1.0 Introduction

This Preliminary Water system assessment has been prepared to provide a base level of due diligence and a preliminary budgetary opinion of probable cost for the City to upgrade the existing water treatment system.

This Preliminary Plan is not intended to be a technical document that details operations and/or specific designs for any of the existing or proposed items. It is, however, to be used as a summary of correspondences held, observations taken, preliminary outline of treatment alternatives, and a preliminary engineer's opinion of probable costs for potential system upgrades.

The opinion of probable costs provide a range of capital for the treatment system alternatives. Opinions of probable cost could be refined through additional assessment and design evaluation. These preliminary estimates include ranges for design engineering, construction, construction administration/observation, and contingency. This analysis is intended to be adequate for planning and budgetary purposes only. Prior to the City seeking funding for the water treatment system improvements a more detailed design and costing must be performed. If the City would plan to use Illinois Environmental Protection Agency (IEPA) funding, a full facility planning study will also need to be performed.

2.0 Study Area

The City of Mt. Pulaski is located in Logan County along Illinois Route 121. According to City personnel, the service area is comprised mainly of residential customers, with a few seasonally higher commercial water use customers.

The population data for the City is approximately 1566 people and the number of current water customers is found to be approximately 850 service connections.

3.0 Water Usage

According to data provided by the City, typical daily water usage is approximately 125,000-150,000 gallons per day. IEPA identifies the daily average (DAF) at approximately 143,000 gpd and a daily max (DMF) use of 230,000 gpd.

Based on the flow data provided by the City, there appears to be a few days in which the daily flow exceeds this DMF, however, Mr. Presswood has indicated that these are anomalies in the data that can be contributed to main repairs or to the method of recording flows.

Mr. Presswood indicated typical water loss in the system is approximately 15-18%. The IEPA reports in 2005, the water loss was 12%. System water loss is within the acceptable range for a system of this size.

Utilizing the historical data and the well data, a treatment system would need to be designed for 250-300 gpm. With 300 gpm treatment system average run times would be as follows.

- At DAF Conditions: Approximately 8 hours per day
- At DMF Conditions: Approximately 13 hours per day

Based on these run-times and preliminary review, 300 gpm seem to be an appropriately sized process train. Based on a conversation with equipment manufacturers, there would be little upfront savings in sizing the system to 250 gpm, so 300 gpm will be used for the development of all costs.

4.0 Water System Components

The City of Mt. Pulaski currently operates and maintains Water System No. IL1070400 located in Logan County, Illinois. In general, the water system consists of four (4) water supply wells, chemical feed systems, a 300,000 gallon elevated storage tank, and the water main distribution system.

Near the well field, the City owns an existing metal building that is currently utilized for storage, as well as housing well #4, the current chemical feed system, and the emergency standby generator. The building has interior dimensions of approximately 29'x39'. For efficiency and cost savings, the City desires to reuse this building if possible for the new treatment system.

Water supply for the City is provided by four (4) groundwater wells located north of the City along IL Route 121. Currently the City blends water from Wells #4, #5, and #6. The following information was provided by the City regarding the wells.

Well #4

- Well #4 is located in the existing treatment building and according to Illinois State Geological Service (ISGS) database information, has a total depth of 34 ft. Based on information provided by the City, the well is currently operated at approximately 95 gpm.
- Mr. Presswood indicated this well has traditionally been the highest in nitrates. The well was sampled for nitrate levels four (4) times in 2016 with the average being 16.25 mg/l.
- Mr. Presswood indicated that raw water concentrations of iron and manganese has not been an issue with this well. According to an analytical report dated 1/12/16, raw water sampling from this well indicated an iron and manganese concentration below the detectable limit.

Well #5

- IEPA Well Data indicates Well #5 has a total depth of approximately 40 feet and is rated up to approximately 150 gpm. Based on information provided by the City, the well is currently operated at approximately 95 gpm.
- Mr. Presswood indicated that this well has also traditionally been high in nitrates. The well was sampled for nitrate levels four (4) times in 2016 with the average being 12 mg/l.
- Mr. Presswood indicated that sampling on Well #5 has also shown low iron and manganese concentrations in this well.

Well #6

- ISGS Water Well Data indicates Well #6 has a total depth of 75 feet and is rated up to approximately 200 gpm. Based on information provided by the City, the well is currently operated at approximately 100 gpm.

- Mr. Presswood indicated that this well has also traditionally been low in nitrates. The well was sampled for nitrate levels four (4) times in 2016 with the average being 1.1 mg/l.
- Mr. Presswood indicated that Well #6 has concentrations of both iron and manganese, analytical reports were not available at the time of this report, however Mr. Presswood indicated these concentrations were slightly less than in Well #7.

Well #7

- IEPA Data indicates Well 7 has a total depth of 42 feet based on information provided by the City, the well is currently operated at approximately 100 gpm.
- Mr. Presswood indicated that this well has also traditionally been low in nitrates. The well was sampled for nitrate levels four (4) times in 2016 with the average being 1.1 mg/l.
- Mr. Presswood indicated that Well 7 has the highest concentrations of both iron and manganese. Analytical reports dated 12/6/11 and 12/29/11 indicate iron concentrations of 2.7 and 2.49 mg/l and manganese concentrations of 160 and 93.1 ug/l.
- Due to iron and manganese concentrations in Well #7, the City is currently not using the well during normal operation.

The wells appear to have the proper wellhead protection in place and according to Mr. Presswood, are all located above the 100-year floodplain as required by State regulations.

5.0 Treatment System Alternatives

This report includes a preliminary evaluation of two treatment alternatives that the City could pursue. The first alternative will address only the iron and manganese found in the raw water. The second potential alternative will address the iron and manganese as well as the nitrates found in the wells.

Both alternatives are outlined below. These alternatives both assume the improved plant will be located at the location of the current facility.

5.1 Iron and Manganese Removal Alternative

The general process evaluated for iron and manganese removal includes aeration of the raw rater, a filtration process, and a minimum of 30 minutes of detention. Chemical feed will be introduced at the plant prior to the water distribution system.

For systems and loading similar to Mt Pulaski, there are manufactures that make packaged units that combine the aeration, detention, and filtration into a single unit. The Tonka Dualator III system is one such unit. A diagram of this unit is included with this report. The dimensions of this unit (LxWxH) would be 21.5x10x14.5. This process offers several advantages for this type of system including a smaller foot print and reduced costs.

IEPA does not have a primary drinking water standard for iron or manganese removal but does have a secondary standard of 0.3 mg/l and 0.05 mg/l respectively. These secondary standards are not mandated levels but are used to set water quality targets for a treatment system. The iron and manganese treatment system will be designed around the loading from Well #7 which has the highest concentrations of these impurities.

The filtration system will require periodic backwash of the filter vessels. With this type of system, the City should be able to obtain an NPDES permit for discharging the filter backwash water into a backwash filter and into the creek, without having to pump this wastewater into the sewage collection system.

An iron and manganese removal system will not address the nitrates present in wells #4 and #5. Nitrate concentration is regulated and has a maximum concentration of 10 mg/l. Because nitrate levels in wells 4 & 5 are typically above this concentration, with an iron and manganese removal system, the City will need to continue blending the raw water to achieve the nitrate concentration limit.

Based on the 2016 average nitrate levels and the well pump rates provided by the City, the approximate average finished water nitrate level is estimated to be 9.6 mg/l. This level is approaching the regulated MCL, but the City monitors finished water on a regular basis and Mr. Presswood indicated the nitrate level continuously maintains below the 10 mg/l limit.

While the iron and manganese system will not remove nitrates, treating the iron and manganese in the raw water will allow the City to have more flexibility on well combinations to achieve this blending including the potential to run wells #6 and #7 together in combination with either well #4 or #5. Estimated nitrate levels for these well combinations are shown below and are based on 2016 average nitrate levels and the pump rates outlined above.

Wells 4, 6, and 7 Combined: 6 mg/l

Wells 5, 6, and 7 Combined: 4.6 mg/l

An iron and manganese only removal system does still allow for the possibility that wells 6 and 7 could both be out of service at the same time meaning the City would not be able to blend from a low nitrate well to achieve the nitrate regulations. If the City were to consider this alternative, it would be prudent to also investigate an alternative site for an additional well that shows low nitrates in the test borings.

5.1.1 Budgetary Engineer Opinion of Probable Cost

System Component	Cost Range	
Building Improvements	$ 80,000.00	$ 100,000.00
Foundation Improvements	$ 80,000.00	$ 100,000.00
HVAC Improvements	$ 40,000.00	$ 60,000.00
Electrical Improvements	$ 50,000.00	$ 100,000.00
Standby Generator	$ 80,000.00	$ 120,000.00
High Service Pumps	$ 20,000.00	$ 30,000.00
Chemical Feed System Improvements	$ 40,000.00	$ 50,000.00
Tonka Dualator III Unit	$ 550,000.00	$ 650,000.00
Clearwell	$ 50,000.00	$ 60,000.00
System Piping	$ 80,000.00	$ 100,000.00
Flow Meters	$ 25,000.00	$ 35,000.00
Backwash Detention Tank/ Filter	$ 50,000.00	$ 60,000.00

Site Piping	$ 15,000.00	$ 25,000.00
Subtotal	$ 1,160,000.00	$ 1,490,000.00
Engineering (15%)	$ 174,000.00	$ 223,500.00
Contingency (10%)	$ 116,000.00	$ 149,000.00
Total	$ 1,450,000.00	$ 1,862,500.00

Average System cost for the iron and manganese removal system = $1,656,250.00

5.1.2 Estimated Operation and Maintenance (O&M) Costs for Treatment Alternative

Based on the iron and manganese treatment system outlined above, the following additional O&M costs are anticipated:

Increased Power Demand

Proposed plant will have additional Power Demand From:

Assumed $0.08/ kw

Estimated 2 HP Aerator

Estimated 40 HP High Service Pump

Assumed Runtime = 10 hrs/day

Estimated annual additional power costs = $10,000

Filter Media Replacement

Filter media has an estimate life cycle cost of 15 years

Estimated annualized cost for media replacement = $4,000

Chemical Feed

Assume the addition of oxidizing agent and elimination of Ora-CLE

Chemical feed costs will remain consistent with current costs

Laboratory Testing

Assume no additional laboratory testing will be required

Laboratory testing costs will remain consistent with current costs

Miscellaneous

Estimate annualized miscellaneous maintenance costs related to treatment equipment = $5,000

Total estimated additional annual O&M costs for an iron and manganese treatment system (not including labor): $19,000

5.1.3 Estimated Annual System Cost

For the estimated annual system cost, an IEPA low interest loan is assumed to be used as the funding mechanism, the following table outlines these costs based on the average treatment system capital costs and O&M costs outlined above.

		Total Loan Amount:	$ 1,656,250
Number of Customers	850		
Interest Rate:	2.50%		
Length of Loan (years):	20		
Annual Debt to be Repaid:	$106,243.68		
Annual O&M Cost:	$ 19,000.00		
Estimated Total Annual Cost Increase	**$125,243.68**		
Estimated Monthly Increase Per Customer	**$ 12.28**		

5.2 Iron, Manganese, and Nitrate Removal Alternative

The treatment process for iron, manganese, and nitrate removal will still utilize aerator, detention, and filtration for iron and manganese removal and adds anion exchange softeners for nitrate removal. With the addition of the exchange vessels, the packaged system discussed above would likely not fit within the footprint of the existing building. This system would likely require separate aeration and filtration vessels. Further design evaluation would need to be conducted to determine costs of expanding the building. Similar chemical feed will be introduced at the plant prior to the water distribution system.

The iron and manganese removal portion will still be designed around the loadings in Well #7. The nitrate removal will be designed around projected loadings from Well #4.

Again the target concentrations for iron or manganese would be 0.3 mg/l and 0.05 mg/l respectively. The anion exchange vessel can be designed with a nitrate selective resin. Specific resins would need to be pilot tested during the design phase to select the most efficient resin for the raw water treatment. Nitrate selective anion exchange resin can achieve nitrate removals up to 90% in certain conditions.

The nitrate removal resin in the anion exchange process does not require a cation exchange (softening) process ahead of the nitrate removal process except in case of high-hardness raw water. Additional testing may be necessary to establish the baseline hardness for the raw water to evaluate if conditions above the level that could cause precipitation of calcium or magnesium in the anion exchange resin bed exist. This can be determined in the pilot testing phases, based on conversations with equipment manufacturers, we have assumed softening will not be necessary.

A treatment system that includes anion exchange in the process offers several advantages to the City including the following.

- Reduces concern of Wells #6 and #7 being down at the same time
- Reduces concern of upward trend in the well nitrate levels
- Allows for the nitrate concentration to be reduced below the threshold feasible with blending

A pump station would be required to pump the anion exchange vessel backwash to the City's sewer collection system. If a pump station was installed, the City would likely be best to avoid the NPDES discharge permit and also pump the filter backwash to treatment.

5.2.1 Budgetary Engineer Opinion of Probable Cost

System Component	Cost Range	
Building Improvements	$ 100,000.00	$ 120,000.00
Foundation Improvements	$ 80,000.00	$ 100,000.00
HVAC Improvements	$ 40,000.00	$ 600,000.00
Electrical Improvements	$ 50,000.00	$ 100,000.00
Standby Generator	$ 80,000.00	$ 120,000.00
High Service Pumps	$ 20,000.00	$ 30,000.00
Chemical Feed System Improvements	$ 40,000.00	$ 50,000.00
Vertical Pressure Filters	$ 375,000.00	$ 400,000.00
System Piping	$ 100,000.00	$ 120,000.00
Flow Meters	$ 25,000.00	$ 35,000.00
Concrete Detention Tank	$ 45,000.00	$ 65,000.00
Aerator Unit	$ 150,000.00	$ 175,000.00
Site Piping	$ 15,000.00	$ 25,000.00
Brine System	$ 100,000.00	$ 120,000.00
Anion Exchange Units	$ 350,000.00	$ 400,000.00
Pump Station	$ 100,000.00	$ 150,000.00
Subtotal	$ 1,670,000.00	$ 2,610,000.00
Engineering (15%)	$ 250,500.00	$ 391,500.00
Contingency (10%)	$ 167,000.00	$ 261,000.00
Total	$ 2,087,500.00	$ 3,262,500.00

Average System cost for the iron, manganese, and nitrate removal system = $2,675,000.00

5.2.2 Estimated Operation and Maintenance (O&M) Costs for Treatment Alternative

If proposed system utilizes anion exchange for nitrate removal, the following O&M costs apply in addition to the costs outlined above for the iron and manganese removal system.

Salt

Estimated salt use an anion exchange system = 54,000 lbs/mo = 324 ton/yr

Estimated cost ton of salt = $51/ton

Estimated annual salt cost = $16,500

Ion Exchange Resin Replacement

Resin has an estimate life cycle cost of 15 years
Estimated annualized cost for media replacement = $5,000

Backwash Pump Station

Pump Station will require periodic maintenance
Estimated annualized maintenance cost = $3,000

Increased Power Demand

Nitrate removal process will have additional Power Demand From:
Assumed $0.08/ kw
Estimated 2 HP Brine Pumps
Estimated 10 HP Submersible Pump Station
Assumed Runtime = 10 hrs/day
Estimated annual additional power costs = $3,000

Total estimated additional annual O&M costs for an iron, manganese, and nitrate treatment system (not including labor): $46,500

5.2.3 Estimated Annual System Cost

For the estimated annual system cost, an IEPA low interest loan is assumed to be used as the funding mechanism, the following table outlines these costs based on the average treatment system capital costs and O&M costs outlined above.

Total Loan Amount:	$ 2,675,000
Number of Customers	850
Interest Rate:	2.50%
Length of Loan (years):	20
Annual Debt to be Repaid:	$171,593.57
Annual O&M Cost:	$ 46,500.00
Estimated Total Annual Cost Increase	**$218,093.57**
Estimated Monthly Increase Per Customer	**$ 21.38**

6.0 Additional Considerations

The following additional thoughts are being presented for your consideration when evaluating the information presented above.

6.1 Reverse Osmosis

An additional treatment process that was considered but not included in the alternatives discussed above is a reverse osmosis (RO) treatment plant. RO provides several advantages including a small foot print with softening and nitrate removal in one process. RO can be combined with aeration and filtration to provide a full treatment process.

An RO treatment process tends to be a more expensive system to operate and has some long term operational challenges including the tendency to make finished water aggressive and the need for additional chemical feeds to control corrosiveness in the distribution system.

Operation and maintenance (O&M) Costs also tend to be higher with an RO system including a continual 10-15% water loss in the treatment system process and the regular need for membrane maintenance and replacement.

If the City would decide to move forward with a full treatment system, including softening, this alternative can be assessed further to determine if the capital cost savings could offset the added O&M costs. The City can also evaluate their tolerance for the potential operational concerns of this system.

6.2 Well Maintenance

Well maintenance costs and operations have not been included in the engineer opinion of probable costs outlined above.

If the City should decide to proceed with an iron and manganese only removal system, an additional well site that will be low in nitrates should be investigated. For long term water quality stability an additional low nitrate well will reduce some of the concerns of the potential rising nitrate levels in the existing wells.

This would not need to be completed with a treatment plant project but doing so would allow for the City to utilize the same funding source such as an IEPA low interest loan. The City could also use this opportunity to televise the existing wells and add some well maintenance operations into the water system improvements.

6.3 Pump Station to Service Subdivision to North

If a pump station was required at the water treatment plant site for handling backwash water, there is potential that this could be designed to also provide the ability to service the Country Place subdivision north of Mt. Pulaski.

6.4 Elkhart Potential

This consideration will be discussed with the Council prior to finalizing in this report.