



**To:** Mayor and City Council  
**From:** John Dunn  
**Date:** May 5, 2023  
**Subject:** Evaluation of Nutrient Reduction Modifications -  
Cost Escalation Factor

**At the April 11, 2023, City Council meeting, Council tabled two agenda items related to the Water Pollution Control Facility's Nutrient Reduction Modifications Project. The first item requested Council's approval of the Facility Plan. The second item requested Council's approval of an amendment to the professional services agreement with Strand Associates for additional design services related to the proposed demolition and reconstruction of the Administration Building and to the change to proceeding in two construction phases instead of three.**

**The motion to table was to allow staff an opportunity to provide Council with additional information on the cost escalation factors used to translate current day construction cost estimates to bid day estimates.**

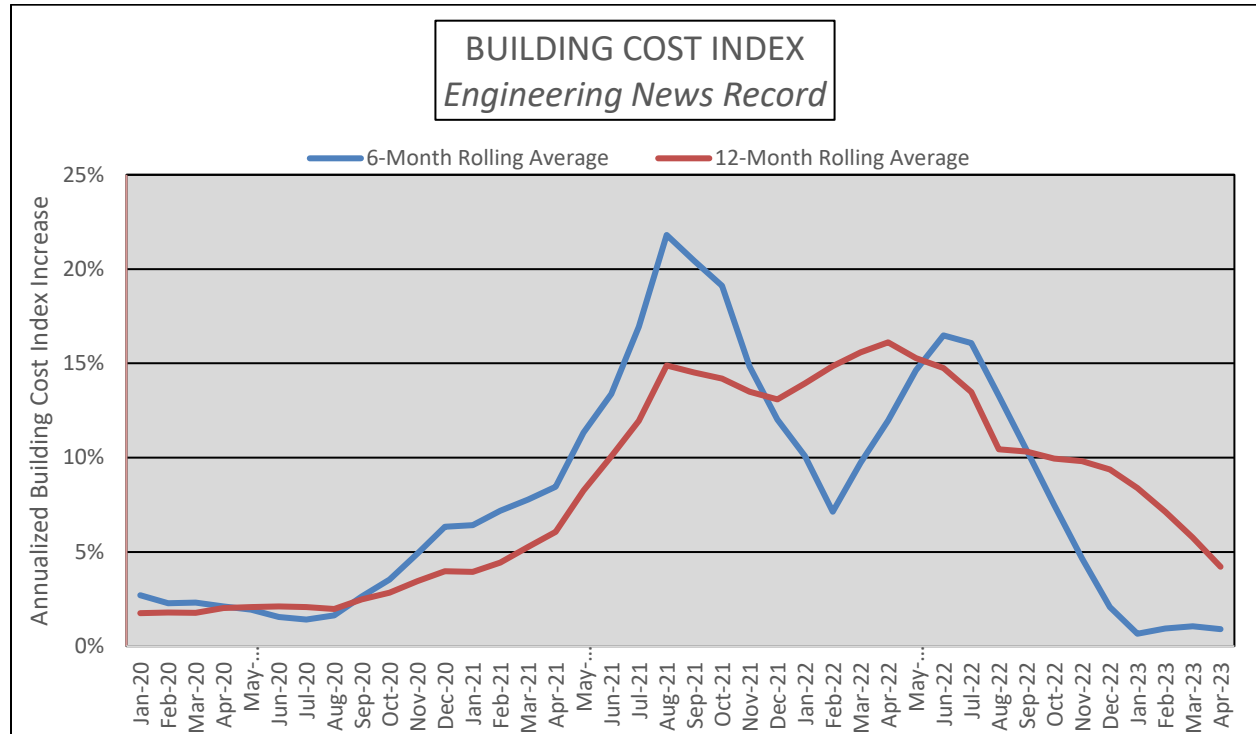
The graph at the top of the following page shows the 6-month and 12-month rolling averages in the "Building Cost Index (BCI)" from Engineering News Record. The BCI includes a mix of skilled labor, steel, cement, and lumber prices, and is a commonly used measure for tracking trends in construction costs. The graphic clearly depicts the high inflation rates experienced in 2021 and 2022. It also shows that the rate of increase in construction costs have slowed substantially in the past six months. Some things to note from the BCI include:

- The BCI forecast for calendar year 2023 is 3.8%.
- The rolling average for May 2022 to April 2023 is 2.8%.
- The average over the past 25 years is 3.5%.
- The current 10-year average is 5.3%; the highest 10-year average since 1990.

For comparison, the Sewer Rate Model that City staff uses to project rates over the coming ten years uses an inflation assumption of 3.5% for capital expenses. Operating and Maintenance

expenses in the model look backwards at the trend over the past 6 years to project those expenses forward for the next 10 years.

**Graph 1: Building Cost Index**



Strand Associates, the consultant on the nutrients project, prepared the following updated cost estimate for the Nutrient Reduction Modifications Project, **expressed in April 2023 dollars in Table 1 below**. Their cost opinion includes both a two-phased construction estimate and, at Council’s request, an estimate to proceed with the entire project in a single large construction phase.

**Table 1: Updated Cost Estimates in April 2023 Dollars**

	Two-Phase Implementation	One-Phase Implementation
<b>Phase 1</b>	\$50,000,000	\$79,900,000
<b>Phase 2</b>	\$31,400,000	-
<b>Total</b>	\$81,400,000	79,900,000

As a conservative projection, Strand utilized the current 12-month rolling BCI of 5.3% to develop the following estimates (Table 2) projected to bid day, which is currently anticipated to be in March 2024 for the two-phase option, and June 2024 for a single-phase option.

**Table 2: Cost Estimates inflated by 5.3% to Bid Day**

	Two-Phase Implementation With Two Activated Sludge Trains in First Phase	One-Phase Implementation
Phase 1	\$51,970,000 (1st Quarter 2024 Bid Date)	\$84,130,000 (2 <sup>nd</sup> Quarter 2024 Bid Date)
Phase 2	\$58,350,000 (1 <sup>st</sup> Quarter 2035 Bid Date)	

*NOTE: The discussion that follows utilizes the 10-year rate model staff developed for projecting sewer rates. When projecting ahead 10 years, there are numerous estimates and assumptions that need to be made. It is important to keep in mind the quote by British statistician George Box who famously noted; “All models are wrong; but when carefully prepared, some can be useful.”*

Table 3 below shows the potential rate implications of having the first phase of a two-phase project increase from \$45.28 million on bid day (as shown in the FY 2023-2028 CIP) to a \$51.97 million project on bid day (current engineer’s estimate). That cost change would require an additional 2% be added to the projected rate increase in FY 2024/2025.

**Table 3: Rate Impact of Changed Project Cost Estimates**

	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31	31-32	32-33
\$45.28M		7%		9%		9%		9%		9%
\$51.97M		9%		9%		9%		9%		9%

Table 4 shows a comparison of the rates needed if the rate of inflation assumed in the model for all capital improvements plan projects were to be varied.

- The first line assumes a rate of 3.5% over the next ten years. This is the 25-year average increase in the BCI discussed above, and is the inflation forecast that staff has used for many years when developing the CIP and rate model.
- The second line assumes a rate of 5.3%, the current ten-year average of the BCI. This is the percentage recommended by the consultants.
- The third line assumes a rate of 7.5%, simply to give Council an additional point of reference.

**Table 4: Rate Impact of Changed Project Cost Estimates (All assume a two-phase project)**

	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31	31-32	32-33
3.5%		9%		9%		9%		9%		9%
5.3%		13%		13%		13%		13%		13%
7.5%		19%		18%		18%		18%		18%

The final comparison developed by staff is shown in Table 5. This table estimates the rates needed if the Nutrient Reduction Modifications Project were to proceed as a single, large project as opposed to two phases separated by 12 years. It used the \$79.9 million estimate from Strand shown in Table 1 as the current day estimate that was then inflated forward to bid day using the following BCI factors.

**Table 5: Single Phase \$79.9 Million Project**

	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31	31-32	32-33
3.5%		13%		12%		12%		12%		12%
5.3%		17%		16%		16%		16%		16%
7.5%		21%		21%		21%		21%		21%

After reviewing the data reflected above, staff believes the best course of action given the impact on water rates would still be to proceed with a two phase approach to accomplishing the project as previously recommended in the April 11, 2023 Council Action Form (See Attachment) However, the projected cost of Phase 1 has been adjusted to project for a March 2024 bid date, rather than as previously shown in 2022 dollars.

Because Phase 2 will not occur for twelve years, staff does not believe the City Council should rely on those projections for estimated total project costs or impact on user rates for the second phase.

In addition, as indicated in the companion Council Action Form regarding a change order to Strand Associates, an effort will be made to value engineer the project in effort to reduce the cost of both phases.

ITEM #: 29  
DATE: 04-11-23  
DEPT: W&PC

**COUNCIL ACTION FORM**

**SUBJECT: NUTRIENT REDUCTION MODIFICATIONS FACILITY PLAN APPROVAL**

**BACKGROUND:**

In early 2019, Council approved the results of a Nutrient Reduction Feasibility Study (referred to as the “2019 Study”). The study recommended the following course of action.

*“The Ames WPCF Nutrient Reduction Feasibility Study recommends an integrated strategy that ... would transition the Ames WPCF from an existing trickling filter/solid contact process to a future biological nutrient reduction process...”*

In June 2022, Council awarded a professional services agreement with Strand Associates for the design of Phase 1 of the modifications. The conceptual design process has now been completed, and the results are documented in a formal Nutrient Reduction Facility Plan (referred to as the “Facility Plan”). This document is required by the Iowa Department of Natural Resources (DNR) in its construction permitting process, and submitting it to the DNR is a key step in being eligible for funding through the Clean Water State Revolving Fund (SRF).

What follows this Council Action Form is a summary of key conclusions and recommendations from the completed Facility Plan. The full document (228 pages) is available on the City website at [www.cityofames.org/nutrients](http://www.cityofames.org/nutrients).

**The cost estimates presented in the Facility Plan now indicate a total cost of \$80,010,000 as compared to the \$77,900,000 cost estimate shown in the 2023-2028 Capital Improvements Plan that were used in preparing the most recent Sewer Fund rate model.** As the design work continues and construction details are further developed, the cost estimates will continue to be refined.

**FACILITY PLAN CONCLUSION:**

**The final conclusion and recommendation of the Facility Plan is that the City pursue construction of a Biological Nutrient Removal facility utilizing a Simultaneous Nitrification Denitrification (BNR-SNDN) process. The screening and grit removal processes require replacement of equipment at the end of its useful life and to expand the hydraulic capacity of the facility. In accordance with the plan, the existing Administration Building would be demolished to allow the new aeration basins to be constructed in close proximity to the final clarifiers, and a new Administration Building constructed to the northeast of its current location.**

**The project is necessary to meet future nutrient limits and expands plant capacity from 20.4 million gallons per day (MGD) to 24.5 MGD to meet the 20-year flows and loadings as required by Iowa DNR and to allow for City growth. Rather than**

proceeding with three phases, the current recommendation calls for construction in two phases, with the detailed final design of Phase 1 beginning immediately. A final completion date for Phase 2 of 2039 was submitted by the City in April 2019 and approved by the Iowa DNR in December 2019. Therefore, Phase 2 should be planned and budgeted such that construction can be completed in 2038, allowing one year of operation prior to the 2039 final completion date.

### **ALTERNATIVES:**

1. Approve the Nutrient Reduction Facility Plan and direct staff to submit it to the Iowa Department of Natural Resources.

**Like the 2019 Study, by submitting this plan the City is committing to implement the project as generally described in the Facility Plan.**

2. Direct staff to make changes to the conceptual design and prepare a revised Facility Plan prior to submission to the Iowa Department of Natural Resources.
3. Take no action.  
This would table the project, and during the next permit cycle in three years would likely result in a violation of the facility's discharge permit and enforcement action by the Iowa DNR. Those violations would be due both to failure to achieve the nutrient limits as well as from reasonably predictable process failures caused by equipment exceeding its useful life.

### **CITY MANAGER'S RECOMMENDED ACTION:**

In 2019, Council accepted the recommendation of a feasibility study that looked at options to convert the Water Pollution Control Facility to a biological nutrient reduction process and achieve the goals of the Iowa Nutrient Reduction Strategy. The conceptual design work that has been completed is the first step towards that eventual goal.

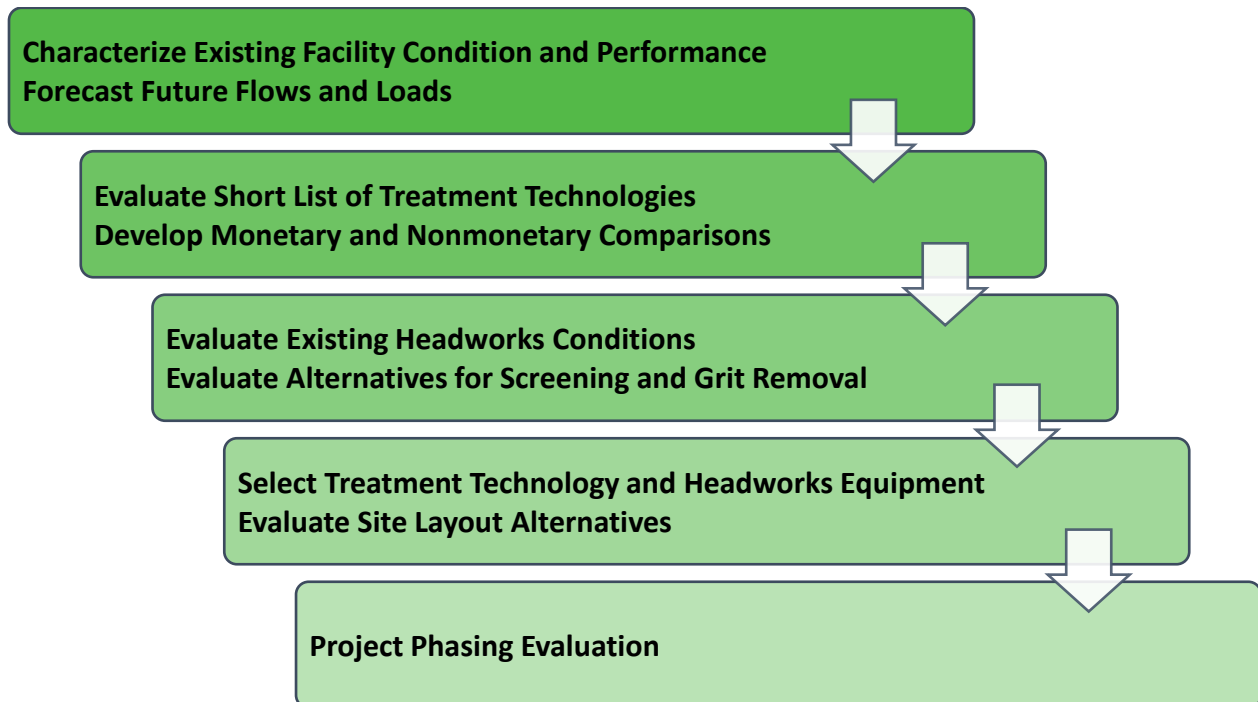
The Facility Plan generally follows the 2019 recommendations, only with the work split into two phases instead of three. It also incorporates the Headworks Modifications CIP Project, and incorporates a demolition and reconstruction of the Administration Building in lieu of the Administration Building Renovation that was shown in the 2022-2027 WPC Facility Improvements CIP Project.

**The cost estimates in the Facility Plan are within 2.7% of the totals reflected in the 2023-2028 Capital Improvements Plan and, therefore, will not result in any change to our projected rates to finance this project. The Facility Plan is now ready to be submitted to the Iowa DNR. Therefore, it is the recommendation of the City Manager that the City Council adopt Alternative No. 1, as described above. Council should be aware that submission of the Facility Plan to the Iowa DNR will again commit the City to proceeding with the Nutrient Reduction Modifications.**

## Summary of Key Findings and Conclusions Report for City of Ames, Iowa - Nutrient Reduction Facility Plan

### **FACILITY PLAN PROCESS**

The Facility Plan was developed through a sequence of five individual technical memoranda (TMs), each building on the decisions and conclusions reached in the prior TM. The process followed this general outline:



The completed Facility Plan is the compilation of the five individual technical memoranda. When reviewing the detailed cost information in the Facility Plan, it should be noted that the details continued to be refined as the process proceeded, and the cost estimates were continually revised. As a result, there are slight differences in the costs between successive tech memos. The cost estimates shown near the end of this summary are the most up-to-date estimates.

### **KEY DRIVERS FOR THE PROJECT**

- **Iowa Nutrient Reduction Strategy** (Section 5)  
The City completed a Nutrient Reduction Feasibility Study in 2019 (“2019 Study”) that recommended a phased transition to an advanced activated sludge treatment process over a period of 20 years. The recommendation was approved by the City Council on February 26, 2019, along with direction to staff to submit the study to the Iowa Department of Natural Resources. The alternative adopted by Council noted that **“Once reviewed and accepted by the Iowa Department of Natural Resources, the City will be committed to implementing the treatment works**

**modifications recommended in the report.”** The study was submitted to the state on April 29, 2019, and was subsequently approved by the Iowa DNR on December 20, 2019.

Because the final compliance date (2039) is beyond the expiration date of the current National Pollutant Discharge Elimination System (NPDES) permit for the WPCF, the current permit simply requires that the City provide an update to the DNR on “...progress towards completion of the projects identified in the City’s approved feasibility plan...” Discharge limits for total nitrogen (Total N) and total phosphorus (Total P) will not be applicable until after all modifications have been complete and one year of operating data has been collected.

- **Condition of Existing Infrastructure** (Section 6)

The other key driver for the project is the condition and remaining useful life of the four trickling filters. As noted in the 2019 Study, the media in the trickling filters are now 35 years old and are beyond their anticipated useful life of 25-30 years. Replacing the media is anticipated to cost in excess of \$10 million. Additionally, trickling filters are not able to be adapted to nutrient removal, as their primary function is to remove carbon from the wastewater, and carbon is vital to biological nutrient removal. Replacement capacity is needed for the trickling filters, and investing in replacement media knowing that the filters cannot function in a nutrient removal treatment scheme was deemed in staff’s professional judgment to be a poor investment.

## **FLOW AND LOAD DESIGN CAPACITY** (Section 4)

Planning appropriate capacity is a crucial part of a facility plan such as this. The consultants utilized the Ames Plan 2040 to establish the projected population and mix of customer types that the facility should be designed to accommodate. Those projections from Ames Plan 2040 were then extrapolated to the year 2045 to provide a full 20-year design life for the project. The 2045 design population used for the Facility Plan was 83,850.

The consultants used several different metrics to then convert the population estimate into a projected flow rate and organic loading rate. These flows and loads form the basis for designing the treatment processes. A reserve industrial capacity was also included in the 2045 design parameters that increased the design flow rate by 1.50 million gallons per day with a corresponding organic load allowance.



Parameter	Original Design (Design Year 2010)	New Design (Design Year 2045)
Maximum Wet Weather Flow, million gallons per day	20.4	24.5
Biochemical Oxygen Demand, BOD <sub>5</sub> , pounds per day	23,740	26,710
Total Suspended Solids, TSS, pounds per day	25,440	52,250
Ammonia-Nitrogen, NH <sub>3</sub> -N, pounds per day	3,850	3,430
Total Kjeldahl Nitrogen, TKN, pounds per day	6,930	5,330
Total Phosphorus, TP, pounds per day	--	740

### **NUTRIENT REDUCTION TECHNOLOGY** (Section 7)

The 2019 Study shortlisted three technologies as being reasonably viable alternatives, and concluded that the actual technology selection should be made during design of the first phase to allow new and emerging technologies time to further mature. Those same three technologies were evaluated in more detail in the current Facility Plan. They include:

- Conventional biological nutrient removal (BNR) activated sludge
- Simultaneous nitrification-denitrification (SNDN) activated sludge
- Aerobic Granular Sludge (AGS)

The consulting team used Ames-specific wastewater data and computer modeling to appropriately size equipment and basins to achieve the discharge limits required under the Iowa Nutrient Reduction Strategy. Each of the technologies was then able to be compared based on its anticipated capital and operating costs.

	Alternative BNR1	Alternative BNR2	Alternative BNR3a	Alternative BNR3b
	Conventional BNR Activated Sludge	SNDN Activated Sludge	AGS with Primary Clarification	AGS without Primary Clarification
Capital Costs	\$62,610,000	\$63,330,000	\$78,330,000	\$79,650,000
Annual O&M Costs	\$296,000	\$264,000	\$255,000	\$249,000

Note that the pricing in the table above does not include the headworks modification. That pricing was developed in a subsequent technical memorandum.

A nonmonetary evaluation was also performed using the following factors. The definitions of each factor and discussion relative to each alternative are contained in Section 7 of the Facility Plan ([www.cityofames.org/nutrients](http://www.cityofames.org/nutrients)).

1. Treatment Performance (10%)
2. Resiliency to Changing Conditions and Process Upsets (9%)
3. Safety (8%)
4. Operational Complexity (8%)
5. Maintenance Requirements (8%)
6. Peak Flow Handling (8%)
7. Adaptability for Future Regulations (7%)
8. Implementation and Constructability (7%)
9. Solids Handling Impacts (7%)
10. Expandability (7%)
11. Environmental Impacts (7%)
12. Flexibility (6%)
13. Social Impacts (4%)
14. Public Acceptance (4%)

	Alternative BNR1	Alternative BNR2	Alternative BNR3a	Alternative BNR3b
	Conventional BNR Activated Sludge	SNDN Activated Sludge	AGS with Primary Clarification	AGS without Primary Clarification
Total Nonmonetary Score (out of 50)	42.7	43.2	46.5	45.2

**After considering both the monetary and nonmonetary evaluations, staff recommended proceeding with “Alternative BNR2 - SNDN Activated Sludge.”**

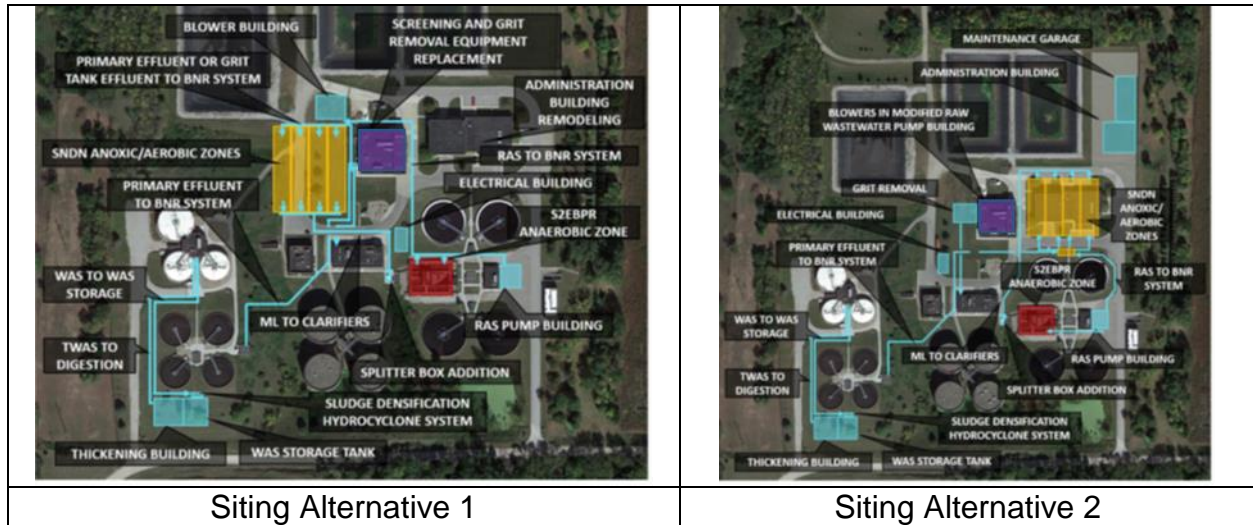
### **SITE LAYOUT EVALUATION** (Section 10)

The initially assumed site layout was configured based on available space without the demolition or relocation of significant structures or buildings. However, these limitations would place the aeration basins in an area that had significant drawbacks:

- It would require the relocation of substantial existing underground utilities
- It would involve extensive construction into the hillside below the digesters
- It left little to no adjacent space for future expansions.

The Administration Building currently sits on level ground adjacent the final clarifiers. Since a reinvestment into the Administration Building was already budgeted (2022-2027 WPC Facility Improvements CIP Project), the possibility of relocating the Administration Building and putting the remodel budget towards the cost of reconstructing the building was deemed worth consideration. Two alternatives were evaluated:

- Alternative 1 would place the aeration basins (shown in yellow in the aerial photos that follow) to the west of the Raw Wastewater Pump Station (shown in purple in the aerial photos).
- Alternative 2 would place the aeration basins to the east of the Raw Wastewater Pump Station where the Administration Building currently sits, with the Administration Building relocated to the northeast.



The cost comparison for Alternative 1 includes the costs budgeted in a separate project for the renovation of the Administration Building. There was an incremental cost of \$4.55 million to relocate the Administration Building versus renovating the existing building. But that was partially offset by a \$3.67 million reduction in the cost of the nutrient modifications. **Due primarily to the increased flexibility for future expansions, staff has recommended Siting Alternative 2.**

	Siting Alternative 1– New Activated Sludge System West of Raw Wastewater Pump Station	Siting Alternative 2– New Activated Sludge System At Location of Existing Administration Building
Simultaneous nitrification-denitrification (SNDN)	\$63,330,000	\$61,480,000
Other Project Components	\$19,660,000	\$22,390,000
<b>Total Opinion of Capital Costs</b>	<b>\$82,990,000</b>	<b>\$83,870,000</b>

### PROJECT PHASING EVALUATION (Section 11)

As mentioned previously, the 2019 Study recommended implementation in three phases over 20 years. The main driver to move forward with the early phases was the aging trickling filter media. The reason for recommending a phased approach was to spread out the rate impacts by allowing other infrastructure components to remain in use for as

long as possible. The ultimate compliance with the Iowa Nutrient Reduction Strategy was to be within 20 years (in the year 2039).

The Sewer Fund rate projections prepared over the past few years have been built on the concept of a three-phase implementation, with Phase 1 occurring in the first five years, Phase 2 occurring in the second five years, and Phase 3 in the final 10 years. Timing of the Headworks Modifications was shown as being concurrent with the first phase.

In the Facility Plan, a two-phase implementation was considered. The evaluation was intended to determine if the overall cost could be reduced without a detrimental impact on sewer rates by combining the scope of the first two phases, and completing the modifications in a second phase that would be deferred for approximately 12 years.

Capital Costs	Phasing Alternative 1 Three-Phase Implementation with One Activated Sludge Train in First Phase	Phasing Alternative 2 Two-Phase Implementation with Two Activated Sludge Trains in First Phase
Phase 1	\$40,690,000	\$49,780,000
Phase 2	\$10,340,000	\$30,230,000
Phase 3	\$32,840,000	--
<b>Total</b>	<b>\$83,870,000</b>	<b>\$80,010,000</b>

**Staff is recommending Phasing Alternative 2.** Deferring a second phase until approximately 12 years from now (design in FY 2035/36 and construction in FY 2036/37 and FY 2037/38) would still allow for more than a year of operational optimization before the 20-year completion target that the City committed to in the 2019 Feasibility Study and that was approved by the Iowa DNR. It adds increased capacity for growth on a quicker timeline than Alternative 1, allows sewer rate projections that are identical to those presented to Council in early 2022, and has an overall capital cost savings of more than \$3 million.

## CONCLUSION AND RECOMMENDATION

The analysis conducted in the Facility Plan results in the following final conclusions and recommendations:

1. The City should pursue construction of a Biological Nutrient Removal facility utilizing a Simultaneous Nitrification Denitrification (BNR-SNDN) process.
2. The existing Administration Building should be demolished to allow the new aeration basins to be constructed in close proximity to the final clarifiers, and a new Administration Building constructed to the northeast of its current location.

3. The project should be constructed in two phases, with the detailed final design of Phase 1 beginning immediately. Phase 2 should be planned and budgeted such that construction can be completed in 2038, allowing one year of operation prior to the 2039 final completion date submitted by the City in April 2019 and approved by the Iowa DNR in December 2019.