternative 3.2 Complete Pumping to the City of Sioux Falls in the 2016 Wastewater Facilities Plan Amendment was reviewed to determine if key components of the treatment system were missing, if costs accurately reflected pricing obtained from manufacturers and observed in tabulations of recently bid projects. Table 3.26 provides a comparison of the opinion of probable capital construction costs for Alternative 3.2: Complete Pumping to Sioux Falls between the 2016 Wastewater Facilities Plan Amendment and the VE Study.

Table 3.26: Construction Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 3.2: Complete Pumping to Sioux Falls

ITEM NO.	DESCRIPTION OF WORK AND MATERIALS	QTY	UNIT	FACILITY PLAN UNIT PRICE	FACILITY PLAN TOTAL		VE UNIT PRICE	VE TOTAL		Difference
1	Mobilization	1	LS	$241,000	$241,000.00		$200,000	$200,000		($41,000)
2	Clearing	1	LS	$10,500	$10,500.00		$10,500	$10,500		$0
3	Traffic Control	1	LS	$10,500	$10,500.00		$10,500	$10,500		$0
4	Gravel Surfacing	100	TON	$22.50	$2,250.00		$22.50	$2,250		$0
5	Remove Existing Dikes	37,500	CY	$4.25	$159,375.00		$4.50	$168,750		$9,375
6	Salvage & Place Topsoil	6,000	CY	$5.25	$31,500.00		$5.25	$31,500		$0
7	16" Force Main	21,000	FT	$70.00	$1,470,000.0		$70	$1,470,000		$0
8	16" Sanitary Bedding Material	21,000	FT	$6.00	$126,000.00		$6.00	$126,000		$0
9	Sludge Removal	15,000	CY	$32.00	$480,000.00		$32	$480,000		$0
10	Seeding, Fertilizing & Mulching	70,000	SY	$1.60	$112,000.00		$1.60	$112,000		$0
11	Bar Screen	1	LS	$0.00	$0.00		$169,000	$169,000		$169,000
12	Bar Screen Building	1	LS	$0.00	$0.00		$320,000	$320,000		$320,000
13	Import and Place Topsoil for Pond Bottom	42,432	CY				$6.50	$275,808		$275,808
14	Pond Bottom Seeding, Fertilizing & Mulching	84,864	SY				$1.60	$135,782		$135,782
				Contingencies (20%)	$2,643,125			$3,560,590		$917,465
				Subtotal	$529,000			$712,118		$183,118
				Total Estimated Construction Costs	**$3,172,125**			**$4,272,708**		**$1,100,583**
				INITIAL SDC	$4,269,000			$3,974,823		($294,177)
				ENGINEERING	$476,000			$640,906		$164,906
				LEGAL, ADMINISTRATION & TESTING (4%)	$127,000			$170,908		$43,908
				TOTAL ESTIMATED PROJECT COST	**$8,044,125**			**$9,059,346**		**$1,015,221**

The VE Study identified the following modifications that impacted the capital construction costs for Alternative 3.2.

- Mobilization costs were assumed at 7.5% of total construction costs which is representative of the amount see on recent bid tabulations.
- The cost to Remove Existing Dikes seemed low compared to what has been observed on recently completed bid tabulations. The cost was increased to $4.50/cubic yard.
- Bar Screen costs were not included, but would be needed to protect the lift station pumps.
- A Bar Screen Building was not included, but would be needed to house the bar screen and screenings.
- Costs were added for topsoil and seeding of the third pond.

3.5.2.3 Treatment Costs for Alternative 3.2: Complete Pumping to the City of Sioux Falls

The fees that would need to be paid to the City of Sioux Falls for treating the pumped wastewater make up a significant portion of the annual operational costs for Alternative 3.2: Complete Pumping to the City of Sioux Falls. Because the third cell has enough capacity to provide 30 days of storage, the City should use it to receive the equalization credit and lower the cost for pumping to Sioux Falls. While odors may develop if it would need to store wastewater for up to 30 days, the cost benefits far outweigh this inconvenience.

Table 3.27 shows projected annual wastewater flows, the volume pumped to Sioux Falls for treatment, the annual fees paid to Sioux Falls with and without equalization credit, and the present worth value of these annual fees. The bolded numbers below the table show the present worth value totaled over the 20-year period and the resulting EUAC for Alternative 3.2. The savings in using the third cell for equalization credit is significant and will be used in the EUAC analysis.

Table 3.27: Projected EUAC and Present Worth Cost for Pumping to the City of Sioux Falls

Year	Average Wastewater Flow (gallons /day)	Annual Wastewater Flow Less Seepage and Evaporation (gallons)	Complete Pumping Option without 30 Days Storage for Equalization Credit		Complete Pumping Option with 30 Days Storage for Equalization Credit	
			Annual Volume Charge – No Equalization Credit	Present Worth Value	Annual Volume Charge – With Equalization Credit	Present Worth Value
2016	370,370	135,185,050	$609,879	$609,879	$542,287	$542,287
2017	385,185	140,592,452	$672,231	$652,651	$597,717	$580,307
2018	400,592	146,216,150	$740,056	$697,574	$658,175	$620,393
2019	416,616	152,064,796	$816,795	$747,483	$727,076	$665,378
2020	433,281	158,147,388	$891,931	$792,469	$793,959	$705,422
2021	450,612	164,473,283	$964,704	$832,162	$858,737	$740,754
2022	468,636	171,052,215	$1,033,381	$865,440	$919,869	$770,376
2023	487,382	177,894,303	$1,106,948	$900,050	$985,355	$801,183
2024	506,877	185,010,076	$1,185,753	$936,045	$1,055,502	$833,223
2025	527,152	192,410,479	$1,270,169	$973,479	$1,130,644	$866,544
2026	548,238	200,106,898	$1,360,594	$1,012,410	$1,211,135	$901,198
2027	570,168	208,111,174	$1,457,458	$1,052,898	$1,297,357	$937,238
2028	592,974	216,435,621	$1,561,218	$1,095,007	$1,389,718	$974,720
2029	616,693	225,093,045	$1,672,365	$1,138,799	$1,488,654	$1,013,701
2030	641,361	234,096,767	$1,791,425	$1,184,343	$1,594,635	$1,054,241
2031	667,015	243,460,638	$1,918,963	$1,231,709	$1,708,160	$1,096,403
2032	693,696	253,199,063	$2,055,580	$1,280,970	$1,829,769	$1,140,251
2033	721,444	263,327,026	$2,201,925	$1,332,201	$1,960,036	$1,185,854
2034	750,302	273,860,107	$2,358,689	$1,385,481	$2,099,577	$1,233,280
2035	780,314	284,814,511	$2,526,614	$1,440,893	$2,249,053	$1,282,604
2036	811,526	296,207,092	$2,706,495	$1,498,520	$2,409,172	$1,333,900
Present Worth Value				**$ 22,660,463**		**$19,279,259**
Equivalent Uniform Annual Cost				**$ 1,455,923**		**$ 1,295,869**

Alternative 3.2: Complete

Note that the 2016 Wastewater Facilities Plan Amendment for Alternative 3.2 appears to have incorrectly calculated the cost to pump to the City of Sioux Falls. Using 2036 average day design flows of 812,000 gpd from the 2016 Wastewater Facilities Plan Amendment, 296.38 million gallons (assuming no seepage or evaporation) would be pumped annually to Sioux Falls for treatment at a cost of $2,631,855 using the $8.88 rate in the 2016 Wastewater Facilities Plan Amendment. However, the cost for 2036 shown in Table 36 on page 64 is only $1,703,536. It is unknown why this cost is so low. Little to no evaporation or seepage will occur as wastewater will only enter the third cell for a short time during emergency periods.

3.5.2.4 Value Engineering (VE) Equivalent Uniform Annual Cost (EUAC) Estimate Review and Modifications

The EUAC developed in the 2016 Wastewater Facilities Plan Amendment for Alternative 3.2: Complete Pumping to Sioux Falls was also reviewed. Table 3.28 provides a comparison of the salvage values developed as part of the EUAC cost analysis for Alternative 3.2: Complete Pumping between the 2016 Wastewater Facilities Plan Amendment and the VE Study. Similar modifications were made to the salvage values as discussed in the EUAC cost analysis for the SBR alternative.

In addition, the 2016 Wastewater Facilities Plan Amendment omitted the cost of contingencies, engineering, and legal, administration and testing from the net present worth calculation. These items have been included in the VE Study calculation of the present net worth.

BANNER
engineering a better community

Table 3.28: Salvage Value Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 3.2: Complete Pumping to Sioux Falls

DESCRIPTION	FACILITY PLAN PRICE	FACILITY PLAN SALVAGE VALUE	FACILITY PLAN PRESENT WORTH OF SALVAGE VALUE	FACILITY PLAN PRESENT NET WORTH	VE PRICE	VE SALVAGE VALUE	VE PRESENT WORTH OF SALVAGE VALUE	VE PRESENT NET WORTH	DIFFERENCE	VE SALVAGE RATE
Mobilization	$241,000	$0	$0	$241,000	$248,500	$0	$0	$248,500	$7,500	0%
Clearing	$10,500	$0	$0	$10,500	$10,500	$0	$0	$10,500	$0	0%
Traffic Control	$10,500	$0	$0	$10,500	$10,500	$0	$0	$10,500	$0	0%
Gravel Surfacing	$2,250	$0	$0	$2,250	$2,250	$0	$0	$2,250	$0	0%
Remove Existing Dikes	$159,375	$0	$0	$159,375	$168,750	$0	$0	$168,750	$9,375	0%
Salvage & Place Topsoil	$31,500	$0	$0	$31,500	$31,500	$0	$0	$31,500	$0	0%
16" Force Main	$1,470,000	$882,000	$488,342	$981,658	$1,470,000	$882,000	$488,342	$981,658	$0	60%
16" Sanitary Bedding Material	$126,000	$0	$0	$126,000	$126,000	$0	$0	$126,000	$0	0%
Sludge Removal	$480,000	$0	$0	$480,000	$480,000	$0	$0	$480,000	$0	0%
Seeding, Fertilizing & Mulching	$112,000	$0	$0	$112,000	$112,000	$0	$0	$112,000	$0	0%
Bar Screen	$0	$0	$0	$0	$169,000	$0	$0	$169,000	$169,000	0%
Bar Screen Building	$0	$0	$0	$0	$320,000	$192,000	$106,306	$213,694	$213,694	60%
Import and Place Topsoil for Pond					$275,808	$0	$0	$275,808	$275,808	
Pond Bottom Seeding, Fertilizing & Mulching					$135,782	$0	$0	$135,782	$135,782	
Contingencies	$0			$0	$712,118	$84,345	$46,700	$665,418	$665,418	12%
Engineering	$0			$0	$640,906	$0	$0	$640,906	$640,906	0%
Legal, Administration & Testing	$0			$0	$170,908	$0	$0	$170,908	$170,908	0%
Remaining Capital Costs (Initial SDC)	$5,401,000	$0	$0	$5,401,000	$3,974,823	$0	$0	$3,974,823	($1,426,177)	0%
Total	**$8,044,125**	**$882,000**	**$488,342**	**$7,555,783**	**$9,059,346**	**$1,158,345**	**$641,348**	**$8,417,999**	**$862,216**	

O&M costs were also part of the EUAC analysis to evaluate the impact of the cost over a 20 year period and are presented in Table 3.29. The O&M costs for Alternative 3.2: Complete Pumping to Sioux Falls were reviewed as part of the VE Study and appear insufficient for a facility of this size and complexity as documented below.

- Equipment: The annual amount allotted for equipment replacement in the 2016 Wastewater Facilities Plan Amendment is insufficient.
- Labor: The annual amount allotted for labor cost in the 2016 Wastewater Facilities Plan Amendment in not adequate. An additional half-time person will be required to handle the increasing wastewater flows increase due to growth, maintaining the mechanical bar screen and screenings, and to maintain the aging pumps.
- Pumping Fees: The 2016 Wastewater Facilities Plan Amendment under projected pumping fees, possibly due to incorrectly assuming seepage and evaporation for this option. In addition, Sioux Falls rates have been adjusted to allow for a 5% increase in 2020, a 4% increase for 2021, and a 3% increase for year 2022 and forward.
- Annual SDC: The 2016 Wastewater Facilities Plan Amendment under projected Annual SDC costs.

Table 3.29: Annual O&M Cost Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 3.2: Complete Pumping to Sioux Falls (with Equalization Credit for the VE Study)

Description	Facility Plan EUAC	Facility Plan Net Present Worth		Alternative 3.2: VE EUAC	Alternative 3.2: VE Net Present Worth		Difference
Equipment	$1,500	$30,000		$128,181	$1,907,100		$1,877,100
Testing	$1,500	$30,000		$1,800	$26,800		($3,200)
Utilities	$15,000	$300,000		$7,362	$109,600		($190,400)
Labor	$3,000	$60,000		$77,376	$1,151,200		$1,091,200
Pumping Fees	$887,500	$17,746,000		$1,295,869	$19,279,300		$1,533,300
Annual SDC	$226,000	$4,525,000		$389,054	$5,788,200		$1,263,200
Total	**$1,134,500**	**$22,691,000**		**$1,899,643**	**$28,262,200**		**$5,571,200**

In Table 3.29, annual O&M costs were converted to a net present worth cost using a 20 year period and 3% interest rate. It appears this calculation was incorrectly performed in the 2016 Wastewater Facilities Plan Amendment as the annual O&M costs were multiplied by 20 instead of performing a present worth calculation over the 20 year planning period.

Finally, the present worth of the capital construction costs was added to the net present worth of the O&M costs and used to develop the overall EUAC value as presented in Table 3.30. This includes the EUAC analysis for Alternative 3.2A: Complete Pumping to Sioux Falls with EQ Credit.

Table 3.30: EUAC Comparison between 2016 Wastewater Facilities Plan Amendment and VE Study for Alternative 3.2: Complete Pumping to Sioux Falls (with Equalization Credit for the VE Study)

	Facility Plan Analysis		Alternative 3.2: VE Study Analysis
Construction Cost Net Present Worth (Less Salvage)	**$7,555,783**		**$8,417,999**
O&M Present Worth Cost	**$22,691,000**		**$28,262,200**
Total Net Present Worth	**$30,246,783**		**$36,680,199**
EUAC	**$1,642,367**		**$2,465,486**

3.6 TREATMENT ALTERNATIVE A: IFAS System

An integrated fixed-film system (IFAS) wastewater treatment system alternative was prepared for consideration in this VE Study. An IFAS system is similar to an activated sludge system except small, honeycomb shaped media are placed in the main aerated tank to support biological growth and prevent bacteria and other microorganisms vital to the treatment process from being lost over the weirs. Use of the media allows the footprint of the basin to be slightly reduced. Anaerobic and pre-anoxic selector tanks are used ahead of the IFAS reactor basins to promote nitrogen and phosphorus removal. Post anoxic and reaeration tanks complete the process. Final clarifiers are provided to settle out solids following the aeration basins with solids either recycled to the head of the plant or sent to aerobic digestion for solids processing. Figure 3.4 presents a flow-through diagram of the activated type sludge system proposed for Harrisburg to facilitate nitrogen and phosphorus removal. The media used in the main aerobic tank are shown in Figure 3.5 and are typically less than in inch in diameter.

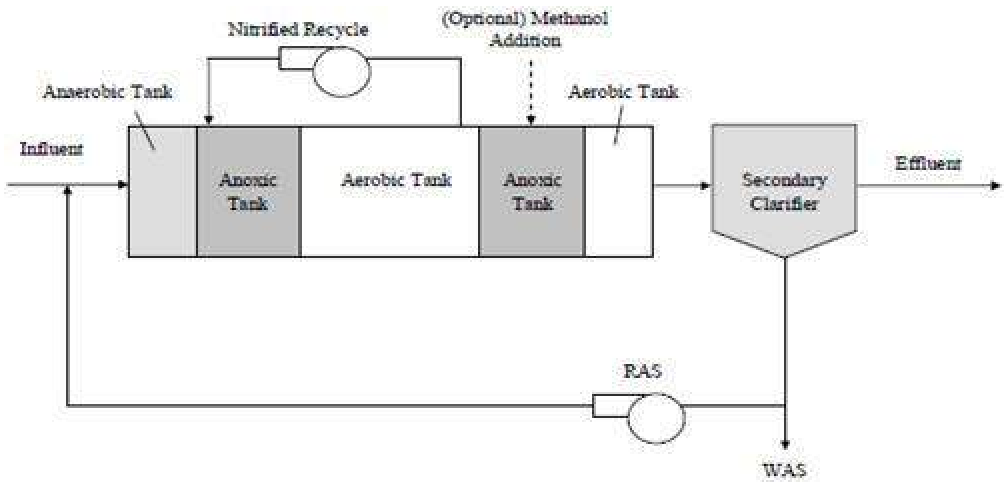


Figure 3.4: IFAS Media as Manufactured by Suez

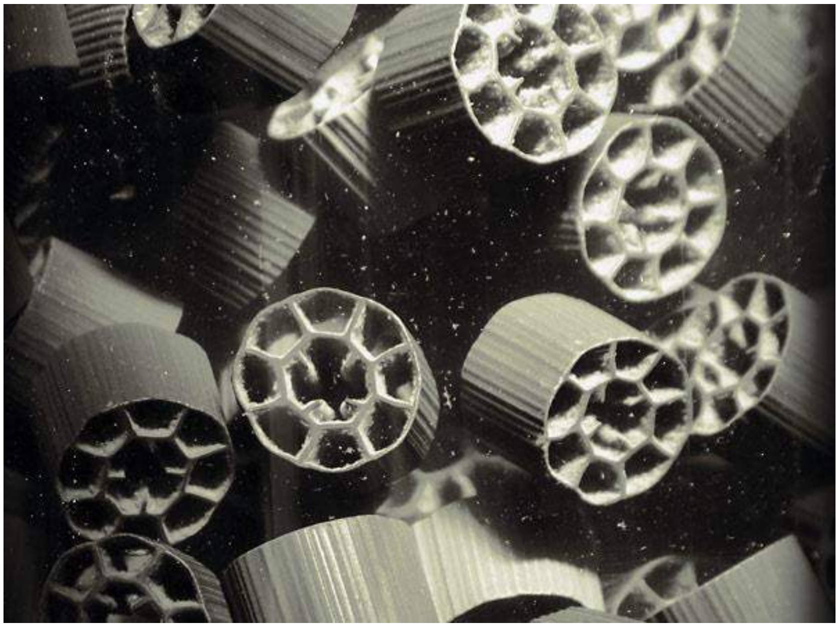


Figure 3.5: IFAS Media as Manufactured by Suez

3.6.1 Process Feasibility

IFAS systems installations began occurring in the United States just after the turn of the century and are often used to expand the treatment capability of existing facilities. They are becoming more common across the United States. Facilities have been installed in Dickinson, ND, Cheyenne, WY, Pelican Rapids, MN, and several Wisconsin installations, but none in South Dakota yet.

The IFAS system offers the following advantages:

- Use of media in activated sludge process promotes compact footprint
- Common wall construction resulting in less tankage, reduced site work, and reduced yard piping requirements
- Selector tank for improved biological treatment
- Operational flexibility
- Chemical phosphorus removal is not anticipated
- Easily expandable

- Reduced power consumption due to smaller footprint and compact design
- Less susceptible to shock loads than an SBR
- Two trains are proposed allowing half the system to be easily taken out of service for maintenance

The IFAS system also has the following disadvantages:

- Because there are no existing South Dakota installations, the SD DENR will likely need to complete a more in depth review prior to approval
- Require a sophisticated level of timing units and controls
- Require knowledgeable operators with a higher degree of training

3.6.2 Value Engineering (VE) Capital Construction Cost Estimate for Alternative A: IFAS

A capital construction cost estimate for Alternative A: IFAS was developed using pricing obtained from manufacturers and tabulations of recently bid projects and in presented in Table 3.31. Note, the 0.5 mile force main extension for the connection to Sioux Falls has been included in the cost as will be required in 2018, before a new IFAS treatment plant could be constructed. The Present Worth of Lost Multiplier Credit has also been included to account for the additional fees paid to the City of Sioux Falls for wastewater treatment during the four years required to construct a new plant.

Table 3.31: Construction Cost for Alternative A: IFAS

ITEM NO.	DESCRIPTION OF WORK AND MATERIALS	QTY	UNIT	VE UNIT PRICE	VE TOTAL
1	Site Grading/Paving	1	LS	$308,000	$308,000
2	Pretreatment Building	1	LS	$768,800	$768,800
3	Bar Screen, Compactor, and Grit Removal	1	LS	$362,700	$362,700
4	Office, Lab and Final Effluent Pump Building	1	LS	$615,200	$615,200
5	Mechanical/Biosolids Dewatering Building	1	LS	$840,000	$840,000
6	Process Equipment	1	LS	$3,008,200	$3,008,200
7	Odor Control	1	LS	$250,000	$250,000
8	Power to Site	1	LS	$100,000	$100,000
9	Standby Power/Generator	1	LS	$250,000	$250,000
10	Instrumentation and Controls/SCADA	1	LS	$257,000	$257,000
11	Electrical Inside Plant	1	LS	$450,000	$450,000
12	Concrete Work Effluent Pumping	127.5	CuYd	$650	$82,875
13	Concrete Work Basins	1,910	CuYd	$650	$1,241,500
14	Concrete Work Disinfection/Post Aeration	465	CuYd	$650	$302,250
15	Plant Piping	1	LS	$513,500	$513,500
16	Mechanical Room Equipment	1	LS	$450,000	$450,000
17	Lift Station Pump and Piping Assembly	1	LS	$300,000	$300,000
18	16" Force Main	36,000	FT	$70	$2,520,000
19	16" Sanitary Bedding Material	36,000	FT	$6.00	$216,000
20	0.5 Mile Force Main Extension	1	LS	$384,960	$384,960
				Contingencies (20%)	$13,221,000
				Subtotal	$2,644,200
				Total Estimated Construction	**$15,865,200**
				ENGINEERING	$2,538,500
				LAND PURCHASE	$1,250,000
				PRESENT WORTH OF LOST MULTIPLIER CREDIT	$2,082,000
				LEGAL, ADMINISTRATION & TESTING (4%)	$634,700
				TOTAL ESTIMATED PROJECT COST	**$22,370,200**

3.6.3 Value Engineering (VE) Equivalent Uniform Annual Cost (EUAC) Estimate Development for Alternative A: IFAS

Table 3.32 presents the salvage values developed for Alternative A: IFAS as part of the EUAC cost analysis.

Table 3.32: Salvage Value Alternative A: IFAS

DESCRIPTION	VE PRICE	VE SALVAGE VALUE	VE PRESENT WORTH OF SALVAGE VALUE	VE PRESENT NET WORTH	VE SALVAGE RATE
Site Grading/Paving	$308,000	$0	$0	$308,000	0%
Bar Screen Pretreatment Building	$768,800	$461,280	$255,400	$513,400	60%
Bar Screen, Compactor, and Grit Removal	$362,700	$0	$0	$362,700	0%
Office, Lab and Final Effluent Pump Building	$615,200	$369,120	$204,373	$410,827	60%
Mechanical/Biosolids Dewatering Building	$840,000	$504,000	$279,053	$560,947	60%
Process Equipment	$3,008,200	$0	$0	$3,008,200	0%
Odor Control	$250,000	$0	$0	$250,000	0%
Power to Site	$100,000	$33,333	$18,456	$81,544	33%
Standby Power/Generator	$250,000	$0	$0	$250,000	0%
Instrumentation and Controls/SCADA	$257,000	$0	$0	$257,000	0%
Electrical Inside Plant	$450,000	$0	$0	$450,000	0%
Concrete Work Effluent Pumping*	$82,900	$49,740	$27,540	$55,360	60%
Concrete Work Basins*	$1,241,500	$744,900	$412,433	$829,067	60%
Concrete Work Disinfection/Post Aeration*	$302,300	$181,380	$100,426	$201,874	60%
Plant Piping	$513,500	$0	$0	$513,500	0%
Mechanical Room Equipment	$450,000	$0	$0	$450,000	0%
Lift Station Pump and Piping Assembly	$300,000	$0	$0	$300,000	0%
16" Force Main	$2,520,000	$1,512,000	$837,158	$1,682,842	60%
16" Sanitary Bedding Material	$216,000	$129,600	$71,756	$144,244	60%
0.5 Mile Force Main Extension	$385,000	$231,000	$127,899	$257,101	60%
Contingencies	$2,644,200	$970,202	$537,177	$2,107,023	37%
Present Worth of Lost Multiplier Credit	$2,082,000	$0	$0	$2,082,000	0%
Engineering	$2,538,500	$0	$0	$2,538,500	0%
Legal, Administration & Testing	$634,700	$0	$0	$634,700	0%
Land	$1,250,000	$2,257,639	$1,250,000	$0	100%
Total Construction Cost	**$22,370,200**	**$7,444,189**	**$4,121,667**	**$18,248,608**	

O&M costs were also part of the EUAC analysis to evaluate the impact of the cost over a 20 year period and are presented in Table 3.33 for Alternative A: IFAS. The annual O&M costs were converted to a net present worth cost using a 20 year period and 3% interest rate.

Table 3.33: Annual O&M Cost Costs for Alternative A: IFAS

Description	VE EUAC	VE Net Present Worth
Equipment	$464,359	$6,908,500
Solids Handling	$31,098	$462,700
Testing	$14,400	$214,300
Utilities	$153,495	$2,283,700
Labor	$656,448	$9,766,300
Total	**$1,319,800**	**$19,635,500**

Finally, the present worth of the capital construction costs was added to the net present worth of the O&M costs and used to develop the overall EUAC value as presented in Table 3.34.

Table 3.34: EUAC for Alternative A: IFAS

	VE Study Analysis
Construction Cost Net Present Worth (Less Salvage)	**$18,248,608**
O&M Present Worth Cost	**$19,365,500**
Total Net Present Worth	**$37,884,108**
EUAC	**$2,546,407**

END OF SECTION 3

SECTION 4: EVALUATION AND RECOMMENDATION

4.1 COST COMPARISON

The revised capital construction costs, annual O&M costs, and EUACs developed for each alternative in Section 3 of the Value Engineering (VE) Study are summarized in Table 4.1. The blue columns on the left side of the table present the values from the 2016 Wastewater Facilities Plan Amendment prepared by Stockwell Engineers. The columns in orange in the middle of the table present the revised costs developed in this VE Study. The second to the last column on the right side of the table, in green, presents the sum of the annual O&M costs and annual loan repayment on the capital improvements developed in the VE study assuming a SRF loan at 2.25% interest for 20 years. The far right column in Table 4.1 (in green) indicates whether each alternatives includes costs for the processes needed to meet future nitrogen and phosphorus limits.

Upfront capital construction costs cannot be used to determine the lowest cost alternative for Harrisburg's future wastewater needs. Annual O&M costs for the alternatives considered vary significantly over the 20-year planning period. Therefore, an equivalent uniform annual cost analysis (EUAC) was used to develop the overall cost for each alternative over the planning period accounting for both upfront capital construction costs and annual O&M costs. The column circled in red in Table 4.1 presents the EUACs for each option and indicates that Alternative 3.2: Complete Pumping to Sioux Falls with 30-Days Emergency Storage Credit offers the lowest cost.

While nitrogen and phosphorus limits are not yet part of discharge permits, the SD DENR has indicated they are coming within the next 10-15 years. The treatment processes implemented should be able to either meet these limits or be able to meet the limits with modifications. In the VE Study, processes have been added to each of the alternatives where Harrisburg would build their own treatment plant to meet anticipated nitrogen limits of 10 mg/l and phosphorus limits of 1.0 mg/l. The alternatives where wastewater would be sent to Sioux Falls for treatment do not include the costs for nitrogen and phosphorus removal. Improvements will be required to the Sioux Falls Water Reclamation Facility to add the processes and equipment to meet future nitrogen and phosphorus limits. Sioux Falls does not yet know the impact to rates and System Development Charges (SDCs) for these improvements. As a result, the cost of alternatives that pump wastewater to Sioux Falls for treatment will be higher than presented in this study by an unknown amount. Harrisburg should work with Sioux Falls to determine the impact future nitrogen and phosphorus removal will have on rates. The updated information can be used to determine if Alternative 3.2 still offers the lowest EUAC. Alternative 2.3 Sequox® process by Aeromod and Alternative A: IFAS offer the next lowest cost options if Alternative 3.2 is ruled out. The cost for the Sequox® process by Aeromod and the IFAS are very similar.

Table 4.1: Summary of Overall VE Study Analysis

DESCRIPTION	FACILITY CAPITAL CONSTRUCTION COST	FACILITY PLAN ANNUAL OPERATING COST	FACILITY PLAN EUAC	VE STUDY CAPITAL CONSTRUCTION COST	VE STUDY ANNUAL OPERATING COST	VE STUDY EUAC	ANNUAL COST FOR LOAN REPAYMENT AND O&M	FUTURE N & P TREATMENT COST INCLUDED
Alternative 3.2 Complete Pumping to Sioux Falls with 30-Days Emergency Storage Credit	$8,044,125	$1,134,500	$1,642,367	$9,059,346	$1,899,643	$2,465,486	$2,467,139	No
Alternative 2.3 Sequox® process by Aeromod	$19,803,400	$347,000	$1,437,208	$22,195,455	$1,331,188	$2,542,637	$2,721,558	Yes
Alternative A IFAS System	NA			$22,370,200	$1,319,800	$2,546,407	$2,721,116	Yes
Alternative 3.1 Partial Pumping to Sioux Falls	$11,413,000	$960,000	$1,570,733	$11,196,790	$1,900,132	$2,601,080	$2,601,522	No
Alternative 2.1 Sequencing Batch Reactor	$19,220,000	$367,000	$1,433,940	$23,286,000	$1,329,746	$2,610,675	$2,788,441	Yes
Alternative 2.2 Oxidation Ditch	$20,761,400	$407,000	$1,597,669	$24,618,000	$1,361,922	$2,712,118	$2,904,044	Yes

BANNER engineering a better community

4.2 ALTERNATIVE SELECTION

A "decision making matrix" was used to evaluate the alternatives and aid in the complex decision of recommending whether to construct a new treatment facility or pump Harrisburg's wastewater to Sioux Falls for treatment. Use of a decision making matrix allows items other than cost to be factored into selection of an alternative. The following criteria were used in the decision making matrix process:

- Low equivalent uniform annual cost (EUAC)
- Reduces initial impact to rate payers
- Ease of operating the treatment process
- Ability to meet discharge permit limits
- Ease of phasing/future expansion
- Accounts for costs associated with future nitrogen and phosphorus removal
- Promotes local control of wastewater system and rates

Development of the matrix first involved assigning a rating value for each area as follows:

- 4: Alternative meets <u>all</u> requirements of the criteria
- 3: Alternative meets <u>most</u> requirements of the criteria
- 2: Alternative meets <u>some</u> requirements of the criteria
- 1: Alternative meets <u>few</u> requirements of the criteria

For example, the lowest construction cost alternative received a rating of 4 for the area of "Low capital construction costs", and the highest construction cost alternative received a rating of 1 in this area.

Next, weighting factors were assigned to criteria with those critical to the decision making process receiving a higher rating. For example, since cost is critical, the "Low equivalent uniform annual cost (EUAC)" received a weighting factor of 30%. The weighting factors are designed to total 100%.

The weighting factor was multiplied by the rating to develop a score for each criteria. The scores were totaled and the alternative with the highest overall score was deemed the most viable to meet the City's needs.

4.2.1 Low Equivalent Uniform Annual Cost (EUAC)

The alternative with the lowest equivalent uniform annual cost (EUAC) offers the lowest cost option for wastewater treatment. The EUAC represents the annual cost in today's dollars to fund each alternative if it could be paid for over a 20 year period. Cost is often a community's most significant consideration in the selection of an alternative for major infrastructure projects. As a result, a weighting factor of 30% has been assigned to the low EUAC criteria. Ratings were assigned for each alternative as follows:

- Alternative 3.2: Complete Pumping to Sioux Falls with 30-Days Emergency Storage Credit has the lowest EUAC and was assigned a rating of 4.
- Alternative 2.3: Sequox by Aeromod, Inc. and Alternative A: IFAS and have slightly higher EUACs, but very close to Alternative 3.2. Therefore, they were assigned ratings of 3.
- Alternative 2.1: SBR and Alternative 3.1: Partial Pumping to Sioux Falls have EUACs slightly higher than Alternatives 2.3 and A and were assigned a rating of 2.
- Alternative 2.2: Oxidation Ditch has the highest EUAC costs and was assigned ratings of 1.

4.2.2 Reduces Initial Impact to Rate Payers

Alternatives 2.1, 2.2, 2.3 and A, in which Harrisburg constructs its own wastewater facility, have a significantly higher initial capital cost than Alternatives 3.1 and 3.2, pumping wastewater to Sioux Falls for treatment. This high initial capital cost will result in rates needing to increase during the first year of operation to fund the annual debt service and O&M costs. If wastewater is pumped to Sioux Falls for treatment, the capital costs and thus debt service costs are considerably lower. In addition, pumping fees and SDCs make up a majority of the annual O&M costs. These will gradually increase over time as the City grows allowing rates to be slowly and steadily increased to fund the costs. A weighting factor of 15% has been assigned to the "Reduces Initial Impact to Rate Payers" with ratings assigned as follows:

- Alternative 3.2: Complete Pumping to Sioux Falls with 30-Days Emergency Storage Credit has the lowest upfront capital cost with O&M costs that will steadily increase as the City grows. It will allow Harrisburg to gradually increase rates to meet costs and was assigned a rating of 4.
- Alternative 3.1: Partial Pumping to Sioux Falls has a slightly lower upfront capital cost than Alternative 3.2. It also offers annual O&M costs that will steadily increase as the City grows allowing Harrisburg to gradually increase rates to meet costs and was assigned a rating of 3.

- Alternative 2.3: Sequox by Aeromod, Inc. and Alternative A: IFAS have the next lowest upfront capital costs. Rates will need to be increased significantly to pay the annual debt service and O&M costs. They were assigned ratings of 2.
- Alternative 2.1: SBR and Alternative 2.2: Oxidation Ditch have the highest upfront capital costs. Rates will need to be increased significantly to pay the annual debt service and O&M costs. They were assigned ratings of 1.

4.2.3 Ease of Operating the Treatment Process

No matter the upfront cost, a wastewater plant that is complicated to operate will be seen as a failure. A weighting factor of 10% has been assigned to ease of operating the treatment process. For ease of operating the treatment process, ratings were assigned for each alternative as follows:

- Alternatives 3.2, completely pumping all wastewater to Sioux Falls for treatment, will be the easiest to operate and was assigned a rating of 4.
- While not viable, the Alternative 3.1: Partial Pumping to Sioux Falls is slightly more complicated as the aeration system would need to be maintained. It was assigned rating of 3.
- Alternative 2.2: Oxidation Ditch was assigned a rating of 3 due to its ability to handle peak flows and loadings.
- Alternative 2.3: Sequox by Aeromod, Inc. and Alternative A: IFAS were assigned a rating of 2 due to the challenges in operating activated sludge systems.
- Alternative 2.1: SBR was assigned a rating of 1 due to the challenges associated with operating a batch activated sludge system

4.2.4 Ability to Meet Discharge Permit Limits

The limits included in a discharge permit directly impact the complexity and number of treatment processes required. A weighting factor of 10% has been assigned to the ability to meet discharge permit limits with ratings assigned for each alternative as follows:

- For Alternatives 3.1 and 3.2, the responsibility of meeting the discharge permit limits will be the City of Sioux Falls. Because Harrisburg will not have to treat their wastewater, these alternatives were assigned a rating of 4.
- Alternative 2.2: Oxidation Ditch, Alternative 2.3: Sequox by Aeromod, Inc., and Alternative A: IFAS were assigned a rating of 3 due to their ability to meet the anticipated discharge permit.
- Alternative 2.1: SBR was assigned a rating of 2 due to its susceptibility for upsets from peak loads.

4.2.5 Ease of Phasing/Future Expansion

Harrisburg has seen explosive growth over the past 20 years and that growth is expected to continue with its proximity to Sioux Falls. Constructing a facility sized to meet the needs of the community in 20 years would place an undue financial burden on current residents. A phased construction process will best meet the needs for Harrisburg and allow the costs to be spread out over time. Processes that allow for easy expansion of treatment capacity will be seen as more favorable. A weighting factor of 10% has been assigned to the ability for future expansion. For ease of phasing/future expansion, ratings were assigned for each alternative as follows:

- For Alternatives 3.1 and 3.2, expansion is as easy as coordinating with City of Sioux Falls operations staff and increasing the speed of the pumps at the lift station that pumps wastewater to Sioux Falls for treatment. Therefore, they were assigned ratings of 4.
- Alternative 2.1: SBR, Alternative 2.2: Oxidation Ditch, Alternative 2.3: Sequox by Aeromod, Inc., and Alternative A: IFAS can all be constructed in phases and will all require a capital construction project for expansion. While the addition of future trains is feasible for increased capacity, they were assigned a rating of 2 due cost and time involved with expansion projects.

4.2.6 Accounts for Costs Associated with Future Nitrogen and Phosphorus Removal

A weighting factor of 15% has been assigned to "Accounts for Costs Associated with Future Nitrogen and Phosphorus Removal" with the following ratings were assigned for each alternative:

- Alternative 2.1: SBR, Alternative 2.2: Oxidation Ditch, Alternative 2.3: Sequox by Aeromod, Inc., and Alternative A: IFAS include the future costs of nitrogen and phosphorus removal. These alternatives were assigned a rating of 4.
- For Alternatives 3.1 and 3.2, the future costs of nitrogen and phosphorus removal are not included in this study and they were assigned ratings of 1.

4.2.7 Promotes Local Control of Wastewater System and Rates

The City of Harrisburg would like to maintain local control over their wastewater system. If they choose Alternatives 3.1 or 3.2, they will be required to pay the SDCs for existing and new customers. The SDCs place high fees on new commercial and industrial customers with large water meters and may affect economic development. The SDCs, as well as the rates paid for wastewater treatment, are set by the City of Sioux Falls. Harrisburg will not have control over the timing and amount of the increases to these fees. A weighting factor of 10% has been assigned to the local control of wastewater system and rates with the following ratings were assigned for each alternative:

- Alternative 2.1: SBR, Alternative 2.2: Oxidation Ditch, Alternative 2.3: Sequox by Aeromod, Inc., and Alternative A: IFAS will allow Harrisburg to maintain local control of the timing and amount of rate increases and fees. As a result, these alternatives were assigned a rating of 4.
- Alternatives 3.1 and 3.2 will not allow Harrisburg to have control over the timing and amount of rate increases and were assigned ratings of 1.

4.2.8 Decision Making Matrix

The resulting decision making matrix evaluating the alternatives considered in the VE Study is presented in Table 4.2. It shows that after considering the parameters in addition to cost, Alternative 3.2: Complete Pumping to Sioux Falls with 30-Day Emergency Storage Credit remains the most favorable alternative for Harrisburg. If Sioux Falls projected rate increase no longer makes Alternative 3.2 viable, Alternative 2.3: Sequox by Aeromod, Inc. or Alternative A: IFAS had the same score in the matrix and either one could be implemented to address Harrisburg's future wastewater needs.

Table 4.2: Decision Making Matrix

		Weighting Factor	Treatment Alternative 2.1: Sequencing Batch Reactor (SBR)		Treatment Alternative 2.2: Oxidation Ditch		Treatment Alternative 2.3: SEQUOX® by Aeromod, Inc.		Treatment Alternative 3.1: Partial Pumping to Sioux Falls		Treatment Alternative 3.2: Complete Pumping to Sioux Falls with 30-Day Emergency Storage Credit		Treatment Alternative A: Integrated Fixed Film Activated Sludge (IFAS)	
			Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
1	Low EUAC Cost	30%	2	0.6	1	0.3	3	0.9	2	0.6	4	1.2	3	0.9
2	Reduces Initial Impact to Rate Payers	15%	1	0.15	1	0.15	2	0.3	3	0.45	4	0.6	2	0.3
3	Ease of Operating the Treatment Process	10%	1	0.1	3	0.3	2	0.2	3	0.3	4	0.4	2	0.2
4	Ability to Meet Discharge Permit Limits	10%	2	0.2	3	0.3	3	0.3	4	0.4	4	0.4	3	0.3
5	Ease of Phasing/Future Expansion	10%	2	0.2	2	0.2	2	0.2	4	0.4	4	0.4	2	0.2
6	Accounts for Costs Associated with Future Nitrogen and Phosphorus Removal	15%	4	0.6	4	0.6	4	0.6	1	0.15	1	0.15	4	0.6
7	Promotes Local Control of Wastewater System and Rates	10%	4	0.4	4	0.4	4	0.4	1	0.1	1	0.1	4	0.4
	Total Score	100%		2.25		2.25		2.90		2.40		3.25		2.90

4.3 RECOMMENDED ALTERNATIVE

The findings of this study and the decision making matrix demonstrates that it is most economical and effective to implement Alternative 3.2: Complete Pumping to Sioux Falls with 30-Days Emergency Storage Credit. Alternative 3.2 offers the following benefits:

- Highest score in the decision making matrix
- Lowest overall EUAC
- Easy to implement, as siting and constructing a new treatment facility is not required
- Offers a system current City staff is familiar with
- Compliance with a discharge permit is not required
- Reduces the initial impact to ratepayers
- City can add and pay for capacity as it grows

The improvements required to implement nitrogen and phosphorus removal at the Sioux Falls Water Reclamation Facility may significantly increase rates to the point that the EUAC for Alternative 3.2 is no longer is the lowest cost option. If that occurs, Harrisburg should implement Alternative 2.3: SEQUOX® by Aeromod, Inc. or Alternative A: IFAS. These alternatives offer the following benefits:

- Second highest scores in the decision making matrix
- Second lowest overall EUACs
- Accounts for the future costs of nitrogen and phosphorus removal
- Promotes local control of the wastewater system
- Provides a treatment system that will be able to meet anticipated discharge permits
- Treatment system can be constructed in phases and expanded to meet future needs

4.4 SUMMARY OF OPPORTUNITIES FOR SAVINGS

One of the VE Study goals was to identify cost saving measures that could be achieved through design modifications and improved efficiency.

If Alternative 3.2: Complete Pumping to Sioux Falls with 30-Days Emergency Storage Credit is implemented, the VE study did not identify cost savings. Unfortunately, the Study identified $1,015,221 in additional costs due to the following:

- Mobilization costs had to be increased slightly due to the overall increase in project costs
- Removing the existing dikes cost is anticipated to be slightly higher based upon recent bid tabulations
- A mechanical bar screen in an enclosed building will be required to protect the pumps
- Placing two feet of cover and seeding the emergency storage pond is recommended to eliminate cattail growth and protect the clay liner
- Other adjustments to contingencies, the SDCs, engineering, and legal, administration, & testing.

If Alternative 3.2 is no longer viable due to nitrogen and phosphorus removal, the VE Study identified the following cost savings for Alternative 2.3: SEQUOX® by Aeromod, Inc., which totaled $2,244,650.

- Removal of pumping equipment and facilities
- Reduction in footprint of Mechanical/Biosolids Dewatering Building
- Reduction in instrumentation/SCADA costs
- Elimination of effluent equalization as is not needed
- Removal of bio-solids holding ponds
- Reduction in costs for Mechanical Room Equipment
- Reduction in costs for legal, administration, & testing

Unfortunately, the VE Study also identified $4,636,705 in additional costs for Alternative 2.3: SEQUOX® by Aeromod, Inc. due to the following:

- Mobilization costs were increased to the amount required for a facility of this size according to recent bid tabulations
- Grit removal equipment was added as it will be required for this type of facility and the Pretreatment Building footprint was increased accordingly
- Office and lab space costs were increased according to recently designed similar facilities
- Process equipment costs seemed low according to pricing received from suppliers
- Electrical costs seemed very low based upon recent bid tabulations for new treatment facilities

- Concrete quantities were increased to account for thicker walls/floor slabs likely required
- Plant piping costs increased based upon recent bid tabulations for new treatment facilities
- 0.5 mile force main extension for the connection to Sioux Falls included in the cost as will be required in 2018, before a new treatment plant could be constructed
- Inclusion of the Present Worth of Lost Multiplier Credit to account for the additional fees paid to the City of Sioux Falls for wastewater treatment during the approximately four years while a new plant is being constructed
- Other adjustments to contingencies and engineering

The savings identified coupled with the additional costs increases the capital construction costs for Alternative 2.3: SEQUOX® by Aeromod, Inc., $2,392,055 above what was shown in the 2016 Wastewater Facilities Plan Amendment.

END OF SECTION 4

APPENDIX A

SD DENR CORRESPONDENCE

DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES
PMB 2020
JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3182
www.state.sd.us/denr

November 9, 2015

Tanya Miller and Joe Munson
Banner Associates, Inc.
2307 W. 57th Street
Suite 102
Sioux Falls, SD 57108

RE: Regional Wastewater Treatment Facility for Harrisburg, Tea, and Worthing

Dear Ms. Miller and Mr. Munson:

I am writing to respond to your request for the predicted effluent limits for a Harrisburg-Tea-Worthing regional wastewater treatment facility at two potential discharge locations. The findings at each site for the 2015-2040 effluent flows are summarized in the attached tables.

Because the regional facility would be considered a new discharger to either site, antidegradation was considered in developing the 2015 limits. See the attached map for discharge site, water quality monitoring and gage locations.

- Antidegradation calculations and water quality based effluent limits for Site 1, Big Sioux River east of Harrisburg, were developed using ambient water quality monitoring data from WQM 65 (Big Sioux River near Canton) and receiving stream flow data from USGS gage 06482020 (Big Sioux River at North Cliff Avenue at Sioux Falls SD). Calculations using WQM 31 (Big Sioux River near Brandon) were also considered and were comparable; WQM 65 was selected due to its proximity to Site 1.
- Antidegradation calculations and water quality based effluent limits for Site 2, Beaver Creek north of Worthing, were developed using ambient water quality monitoring data from WQM 65 (Big Sioux River near Canton) and receiving stream flow data from USGS gage 06482848 (Beaver Creek at Canton SD). Because there were not enough water quality data available from Beaver Creek directly, additional instream monitoring for limits development is recommended if this discharge location is selected.

The ammonia antidegradation and 2015 limit calculations were based on the current ammonia standards. Limits for 2020-2040 were based on the proposed ammonia standards, which are predicted to be adopted after the surface water quality standards 2017 triennial review. As for phosphorous and nitrate limits, a date has not been set for those standards to be adopted, but SDDENR has started to include nutrient monitoring with permit renewals and recommends that facilities build in the capacity for future nutrient removal.

In addition to effluent limits, sampling frequency and operator certification should be considered because they can vary depending on the type of treatment and the discharge frequency, as well as other factors. A continuous discharger would require more frequent sampling than a seasonal one, and a mechanical system may require higher operator certification than a stabilization pond system depending on the processes incorporated.

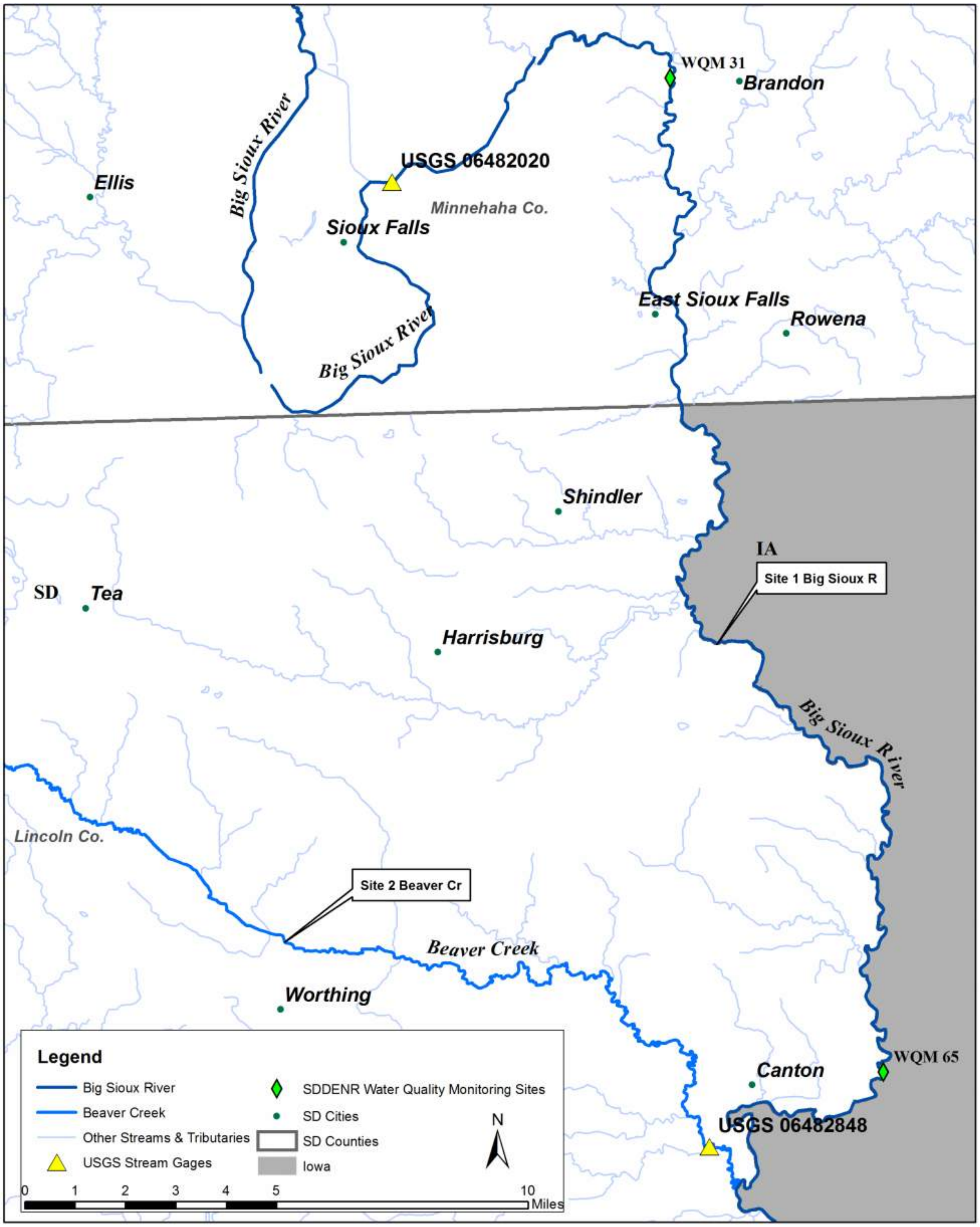
Thank you for your letter. Please let me know if you have any questions, or find any more scenarios to consider.

Sincerely,
Kathleen Grigg

Kathleen Grigg
Engineer II
Surface Water Quality Program

cc: SWD File for City of Harrisburg – SDG823728 SWD File for City of Tea – SD0021784
SWD File for City of Worthing – SD0021474

Harrisburg Tea Worthing Regional Wastewater Treatment Facility



Site 1: Big Sioux River east of Harrisburg

Predicted Effluent Flows		2015	2020	2025	2030	2035	2040
gpd		1,277,336	1,615,672	2,026,298	2,488,490	3,013,578	3,613,695
cfs		1.98	2.50	3.14	3.85	4.66	5.59
Predicted Effluent Limits		**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Ammonia (mg/L)	Daily Max	6.6	2.5	2.2	2.1	2.5	2.2
	30-Day Av	1.0	0.5	0.4	0.5	0.6	0.5
TSS (mg/L)	Max 7-Day Av	45	Based on Secondary Treatment Standards.				
	30-Day Av	30	Based on Secondary Treatment Standards.				
BOD_5 (mg/L)	Max 7-Day Av	45	Based on Secondary Treatment Standards.				
	30-Day Av	30	Based on Secondary Treatment Standards.				
pH (su)	Daily Max	9.0	Based on (5) classification.				
	Daily Min	6.5	Based on (5) classification.				
E. coli (#/100mL)	Daily Max	235	Effective May-September, limit based on (7) classification.				
	30-day Geo Mean	117	Effective May-September; limit based on antidegradation.				
DO (mg/L)	Daily Min	5.0	Based on (5) classification.				
Temp. (°C)	Daily Max	32.2	Based on (5) classification.				
	30-Day Av	Monitor					
Nitrate (mg/L)	Daily Max	Monitor					
	30-Day Av	Monitor					
Total P (mg/L)	Daily Max	Monitor					
	30-Day Av	Monitor					

- According to SDSWQS 74:51:03:07, Big Sioux River is classified for the following beneficial uses at the proposed discharge site: (5) Warmwater semipermanent fish life propagation waters; (7) Immersion recreation waters; (8) Limited contact recreation waters; (9) Fish and wildlife propagation, recreation, and stock watering waters; and (10) Irrigation waters.
- The Secondary Treatment Standards for municipal wastewater treatment listed in SDSWQS 74:52:06 are applicable.
- Ammonia limits were calculated monthly. Presented in the table above are the most stringent monthly limits for the given year. The 2015 30-day average is based on annual antidegradation; all other 30-day averages are based on the new proposed ammonia standards. The 2015 daily maximum is based on the current ammonia standards; all other daily maximums are based on the new proposed ammonia standards. Note that the 2035-2040 limits are greater than those before; this is due to simplified mixing assumptions for dilution based on the effluent to receiving stream ratio. Mixing modeling of the effluent and Big Sioux River would be incorporated in the final effluent limits development for this scenario.

Site 2: Beaver Creek North of Worthing

Predicted Effluent Flows		2015	2020	2025	2030	2035	2040
gpd		1,277,336	1,615,672	2,026,298	2,488,490	3,013,578	3,613,695
cfs		1.98	2.50	3.14	3.85	4.66	5.59
Predicted Effluent Limits		**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Ammonia (mg/L)	Daily Max	4.5	1.4	1.3	1.2	1.2	1.2
	30-Day Av	0.7	0.3	0.3	0.3	0.3	0.3
TSS (mg/L)	Max 7-Day Av	45	Based on Secondary Treatment Standards.				
	30-Day Av	30	Based on Secondary Treatment Standards.				
BOD_5 (mg/L)	Max 7-Day Av	45	Based on Secondary Treatment Standards.				
	30-Day Av	30	Based on Secondary Treatment Standards.				
pH (su)	Daily Max	9.0	Based on (6) classification.				
	Daily Min	6.0	Based on (6) classification.				
E. coli (#/100mL)	Daily Max	1178	Effective May-September, limit based on (8) classification.				
	30-day Geo Mean	392	Effective May-September; limit based on antidegradation.				
DO (mg/L)	Daily Min	5.0	Effective May-September; limit based on (6) classification.				
	Daily Min	4.0	Effective October-April; limit based on (6) classification.				
Temp. (°C)	Daily Max	32.2	Based on (6) classification.				
	30-Day Av	Monitor					
Nitrate (mg/L)	Daily Max	Monitor					
	30-Day Av	Monitor					
Total P (mg/L)	Daily Max	Monitor					
	30-Day Av	Monitor					

- According to SDSWQS 74:51:03:07, Beaver Creek is classified for the following beneficial uses at the proposed discharge site: (6) Warmwater marginal fish life propagation waters; (8) Limited contact recreation waters; (9) Fish and wildlife propagation, recreation, and stock watering waters; and (10) Irrigation waters.
- The Secondary Treatment Standards for municipal wastewater treatment listed in SDSWQS 74:52:06 are applicable.
- Ammonia limits were calculated monthly. Presented in the table above are the most stringent monthly limits for the given year. The 2015 30-day average is based on annual antidegradation; all other 30-day averages are based on the new proposed ammonia standards. The 2015 daily maximum is based on the current ammonia standards; all other daily maximums are based on the new proposed ammonia standards.

APPENDIX B

OPERATION AND MAINTENANCE (O&M) COSTS

Opinion of Probable Operation and Maintenance Costs

BANNER
engineering a better community

Location:	Harrisburg, SD
Date:	November 8, 2017
Project:	Harrisburg VE Study
	BAI 22641.00

Cost per Item		
Power Costs	$ 0.10	per KW-hr
Labor Costs (Operator)	$ 62.00	per hour
Labor Costs (Office Manager)	$ 77.00	per hour
Ferric Chloride	$ 1.70	per gallon
Methanol	$ 1.50	per gallon
Polymer	$ 2.00	per gallon
Sludge Loading, Land Application and Incorporation	$ 6.00	per Tons (wet)
Sludge Hauling	$ 1.00	per ton-miles
Water	$ 5.76	per 1,000 gal
Filters	$ 80	per change
Oil	$ 70	per change
Belts	$ 250	per change

	Required Operational Information						Annual Cost					
	Quantity	Value	Units	Total	Hours of Operation per day	kW-hrs./day	Alt. 2.1: SBR	Alt. 2.2: Oxidation Ditch	Alt. 2.3: Sequox-Aeromod	Alt. 3.1: Partial Pumping to Sioux Falls	Alt. 3.2: Complete Pumping to Sioux Falls	Alt. A: IFAS
Labor												
Partial Pumping Labor - 1 full-time staff	1	40	hours/week	2,080						$ 128,960		
Complete Pumping Labor - 0.5 full-time staff	0.5	40	hours/week	1,040							$ 64,480	
WWTF Labor - 3 full-time staff	3	40	hours/week	6,240			$ 386,880	$ 386,880	$ 386,880			$ 386,880
WWTF Labor - 1 Plant Superintendent	1	40	hours/week	2,080			$ 160,160	$ 160,160	$ 160,160			$ 160,160
Labor Total							**$ 547,040**	**$ 547,040**	**$ 547,040**	**$ 128,960**	**$ 64,480**	**$ 547,040**
Utilities												
Grit Removal Mechanism	2	1.0	HP	2	24	36	$ 1,307	$ 1,307	$ 1,307			$ 1,307
Grit Transfer Pump	2	7.5	HP	15	24	269	$ 9,802	$ 9,802	$ 9,802			$ 9,802
Grit Classifier	2	1.0	HP	2	24	36	$ 1,307	$ 1,307	$ 1,307			$ 1,307
Rotary Fed Drum Screen	2	2.0	HP	4	24	72	$ 2,614	$ 2,614	$ 2,614	$ 2,614	$ 2,614	$ 2,614
Screenings Conveyor/Compactor	2	2.0	HP	4	24	72	$ 2,614	$ 2,614	$ 2,614	$ 2,614	$ 2,614	$ 2,614
SBR												
Mixer	2	25.0	HP	50	12	448	$ 16,337					
Blower	2	50.0	HP	100	12	895	$ 32,675					
Sludge Wasting Pumps	1	2.0	HP	2	0.67	1	$ 36					
Post Equalization (Aerated)												
Blower/Mixer						198	$ 7,238					
Aerobic Digester												
Blower						536	$ 19,564	$ 19,564	$ 19,564			$ 19,564
Mixer						446	$ 16,279	$ 16,279	$ 16,279			$ 16,279
AeroMod-Sequox - 75% of full load	1	163.0	HP	163	24	2189			$ 79,890			
Oxidation Ditch	1	119.0	HP	119	24	1598		$ 58,325				
IFAS System	2	75.0	HP	150	24	2014						$ 73,518
Surface Aeration	1	166.5	HP	166.5	24	2236				$ 81,605		
UV Power Consumption (hrs. of use)	5040	6.0	kW/hr.	9072			$ 907	$ 907	$ 907	$ 907	$ 907	$ 907
Utilities Total							**$ 110,681**	**$ 112,719**	**$ 134,284**	**$ 87,740**	**$ 6,135**	**$ 127,913**
Solids Handling												
Ferric Chloride for Phosphors Removal	1	4.8	gal/day	1752			$ 2,978					
Belt Filter Press Electrical Usage	392		kW/month	392		13	$ 470	$ 470	$ 470			$ 470
Polymer Feed	79		gal/month	79			$ 1,896	$ 1,896	$ 1,896			$ 1,896
Polymer Metering Pump	1	0.5	HP	0.5	6	2	$ 82	$ 82	$ 82			$ 82
Washwater	7275		gal/day (10 days/month)	873000			$ 5,028	$ 5,028	$ 5,028			$ 5,028
Flash Mixing Tanks	3	0.2	kW	0.6	6	3	$ 98	$ 98	$ 98			$ 98
Flocculation Tank	3	0.75	kW	2.25	6	10	$ 368	$ 368	$ 368			$ 368
Sludge Loading, Land Application and Incorporation			Tons (wet)				$ 7,703	$ 7,703	$ 7,703			$ 7,703
Sludge Hauling			ton-miles				$ 10,270	$ 10,270	$ 10,270			$ 10,270
Solids Handling Total							**$ 28,893**	**$ 25,915**	**$ 25,915**	**$ -**	**$ -**	**$ 25,915**
Testing												
Laboratory Testing							$ 12,000	$ 12,000	$ 12,000	$ 1,500	$ 1,500	$ 12,000
Supplies/Testing Total							***$ 12,000***	***$ 12,000***	***$ 12,000***	***$ 1,500***	***$ 1,500***	***$ 12,000***
Equipment												
Equipment/Pumps							$ 407,622	$ 435,376	$ 388,199	$ 151,722	$ 106,818	$ 385,081
Lamp Replacement	5	$377.00	per lamp	$ 1,885.00			$ 1,885	$ 1,885	$ 1,885			$ 1,885
Equipment Total							***$ 409,507***	***$ 437,261***	***$ 390,084***	***$ 151,722***	***$ 106,818***	***$ 386,966***
Subtotal							*$ 1,108,122*	*$ 1,134,935*	*$ 1,109,324*	*$ 369,922*	*$ 178,933*	*$ 1,099,834*
Contingency (20%)							$ 221,624	$ 226,987	$ 221,865	$ 73,984	$ 35,787	$ 219,967
TOTAL =							**$ 1,329,746**	**$ 1,361,922**	**$ 1,331,188**	**$ 443,907**	**$ 214,719**	**$ 1,319,800**