2020 FACILITY PLAN
WASTEWATER TREATMENT PLANT

Villa Grove, Douglas County, Illinois

Project No.: 19-406

November 5, 2020

FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

1610 Broadmoor Drive

Champaign, Illinois 61821

Prepared for:

City of Villa Grove

120 North Main Street

Villa Grove, Illinois 61956

TABLE OF CONTENTS

TABLES

EXHIBITS

TERMINOLOGY

Activated Sludge – A wastewater treatment process wherein a mixed microbial population in a liquid suspension removes oxygen demanding substances and solids from wastewater in an aerobic environment. Also, referred as Conventional Activated Sludge (CAS).

Aerobic Digestion – Microbial decomposition of wastewater sludge in the presence of oxygen.

Anaerobic Digestion – Microbial decomposition of wastewater sludge in the absence of oxygen.

Base Flow – As used in this report, this represents the lower limit of the wastewater flow curve, corresponding to the flows for non-rainfall days.

Biochemical Oxygen Demand (BOD) – A measurement of the oxygen utilized in the stabilization of the organic matter present in wastewater by microorganisms.

Biosolids (or Sludge) – Concentrated organic solids produced during wastewater treatment.

Bypass – A device and/or pipeline within a sewer system that allows the discharge of wastewater to natural water courses. A bypass diverts wastewater flows away from or around pumping or treatment facilities to prevent the surcharging of or adverse operation or performance of these facilities.

Carbonaceous Biochemical Oxygen Demand (CBOD) – A measurement of oxygen utilized for the biological oxidation of carbon-containing compounds present in wastewater by microorganisms.

Collection System – A system of manholes, sewers and pumping facilities that transport wastewater from points of origin to the wastewater treatment plant, or other disposal units.

Combined Sewer – A sewer intended to serve as a sanitary or industrial sewer and a storm sewer.

TERMINOLOGY

Denitrification – A biological process whereby bacteria in an anoxic environment convert nitrite and nitrate formed during the nitrification process to elemental nitrogen gas. The denitrification process is used when nitrogen must be removed from the wastewater.

Excessive Infiltration/Inflow – The quantities of Infiltration/Inflow that can be eliminated economically from a sewer system by rehabilitation, as determined by an economic analysis that compares the cost for correcting the Infiltration/Inflow conditions with the total costs for transportation and treatment.

Exfiltration – The leakage or discharge of flows being carried by a sewer out into the ground through leaks in pipes, joints, manholes, or other sewer system structures; the reverse of "infiltration."

Extended Aeration – An activated sludge process variation in which long detention times result in wastewater nitrification and substantial reduction in the quantity of sludge produced.

Infiltration – Ground water entering a sewer system, including building sewers, through such means as defective pipes, pipe joints, connections, or manhole walls.

Inflow – Storm runoff discharged into a sewer system, including building sewers, from such sources as roof leaders; cellar, yard, and area drains; foundation drains; cooling water discharges; drains from springs and swampy areas; manhole covers; cross connections from storm sewers and combined sewers; catch basins; inlets and other sources of drainage.

Infiltration/Inflow (I/I) – A combination of infiltration and inflow volumes in sewer lines, with no way to distinguish either of the basic sources, and with the same effect of usurping the capacities of sewer systems and other sewer system facilities.

Lift Station – A pumping facility that collects wastewater at low elevations and lifts the wastewater to portions of the collection system at a higher elevation.

TERMINOLOGY

Microorganisms – Microscopic organisms.

Nitrification – A two-phase biological process whereby bacteria convert ammonia to nitrate in an aerobic environment.

Nitrogenous Biochemical Oxygen Demand (NBOD) – A measurement of the oxygen utilized for the biological oxidation of nitrogenous material.

Overflow – A diversion device, allowing the discharge of portions of combined sewer flows to receiving waters or other points of disposal, thereby preventing or reducing surcharge of sewer lines, pumping, and/or treatment facilities. Overflow is often used interchangeably with "bypass." Also referred as Combined Sewer Overflow (CSO).

Sanitary Sewer – A sewer intended to carry only sanitary and industrial wastewaters.

Single Sludge Secondary System – An advanced treatment process that consists of multiple aerobic, anoxic and anaerobic zones in series and provides biological nutrient removal.

Storm Sewer – A sewer intended to carry only stormwaters, surface runoff, street washwaters, and drainage.

Surcharge – When the sewer flow exceeds the hydraulic carrying capacity of the sewer line.

Theoretical Wastewater Flow – The rate of wastewater flow in a sewer system if there is no infiltration/inflow. Usually, the theoretical wastewater flow is estimated from the water consumption data.

Total Suspended Solids (TSS) – Particulate matter suspended in wastewater.

Volatile Suspended Solids (VSS) – The portion of the suspended solids that is destroyed at temperatures above 550°C and is an indicator of the organic fraction of the suspended solids.

ABBREVIATIONS

Ac.	Acre
AOR	Actual Oxygen Requirements
Avg.	Average
BOD5 or BOD	Biochemical Oxygen Demand
BPWTT	Best Practical Wastewater Treatment Technology
CaCO3	Calcium Carbonate
CAS	Conventional Activated Sludge
CBOD5 or CBOD	Carbonaceous Biochemical Oxygen Demand
CCRPC	Champaign County Regional Planning Commission
CF or cu. ft.	Cubic Feet
cfm	Cubic feet per minute
cfs	Cubic feet per second
col/100 mL	Colonies (bacteria) per 100 milliliters
cfu/100 mL	Colony Forming Units/100 milliliters
CSO	Combined Sewer Overflow
CWA	Clean Water Act
ct	Counts
DAF	Design Average Flow or Daily Average Flow
Dia.	Diameter
DMF	Design Maximum Flow or Daily Maximum Flow
DMR	Daily Monitoring Report
DO	Dissolved Oxygen
DY20xx	Design Year 20xx
EPA	Environmental Protection Agency
FOG	Fats, Oils and Grease
FPA	Facilities Planning Area
°F	Degrees Fahrenheit
Ft.	Feet
FWS	Free Water Surface
gal.	Gallons
GBT	Gravity Belt Thickener
gpcd	Gallons per capita per day
gpd	Gallons per day
gpm or GPM	Gallons per minute
HP	Horsepower
Hr.	Hour
HRT	Hydraulic Retention Time
IAC	Illinois Administrative Code
IAWA	Illinois Association of Wastewater Agencies

ABBREVIATIONS

ID	Identification
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
IFAS	Integrated Fixed Film Activated Sludge
I/I	Infiltration/Inflow
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
KW	Kilowatt
Lbs. or #	Pounds
MBBR	Moving Bed Bio Reactor
MBR	Membrane Bio Reactor
MG	Million gallons
MGD	Million gallons per day
mg/L	Milligrams per liter
mL	Milliliter
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
Mo.	Month
NBOD	Nitrogenous Biochemical Oxygen Demand (also referred to as NOD)
NH3-N	Ammonia Nitrogen as Nitrogen
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
O&M&R or OMR	Operation, Maintenance and Replacement
ORP	Oxidation-Reduction Potential
OTE	Oxygen Transfer Efficiency
OTRf	Oxygen Transfer Rate at Actual Field Conditions
P.E.	Population Equivalent
pH	The negative logarithm of the hydrogen ion concentration
PLC	Programmable Logic Controller
PO4-P	Phosphates as Phosphorus
ppd	Pounds per day
PRN	Prairie Rivers Network
RAS	Return Activated Sludge
scfm	Standard Cubic Feet per Minute
SCADA	Supervisory Control and Data Acquisition
SF or sq. ft.	Square Feet
SOTE	Standard Oxygen Transfer Efficiency
SOR	Oxygen Requirements at Standard Conditions
SOTR	Oxygen Transfer Rate at Standard Conditions

ABBREVIATIONS

SS	Suspended Solids
SSES	Sewer System Evaluation Survey
STP	Sewage Treatment Plant
SUO/UCS	Sewer Use Ordinance/User Charge System
SWD	Side Water Depth
TDH	Total Dynamic Head
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACOE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet (as in UV disinfection)
VSB	Vegetative Submerged Bed
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WLA	Waste Load Allocation
WPCLP	Water Pollution Control Loan Program
WQBEL	Water Quality Based Effluent Limitation
WQM Plan	Water Quality Management Plan
WQS	Water Quality Standards
WRF	Water Reclamation Facility
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

REFERENCES

1. NPDES Permit No. IL0059005, dated July 18, 2014.
2. Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, Part 304: Effluent Standards. State of Illinois, September 30, 1994.
3. Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter II: Environmental Protection Agency, Part 365: Procedures for Issuing Loans from the Water Pollution Control Revolving Fund. State of Illinois, May 1989, Revised January 1996.
4. Title 35: Environmental Protection, Subtitle C: Water Pollution Chapter II: Environmental Protection Agency, Part 370: Illinois Recommended Standards for Sewage Works. State of Illinois, November 1997.
5. U.S. Census Bureau, 2012-2018 Census data, (www.census.gov)

1.0 EXECUTIVE SUMMARY

The purpose of this Facilities Plan is to present improvement upgrades for the WWTP owned and operated by the City of Villa Grove (City). The proposed improvements will provide greater treatment capacity, treatment reliability, energy efficiency, and higher levels of treatment that will ensure that the plant is compliant with current and future NPDES permit requirements.

1.1 Applicant and Project Information

The City, located in Douglas County, proposes to construct WWTP Improvements. The US Census Bureau utilizing American Community Survey estimates the 2018 population to be 2,332 ± 170 residents.

1.2 Project Description

The proposed improvements are designed to produce effluent phosphorous levels below 1.0 mg/L and provide denitrification capability. The WWTP consists of an influent flow equalization basin, dual activated sludge plants, rapid sand filtration, an excess flow lagoon, chlorine contact tank, stormwater clarifier, and stormwater sludge pump station. Alternative #2 is recommended, the CAS system with biological nutrient removal (BNR) WWTP improvements alternative. Phase 1 of Alternative #2 will include the continuation of chemical phosphorus removal, refurbishment of the activated sludge package plants, installation of denitrification equipment, installation of new sludge storage tanks, and refurbishment of the control building including the installation of new blowers. See Exhibit B for the project location map.

1.3 Project Justification

The plant was originally constructed around 1977. Improvements to the treatment of excess flow were made around 2001. Due to the age of the equipment, the plant is at a critical point where significant improvements need to be made to extend the service life of the treatment plant and add necessary treatment units for expected future effluent limits. Due to financial constraints, the City has elected to complete Phase 1 of the planned improvements to immediately address safety hazards and other prioritized improvements.

1.4 Estimated Construction Start/Completion Dates

October 2021 – September 2022

1.5 Project Cost Estimate

The project cost estimate for Phase 1 of Alternative #2 is $5,309,000.

1.6 Project Affordability for Residents and Utility Customers

1.6.1 Source of Loan Repayment

The City will use its sewer system funds to repay the annual debt service associated with financing the proposed project and an increase to sewer user rates will be necessary. The City will need to adopt the increase to the sewer rate ordinance as recommended in Section 8.4 of this report.

1.6.2 Current Average Monthly Residential Cost of Sewer Service

$39.23 /user

1.6.3 Proposed Average Monthly Residential Cost of Sewer Service

$58.01 / user

1.6.4 Average Monthly Residential Billed Use

3,386 gallons/user

1.6.5 Current/Proposed Monthly Rate/Cost of Service Calculation

The current rate for sewer use is $22.470 for the first 1,000 gallons and $0.730 per 100 gallons after 1,000 gallons. The proposed rates will be raised in 2021 to $23.97 for the first 1,000 gallons and $0.770 per 100 gallons. The proposed sewer user rates resulting from the rate analysis and new debt service to fund the proposed project as described herein will be $19.61 for the first 1,000 gallons and $1.134 per 100 gallons beyond the first 1,000 gallons used.

1.6.6 Number of Customers or Service Connections

1,054 users

1.6.7 Median Household Income

Current Estimate: $52,893 (2018 American Community Survey Estimate)

1.6.8 Percentage of MHI to Pay Projected Cost of Service

1.3%

1.7 **Environmental Review and Impacts**

This improvement project is expected to have a positive effect on the water quality of the Embarras River since the proposed plant improvements will enable the plant to treat wastewater to remove phosphorous and nitrate; thus, ensuring compliance with current and future NPDES permit requirements. All construction will take place on previously disturbed land within the plant site. Initial consultation with the IDNR to determine compliance with the Illinois Endangered Species Act, Illinois Natural Areas Preservation Act, and the Illinois Wetland Act, indicated protected resources present near the project. Upon further review, IDNR found that with implementation of best management practices during construction, adverse impact to rare or endangered species of animals and plants; natural areas; nature preserves; or wetlands are unlikely. Construction of the project will not impact any wetlands.

2.0 INTRODUCTION

2.1 Study Purpose and Scope

The purpose of this report is to study and evaluate the proposed plant improvements, provide recommendation, and assess the financial impacts to the City.

As noted in previous sections, this document was specifically written to improve operating conditions at the plant, while also providing information on project financing and other items that are required by the IEPA WPCLP. Therefore, the plant improvements proposed in this report will be designed to serve the expected population in the next 20-year planning period or 2040 design year.

This report does not address any future requirements beyond what was previously discussed during the 20-year planning period. Towards the end of this 20-year planning period, it is recommended that a new facility plan be written to identify the needs for the next planning period. Until that time, further amendments to this Facility Plan may be required if the estimates, assumptions, and projections summarized in this document become significantly different than have been accounted for in the 20-year planning period. Additionally, any changes in the regulations that may occur over the 20-year planning period that require further upgrades of the facilities will also have to be addressed as such needs arise.

2.2 General Background

2.2.1 Project Location

The City is in Douglas County, in central Illinois approximately 18 miles south of Champaign. The WWTP is in the far northwest corner of the city, east of the Embarras River. See Exhibit B for project location maps.

2.2.2 Demographics

The US Census Bureau estimates the 2018 population to be 2,332 ± 170 residents, while the 2010 census pollution was 2,537. Per US Census Bureau's estimation, the City's median household income is $52,893. The population is not increasing and is not anticipated to increase over the planning period.

3.0 EFFLUENT LIMITATIONS

3.1 General Information

The City's WWTP is rated for a DAF of 0.6 MGD and a DMF of 1.2 MGD.

3.1.1 Current Permits

The WWTP operates under its NPDES permit and sludge disposal permit issued by IEPA. Copies of these permits are included in Exhibit A.

Table 3.1.1

Current NPDES Permit (No. IL 0059005) Discharge Limits

Parameter	Load Limits, lbs./day DAF (DMF)			Concentration Limits, mg/L		
	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum
Flow (MGD)	0.6 MGD (Monthly Average) and 1.2 MGD (Daily Maximum)					
$CBOD_5$	50 (100)	-	100 (200)	10	-	20
Suspended Solids	60 (120)	-	120 (240)	12	-	24
pH	Shall be in the range of 6.0 to 9.0 standard units					
Fecal Coliform	Monitor Only					
Chlorine Residual	-	-	-	-	-	0.05
Ammonia - Nitrogen as N:						
April-May/Sept.-Oct.	7 (14)	22 (43)	24 (47)	1.4	4.3	4.7
June-August	7 (14)	19 (38)	24 (47)	1.4	3.8	4.7
Nov.-Feb.	20 (40)	-	36 (71)	2.7	-	7.1
March	8.5 (17)	22 (43)	36 (71)	1.7	4.3	7.1
Total Phosphorous (as P)	5 (10)	-	10 (20)	1.0	-	2.0
Total Nitrogen (as N)	Monitor Only					
Dissolved Oxygen				Monthly Average not less than	Weekly Average not less than	Daily Minimum
March-July	-	-	-	N/A	6.0	5.0
August-February	-	-	-	5.5	4.0	3.5

3.1.2 Water Quality and Effluent Standards

As part of the federal CWA, all states are required to identify waters that are not meeting water quality standards, otherwise known as "impaired waters." The IEPA has compiled a list of impaired waters within the state of Illinois and has prioritized them for studies necessary to develop TMDLs for each pollutant of concern. The segments of the Embarras River that the WWTP discharges to is ILBE14, which has fecal coliform impairments.

3.1.3 Expected Effluent Limits

The City is committed to maintaining and improving the water quality and designated uses of the streams within its boundary. To meet these goals, the City has contacted the IEPA to discuss further expected discharge limits in expectation of upgrading its WWTP facilities. The IEPA response email dated October 24, 2019, with a summary of expected effluent limits for the plant improvements is included as Exhibit R. The limits proposed in this correspondence have been summarized in Table 3.1.3 below.

Table 3.1.3

Expected Future NPDES Permit Effluent Limits

Parameter	Load Limits, lbs./day DAF (DMF)			Concentration Limits, mg/L		
	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum
Flow (MGD)	0.6 MGD (Monthly Average) and 1.2 MGD (Daily Maximum)					
$CBOD_5$	50 (100)	-	100 (200)	10	-	20
Suspended Solids	60 (120)	-	120 (240)	12	-	24
pH	Shall be in the range of 6.0 to 9.0 standard units					
Fecal Coliform	Monitor Only					
Chlorine Residual	-	-	-	-	-	0.05
Ammonia - Nitrogen as N:						
April-May/Sept.-Oct.	7 (14)	22 (43)	24 (47)	1.4	4.3	4.7
June-August	7 (14)	19 (38)	24 (47)	1.4	3.8	4.7
Nov.-Feb.	20 (40)	-	36 (71)	2.7	-	7.1
March	8.5 (17)	22 (43)	36 (71)	1.7	4.3	7.1
Total Phosphorous (as P)	5 (10)	-	10 (20)	1.0	-	2.0
Total Nitrogen (as N)	Monitor Only					
Dissolved Oxygen				Monthly Average not less than	Weekly Average not less than	Daily Minimum
March-July	-	-	-	N/A	6.0	5.0
August-February	-	-	-	5.5	4.0	3.5

3.2 Other Discharges in the Planning Area

No other known discharges exist in the planning area.

4.0 EXISTING FACILITIES

4.1 Existing Treatment System

4.1.1 System Description

The WWTP was constructed around 1977 and then upgraded around 2001. The facility is rated for a daily average capacity of 0.6 MGD and a DAF of 1.2 MGD. Treatment exists for dry flow conditions and a limited amount of excess flows. The site plan and process flow diagram are shown in Exhibit D and Exhibit C respectively.

The plant receives influent from 12-inch and 6-inch force mains during dry weather, and additionally through a 12-inch excess flow force main during wet-weather. The flow is first directed to a diurnal equalization basin that regulates daily variations in flow. Excess flow is directed from the basin by a 20-inch gravity pipe to the stormwater diversion box, which directs initial flows, also known as first flush flows, to the first flush lagoon. Once the first flush flows have been captured, the excess flow is sent to excess flow clarifier for primary sedimentation and chlorination/dichlorination treatment. Once excess flow subsides, the first flush flow is pumped back to the headworks for full treatment before discharge to the Embarras River.

Dry-weather flows are directed from the diurnal equalization basin to the dual activated sludge plants. The activated sludge plants provide aerobic treatment, clarification, and digestion. Treated water is sent to rapid sand filters, the final part of the treatment process before discharge to the Embarras River.

4.1.2 Headworks and Preliminary Treatment

Two pump stations upstream of the WWTP send flow to the diurnal equalization basin on site. Large solids are separated from the wastewater by a comminutor that is cleaned regularly. The diurnal equalization basin provides storage that allows settlement of solids. In addition to regular wastewater transport, the influent pump stations are capable of pumping excess flow to the wastewater treatment plant for treatment during and after rainfall events. The screening and grit removal systems are not adequate for modern treatment and need upgrades.

4.1.3 Secondary Treatment

The wastewater treatment system consists of two activated sludge plants for biological treatment, clarification, and digestion. Aeration tanks located in the outer ring treat the wastewater for BOD, which then flows into the central clarification tank for sludge separation. The clarifier effluent then flows by gravity to the downstream tertiary filtration process. Separated sludge is then pumped into the digesters in the outer ring where it is digested and stored, and then eventually applied to agricultural land as a method of disposal. The digestion chambers are not large enough for storing the sludge for the minimum of 150-days. And due to 1977 construction, the activated sludge plants have reached the end of their service life.

4.1.4 Tertiary Treatment

Tertiary treatment is provided by rapid sand filtration within the control building, which filters inert solids out of the effluent from the secondary treatment facilities. The rapid sand filtration unit was installed around 1977 and has reached the end of its service life.

4.1.5 Disinfection and Discharge

Chlorine contact tanks are located within the control building. There is only monitoring required for fecal coliform in the dry weather flow effluent; therefore, disinfection is not performed as a final treatment to the effluent before it is discharged to the Embarras River.

4.1.6 Solids Treatment and Disposal

Sludge from secondary treatment and the excess flow clarifier is digested and stored in the digester compartments of the activated sludge plants. The City applies the digested sewage sludge to agricultural land and operates under permit 2017-SC-61805 issued March 9, 2017.

4.2 **Current Flows and Loads**

4.2.1 Current 3 Low Flow Months Average Flow and Loads

IEPA criteria (35 IAC 392) for the designation of the WWTP under "Critical Review" status is based on the average of the three low-flow months for the preceding 12-month period exceeding 80-percent of the WWTP's DAF and/or 80% of the WWTP's design organic loading for the past 12-month period. When a plant is placed on Critical Review, IEPA begins to closely monitor the plant's effluent, monitor sewer connection permit applications, and

recommend that planning for a facility expansion commence. When these flow and organic loadings surpass 100% of the plant's respective design capacities, it can be placed on "Restricted Status," whereby no new sewer connections are permitted, which ceases the growth of the community.

For the Villa Grove WWTP, the three low-flow months between January 2016 and December 2018 averaged 0.241 MGD, which is at 40-percent of the WWTP's rated 0.6 MGD DAF. The WWTP is therefore not considered to be hydraulically overloaded, nor can it expect to be placed on Critical or Restricted Review status at present.

Plant influent data obtained from DMRs from the IEPA's website was used to obtain the average of the three months in the preceding 12-month period that had the lowest recorded levels of BOD5 and TSS. These averages are shown below in table 4.2.1.

Table 4.2.1

3 Low Flow Months Average Flow and Loads (1)

Parameter	Average [mg/L]	Average [lbs./day]
Flow	0.241 MGD	
BOD_5	163	285
TSS	77	134

1. Based on DMR data as reported to the IEPA for January 2016 through December 2018.

4.2.2 Current 12 Month Average Flows and Loads

Critical and Restricted review status can also be triggered if 12-month averages of hydraulic and/or organic loadings exceed 80 and 100-percent of their intended design capacities, respectively. Based on the average flows and loads of plant influent data from a 12-month period from January 2018 to December 2018, the WWTP does not exceed any of these limits and therefore is not expected to be put on critical or restricted review status at present.

These averages are shown below in table 4.2.2.

Table 4.2.2

12 Month Average Flow and Loads (1)

Parameter	Average [mg/L]	Average [lbs./day]	P.E. (2)
Flow	0.564 MGD		5,640
BOD_5	84	374	2,200
TSS	55	232	1,160

(1) Based on DMR data as reported to the IEPA for January 2018 through December 2018.

(2) Based on 100 GPD / PE, 0.17 ppd BOD / PE, and 0.20 ppd TSS / PE

5.0 FUTURE SITUATION

5.1 Planning Period

A 20-year planning period for the City's WWTP is used for the preparation of this report and for the recommendations for the facility improvements included herein. Assuming project construction occurring in 2020, the design year for the selected project alternative is tentatively set as 2040.

5.2 Land Use and Zoning

As previously mentioned, land use and zoning are split between residential and industrial/commercial uses throughout the city. Additionally, there are Tax Increment Financing parcels on the eastern side of the city. The City plans on an expansion of commercial and industrial zones. These future developments are expected to bring additional waste loads to the WWTP and will be a factor in the design of new wastewater facilities.

5.3 Forecast of Flows and Loads

Based on the sewer overflows and anticipated economic development, no increase to the plants permitted DAF or DMF is necessary. The proposed plant improvements will be designed for a DAF of 0.60 MGD and DMF of 1.2 MGD. This should provide enough capacity for which the population and industry can reasonably afford and will adequately handle expected flows.

5.3.1 Additional Flows and Loads

The population is not expected to increase by design year 2040, which is the reason flows and loads will stay the same for the future WWTP will need to process. The proposed design will incorporate estimates for limiting infiltration and inflow from aging sewers.

5.3.2 Future 3 Low Flow Months Average Flows and Loads

The three months where flows and loads were lowest in the past year followed the expected patterns of seasonal variation for domestic wastewaters. It is predicted that these variations will continue and will increase proportionately with the flows and loads detailed in the next sections.

5.3.3 Future 12 Month Average Flows and Loads

Assuming that there will be no remarkable changes in the constituents and characteristics of wastewater flows from the City during the 20-year planning period, it is anticipated that the wastewater loading will stay the same.

To estimate future mass loadings to the WWTP for design year 2040, the following loading rates are used: a BOD5 loading of 0.17 ppd/P.E., a TSS loading of 0.20 ppd /P.E., a TKN loading of 0.029 ppd /P.E., and a total phosphorus loading of 0.005 ppd /P.E.. The loading rates for BOD5 and TSS are based on 35IAC Part 370, and that for TKN and phosphorous are based on Table 3-16 from Metcalf & Eddy Wastewater Engineering: Treatment, Disposal, and Reuse, 5th ed.

5.3.1 Future 24-Hour Maximum Flow and Load

The DMF (24-hour Maximum) for the design is 1.20 MGD and remains unchanged from the DMF.

5.3.2 Future 1-Hour Maximum Flow

The future 1-hour maximum flow is estimated to be 1.90 MGD based on a population of 6,000 and Appendix D, Figure 1 of 35 IAC 370.

5.4 **Summary of Planning Considerations**

The City's WWTP will continue to be a key facility in the sewerage system in the foreseeable future. The treated wastewater discharges into the Embarras River, which has been identified by the IEPA as an impaired waterway, however no TMDL has been established. In summary the following goals and objectives have been identified for the expansion of the WWTP:

1. Maintain or improve WWTP effluent quality for all pollutants.
2. Limit long term average fecal coliform to the Embarras River to water quality levels.
3. Provide treatment of nutrients in the wastewater stream.
4. Retain fundamental WWTP operations to minimize operator training.
5. Provide continuing treatment to wastewater received at the WWTP throughout construction.
6. Minimize total cost (present worth) of improvements, including project cost, operations and maintenance cost, and replacement costs.
7. Allow for easy future expansion without requiring additional property.
8. Maintain or improve operational reliability and flexibility.

6.0 EVALUATION OF ALTERNATIVES

Facilities planning requires an evaluation of several project alternatives that will reasonably meet the needs of the service area and all anticipated discharge limits within the planning period. It is also important to outline the consequences and impacts to the service area if no action is taken. Additionally, the WWTP site has limited space to accommodate plant expansion, so the most efficient technologies and processes that provide additional capacity while preserving available land will be considered. This section will discuss alternatives that are considered viable and may meet the objectives outlined in Section 5.

Future USEPA regulations are expected to require IEPA to add limits for fecal coliform to the City's NPDES permit at some time during the 20-year planning period. It is also expected that the phosphorous limits may be lowered, and total nitrogen or nitrate limits will be added to the NPDES permit in the future. The near term and expected long term NPDES limits for the WWTP effluent are summarized in Section 3.1.

Section 4 presented the operational data for the WWTP. A review of the data allows the assumption to be made that the plant is receiving and treating a mix of a large fraction of domestic and remainder of commercial wastewater flows. Utilizing plant data and sampling results received from the City, preliminary assumptions were made on the loading of BOD5, Total SS, TKN, and Total Phosphorous at the WWTP. Census data was then utilized to determine the expected future loading of the subject pollutants at Design Year 2040, which is presented in Section 5.3.

This report identifies, discusses, and determines the general strategies for meeting the previously identified goals by the City. The alternatives identified and discussed below.

6.1 No Action

For the purposes of this report, "No Action" involves the City not taking any actions towards planning for a major plant improvement. Instead, the City would contest any new effluent limitations for the WWTP NPDES permit by appealing IEPA's decision to the IPCB, who is the regulatory body that would decide on whether IEPA should impose such new effluent limits.

Should the IPCB rule in favor of IEPA's decision, the City could appeal IPCB's decision to the Illinois Fourth Appellate District Court as an attempt to block such limits from being finalized. If either the IPCB or appellate court ruled in favor of the City, then the effluent limits would be removed from the final NPDES permit until the next renewal cycle in five years.

While the City would certainly be within its legal rights to follow the "No Action" strategy, the chances of success are slim. Any argument to the IPCB or appellate court would need to be based on technical merit, and the burden of proof would be on the City. Given the thinking of USEPA, the costs associated with providing a technically based protest of a TMDL or similar argument, and the relative chance of successfully arguing against the addition of nutrient limits to the City's NPDES permit, the "No Action" alternative cannot be considered a viable strategy and is given no further consideration herein. Should the City be interested in a "No Action" strategy, it is recommended they consult with an attorney familiar with environmental law, specifically NPDES permits and the CWA.

6.2 Alternative #1 - Regionalization

Regionalization to consolidate with other nearby communities was given consideration but determined to be economically non-feasible, as the nearest community that may have a large enough WWTP capacity to accept the City's wastewater would be the Urbana & Champaign Sanitary District's (UCSD) WWTP. A large pump station to transport the wastewater to UCSD would be required with approximately 127,000-feet of sanitary forcemain. In general, land and easement costs as well as pump station and forcemain facilities could be more than the other considered strategies. Additionally, this alternative will involve a longer timeframe, three years or more, to allow for completing all necessary inter-governmental agreements, obtaining easements, and completing construction. The City will lose control of the cost of service as well as be unable to extend sewer service without permission from UCSD. Also, there will be a large fluctuation in the cost associated with UCSD's charges on the amount of wastewater processed for the City, due to I&I induced flows.

The capital project cost is estimated to be around $56,248,000, an annual O&M cost of $338,000, and a Net Present Worth of approximately $39,685,000. See Exhibit F for capital and present worth cost details. In summary, the regionalization alternative is not given further consideration.

6.3 Alternative #2 – CAS with BNR

This alternative involves upgrading the package activated sludge plants for use as proposed BNR plants. The scope of the work would include new preliminary screening and grit treatment, refurbishing process units, and constructing new clarifying units and sludge storage facilities. These improvements are summarized below:

- Modified influent splitter structure.
- New preliminary treatment building with headworks structure with screening equipment and grit removal equipment.
- New BNR activated sludge plant splitter box.
- Modifying activated sludge plants to include nutrient removal and converting center clarifiers to aerobic digester tanks.
- New secondary clarifier splitter box
- Two new secondary clarifiers.
- Refurbishment of control building.
- Modify chlorine contact tank to be used for future UV treatment channels.
- Abandonment and fill of first flush lagoon.
- Plant site piping, manholes, valves, and appurtenances.
- Plant electrical controls, instrumentation, and PLCs.
- Plant site electrical.

This alternative would also maintain the permitted DAF of 0.6 MGD and DMF of 1.2 MGD. The two activated sludge plants would be reconstructed to create nutrient treatment units, where the outer annulus of the structure contains Anaerobic and anoxic compartments to remove nitrogen and phosphorus, and an aerobic compartment to treat for BOD and ammonia. The inner annulus will be converted to serve as the digestion area for sludge. Two clarifiers would be constructed to provide treatment after wastewater goes through the activated sludge plants. A new sludge storage tank would be constructed to provide required wintertime detention needed for land disposal. This alternative would also provide a new unheated headworks building with screening and grit removal. All structures would be sized for the design DMF of 1.2 MGD. No changes to excess flow treatment process are necessary. A site plan detailing this design is attached as Exhibit J.

This alternative has a probable total project cost of $14,696,000, an annual O&M cost of $338,000, and a Net Present Worth of $16,432,000. See Exhibit F for capital and present worth cost details.

6.4 Alternative #3 – CAS with CPR

The improvements in Alternative #3 are essentially the same as Alternative #2, but the nutrient treatment is chemical rather than biological. This alternative has a probable total project cost of $14,081,000, an annual O&M cost of $563,000, and a Net Present Worth of $17,849,000. See Exhibit F for capital and present worth cost details. These improvements are summarized below:

- Modified influent splitter structure.
- New preliminary treatment building with headworks structure with screening equipment and grit removal equipment.
- New activated sludge plant splitter box.
- Modifying activated sludge plants to convert center clarifiers to aerobic digester tanks.
- Chemical treatment system for phosphorous removal
- New secondary clarifier splitter box
- Two new secondary clarifiers.
- Refurbishment of control building.
- Modify chlorine contact tank to be used for future UV treatment channels.
- Abandonment and fill of first flush lagoon.
- Plant site piping, manholes, valves and appurtenances.
- Plant electrical controls, instrumentation and PLCs.
- Plant site electrical.

6.5 Evaluation of Alternatives

6.5.1 Life Cycle Cost Analysis

The Life Cycle Cost Analysis below is based on a discount rate of 1.5%, as appropriate for a 20-year planning period based on Office of Management and Budget Circular A-94.

- P/A = 17.1686
- P/F – Year 20 = 0.74247

Electrical costs were based on estimates of operational hours and power requirements for various pieces of equipment. Chemical costs were based on process design requirements for phosphorous removal and sludge handling. Maintenance costs were estimated based on the recommendations from equipment manufacturers, and from typical maintenance requirements encountered in similar WWTPs. Replacement costs are based on the expected service life of the various equipment and structural components in the proposed design. Salvage costs are based on the price of selling WWTP assets after the 20-year planning period.

A summary of the present worth analysis calculations is given in the table below. See Exhibit F for details on all alternatives.

Table 6.5.1

Present Worth Cost Comparison for the Three Alternatives

Alternative	Capital Cost	Present Worth O&M	Present Worth Salvage Value	Present Worth Replacement Costs	Total Present Worth
Regionalization	$56,248,000	$5,811,000	($19,992,000)	$10,000	$39,685,000
CAS with BNR	$14,696,000	$2,902,000	($2,929,000)	$1,763,000	$16,432,000
CAS with CPR	$14,081,000	$4,834,000	($2,773,000)	$1,707,000	$17,849,000

Alternative #1 is cost prohibitive with the construction of 24 miles of 18-inch force main and a large pump station with high energy requirements. In addition, there would be a monthly user fee from the UCSD and most likely a connection fee for each customer.

Based on the analysis conducted in this report and the cost to implement the alternatives discussed, the most practical and cost-effective alternative that meets all the objectives outlined in Section 5.6 is upgrading the WWTP. Alternative #2 and Alternative #3 have similar capital and maintenance costs, but Alternative #2 provides reliable treatment of nutrients at a reduced operations and maintenance cost. This will provide advanced treatment while maximizing the use of facilities and will enable the plant to treat future loads.

The proposed improvements will produce effluent phosphorous levels of 1 mg/L or lower, while also improving the operational reliability and flexibility of the entire plant. In addition to the BNR process, a new influent structure will provide screening, grit removal and primary treatment, a UV disinfection system will be able to replace the chlorination system in the future, and sludge handling equipment will be upgraded to meet storage requirements.

7.0 PROPOSED PROJECT

7.1 Description of Proposed Project

Due to financial constraints, the City has split the recommended alternative into phases, and intends to complete Phase 1 as soon as the design and permitting are complete. The proposed improvements will produce effluent phosphorous levels of 1 mg/L or lower and provide denitrification capability, while also improving the operational reliability and flexibility of the entire plant.

The design will maintain the DAF of 0.6 MGD and the DMF of 1.2 MGD. The proposed project includes construction of the following major facilities for dry weather flows:

- Reconstruction of the dual activated sludge plants to provide a new anoxic reactor structure for BNR process, compartments for aerobic treatment of wastewater, and compartments for digestion of sludge.
- Refurbishment of the control building to upgrade labs, HVAC, effluent pumps, blowers, and non-potable water systems.
- New sludge storage tanks.
- Plant site piping, manholes, valves, and appurtenances.
- Plant electrical controls, instrumentation, and PLCs.
- Plant site electrical and generator
- Miscellaneous site improvements, including access driveways, sidewalks, fencing, painting, etc.
- Other miscellaneous structures and facilities.

See Exhibit H and I for the proposed process flow diagram and site plan. The project will be designed as per 35 Illinois Administrative Code (IAC) Part 370, and the Ten State Standards for wastewater facilities and the IEPA Construction Permit application will be filed at the end of design phase.

7.2 Environmental Impacts

7.2.1 Characterization of Existing Stream

Effluent from the WWTP is discharged to the Embarras River and is subject to regulation by the State of Illinois. The portion of the waterway that receives the effluent from the WWTP is a tributary to the waterbody segment ILBE14 that has been identified as an impaired waterway on the 303(d) list of impaired waters. The identified impaired use is primary

contact recreation, and the potential cause is fecal coliform. The waterbody segment has medium priority on the 303 (d) list, which means that a TMDL has not been developed and is not being developed.

7.2.2 Primary Impacts

The proposed improvements will provide greater treatment capacity, treatment reliability and higher levels of treatment that will ensure that the plant is compliant with current and future NPDES permit requirements. The plant will produce a better-quality effluent than current treatment based on the expected plant performance with treatment upgrades, thereby improving the quality of the Embarras River.

7.2.3 Construction Impacts

The following construction impacts are anticipated:

1. Some erosion may occur during construction. Mitigative measures to minimize erosion will be required of the contractor and shall be in accordance with the Illinois Procedures and Standards for Urban Soil Erosion and Sedimentation Control.
2. Normal construction noise will be present during construction periods, which will be limited to normal working hours.
3. Air pollution, including dust contamination, may be present during periods of construction. Mitigative measures will include dust control and excessive wind erosion protection.

7.2.4 IDNR Signoff

IDNR signoff was requested using the EcoCAT web-based tool. A copy of the EcoCAT consultation and follow-up consultation letter is included as Exhibit K. IDNR concluded that there are State-Listed species within the project vicinity including:

1. Little Spectaclecase (Villosa lienosa)
2. Mudpuppy (Necturus maculosus)

Due to the project location and proximity to threatened resources, the Department recommends the following actions be considered to avoid causing adverse impacts:

- The Department recommends utilization and strict adherence to sediment and erosion control BMP's during and after construction.

Given the above recommendations are adopted, the Department has determined that impacts are unlikely.

7.2.5 State Historical Preservation Office (SHPO) Signoff

The proposed project will be located on land within the plant site. Since the site has already been disturbed by construction activities several times in the past, it is not anticipated that the proposed work would disturb anything that would be historical or cultural relevance. SHPO determined that no historic properties would be affected by this project. See Exhibit K for SHPO response letter.

7.2.6 Agricultural Land

The proposed project will be located on land within the plant site. The site location is bordered by the Embarras River, city streets, and residential community. Therefore, the proposed work would not disturb any agricultural land.

7.2.7 Wetlands

The proposed project will be located on land within the plant site. The project location is not recognized as a wetland, however, to the southwest of the site is a freshwater emergent wetland. A map of the designated wetland areas surrounding the WWTP is shown in Exhibit N. It is not expected that construction will extend beyond the plant boundaries into any of the surrounding wetland areas.

7.2.8 Floodplains

The existing and proposed plant facilities are located outside of the designated floodway limits and within the flood fringe. The construction activities of the proposed project will remain outside of the floodway and will not impact any wetlands. The Section 404 Joint Permit is therefore not required from the IDNR, the USACOE, and IEPA. All other state and local requirements for construction within the flood fringe will be met. New plant facilities will be designed to withstand physical damage from a 100-year flood event. In summary, since no construction activities will be within the floodway, the natural and beneficial values of the floodway area will remain intact. See Exhibit O for the FIRMette map.

8.0 PROJECT FINANCING

8.1 Current Sewer System Revenues and Expenditures

The City operates its wastewater system as a separate sewer utility for accounting purposes. The wastewater system is maintained as part of the "Sewer Enterprise Fund," which is intended to be self-supporting through connection and user fees charged for services to the public.

The wastewater flows from all users of the wastewater facilities are non-metered and clients are billed based on their potable water usages.

8.1.1 Operating Revenue

Based on the 2020 audited financial statements, the annual operating revenue from sewer charges is $488,615.

8.1.2 Operating Expenses

The sewerage system operation and maintenance expenditures for the fiscal year ending April 30, 2020 are $460,801. When the City completes construction of the refurbished plant, operating expenses are projected to be $485,739.

8.1.3 Depreciation

The amount of depreciation shown on the 2020 audited financial statements is $74,622.

8.2 Opinion of Probable Project Cost

The estimated total project costs for the recommended project as shown in Exhibit G is $5,309,000. The estimated project costs include project contingencies, design, bidding and construction engineering, construction inspection, and legal/administration costs.

8.3 IEPA WPCLP

IEPA's WPCLP will be used by the city to finance the proposed plant improvements. The fiscal year 2020 interest rate is a 2.0-percent base rate for a 20-year term. Based on the IEPA subsidizing criteria, Villa Grove is eligible to receive 15-percent principal forgiveness and a loan for the balance of the project at 1.0-percent for a 30-year term. Under these assumptions, an annual debt service of $175,576 would be undertaken by the City. The annual

revenue will need to be increased to accommodate the new annual debt service amount in addition to the ongoing operating expenses and depreciation as described previously, which would be distributed among the 1,054 users. The operating expenses will be distributed based on flow, whereas the fixed debt service and depreciation expenses will be distributed evenly amongst all users.

8.3.1 Debt Service

Increased user rates will be required to fund the annual debt service associated with the WPCLP. As noted above, an annual debt service of $175,576 is estimated along with an increase in operating expenses associated with maintenance of the new facilities.

8.3.2 OMR

Funds will also have to be allocated for the operations and maintenance of the improved wastewater facilities. After construction of the proposed wastewater treatment improvements, operating expenses are anticipated to be $485,739. $72,441 will be collected to defray the depreciated value of the WWTP and be used for future replacement of equipment.

8.4 Sewer Rates and Average Sewer Bills

8.4.1 Current Rate and Billing Estimate

- Effective July 13, 2020, sewer rates are $22.470 minimum charge for the first 1,000 gallons and $0.730/100 gallons beyond the first 1,000 gallons.
- Average Bill = $39.23/month/user (based on 2020 operating revenues).
- Average Billed Use = 3,386 gallons/month/user (based on 2020 usage).

8.4.2 Proposed Rate and Billing Estimate

- Proposed Average Bill = $58.01/month/user
- Proposed sewer rates would be $19.61 minimum charge for the first 1,000 gallons and $1.134/100 gallons beyond the first 1,000 gallons.

9.0 PROJECT IMPLEMENTATION

9.1 Project Schedule

Summarized below is a project implementation schedule depicting major milestones with anticipated completion timeframes:

- Facilities Planning Study/Report Phase — April 2019 – November 2020
- Design Phase (including Permit applications) — December 2020 – July 2021
- Pass Rate Ordinance — February 2021 – June 2021
- Pass Debt Ordinance — June 2021 – July 2021
- Loan Application — November 2020 – June 2021
- Bidding/Negotiation — July 2021 – September 2021
- Construction — October 2021 – September 2022
- Start-Up & Commissioning — September 2022 – December 2023
- Normal Operation — December 2023