PRELIMINARY ENGINEERING REPORT
AUGUSTA WATER TREATMENT PLANT UPGRADE

Prepared For:

CITY OF AUGUSTA
PO BOX 85 219 Main Street
Augusta, Kentucky 41002
Phone (606) 756-2183

Prepared By:

CANN -TECH, LLC / KENVIRONS
770 Wilkinson Blvd.
Frankfort, Kentucky 40601
Phone (502) 695-4357
Fax (502) 695-4363
Cell (502) 343-0224
E-mail: lcann@kenvirons.com

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Chapter 1
Introduction

1.1 Purpose of Study

The City of Augusta entered into an agreement with the Bracken County Water District to resolve issues pending before the Kentucky Public Service Commission's Case No. 2020-00277. The agreement stipulated that Augusta would "retain an engineering firm to conduct a comprehensive evaluation and review of the Augusta Water Treatment Plant, including its existing condition, operating practices and capital improvements needs and that will prepare a written report detailing the plant's current condition and operating practices, and identifying any changes in the method of operation and capital improvements required to improve the plant's efficiency and to ensure the plant's operations comply with state and federal law and best industry practices." To that end, the City issued a Request for Qualifications (RFQ) from engineering firms and selected Cann-Tech to perform the study. On September 29, 2021, Cann-Tech was acquired by Kenvirons, Inc. a civil and environmental engineering firm headquartered in Frankfort, Kentucky.

1.2 Background

The City of Augusta provides potable water service to 577 residential, commercial and industrial customers within the City of Augusta. The City also wholesales water to the Bracken County Water District (BCWD) which has 2,723 residential customers. The potable water is produced at the Augusta Water Treatment Plant (WTP) and the plant is rated for 1.72 million gallons per day (mgd). During 2021, the WTP experienced an average day production rate of 0.611 mgd and peak day production of 0.840 mdg. The WTP is operating at 36% of capacity on average and 49% during peak demand. Table 1 shows the average daily water consumption for the BCWD, Augusta, and the WTP, as well as the raw water treated for years 2017 through 2021.

Table 1 – Average Daily Water Consumption

Year	Average Daily Water Consumption (gallons/day)				Raw Water
	WTP	BCWD	Augusta	Total	Treated
2017	6,020	398,736	137,942	542,699	639,899
2018	7,254	392,659	171,227	571,141	673,436
2019	6,315	443,912	153,023	603,251	711,296
2020	5,761	437,544	164,995	608,299	717,250
2021	8,729	479,660	174,192	662,580	781,252

Review of the census and population data prepared by the Kentucky State Data Center (KSDC), indicates the population of Bracken County declined from 8,488 to 8,139 from 2010 to 2020. The twenty (20) year population projection, Year 2040, shows the County's population to continue to decline to a total count of 6,910. Based on the population projection, it is believed that the Augusta WTP

has adequate capacity for the foreseeable future.

The Augusta WTP was constructed in 1995 and utilizes a conventional treatment process consisting of coagulation, flocculation, clarification, and filtration. The Superpulsator Clarifier combines flocculation and clarification in one basin with a vacuum generated flow pulsation that optimizes the homogenous solids contact sludge blanket. The proprietary clarifier technology allows for an economical and compact plant layout.

Chapter 2
Process Analysis

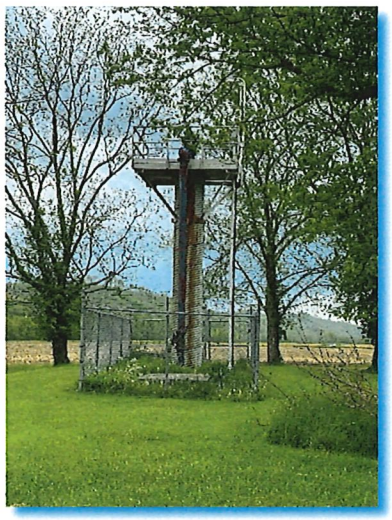
2.1 Groundwater Sources

The WTP is supplied water using four (4) groundwater wells located within 2,000 feet of the plant. Well No. 1 is located inside the turn of the convergence of Long Stretch Road and West 2nd Street. Wells No.2 and 3 are adjacent to the Ohio River bank near the end of West 2nd Street and Well No. 4 is located near the intersection of Ferry Street and West 2nd Street. The following table summarizes the well's statistics.

Table 2 – Groundwater Wells

Description	Well No.1	Well No.2	Well No.3	Well No.4
Year Constructed	1970	1970	1970	2005
Depth (feet)	100'	100'	100'	100'
Casing (inches)	10"	10"	20"	20"
Horsepower (Hp)	25	25	50	40
Flow (gpm)	350	350	700	800

The water supply is classified by the Kentucky Division of Water (KDOW) as a groundwater supply. Discussions with the operators indicated that the well heads are sealed tight and turbidity spikes are not experienced during wet weather conditions.



Wells No. 1, 2, and 3 are pumped using submersible motors with electrical service provide through starters located on an elevated platform. The pumps are controlled through wiring from the WTP and the operator indicated that, while the controls are still functional, the WTP's control system needs to be modernized.

Fencing and/ bollards should be considered at each well to minimize security risks and damage from vehicles.

The City of Augusta has contracted with Moody's of Dayton Ohio to conduct an extensive well evaluation. This work has repeatedly been rescheduled due to COVID-19 issues and it is anticipated to be complete by June 2022. We would like to see the results of the study before recommendations on the raw water source.

Discussions with the WTP personnel indicated that the Groundwater Protection Plan and Well Head Protection Plan are current.

2.2 Chemical Storage and Feed

2.2.1 *Process Building Section*

The WTP consist of a single structure with two separate sections, the Process Section and Administrative Section. The Process Section houses the chemicals feed systems, process basins, pumps, and related equipment. The Administrative Section contains the laboratory, control room, conference room, and offices. A pre-engineered metal building was developed for the WTP and the Process Section covers an area of 81'-6" x 122'-8".

2.2.2 *Chlorine Feed System*

Chlorine gas is used as the primary and secondary disinfectant. The Chlorine Feed Room houses ton cylinders of chlorine gas on dual trunnion scales. Ton cylinders are loaded into and out of the storage with a 2-ton electric hoist connected to a monorail. Gas is fed from the storage cylinders to the chlorinators under a vacuum. The primary components of the feed system include:

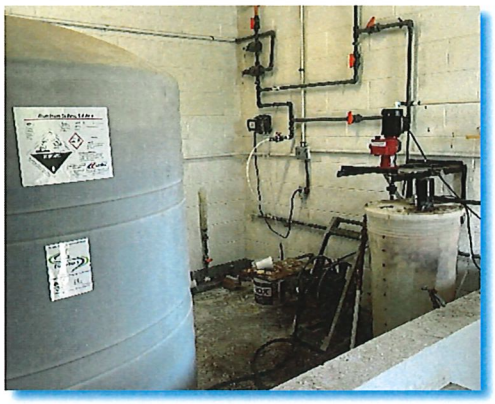
- vacuum regulator, that shuts off the flow of gas upon a loss of vacuum signal from the chlorinators
- chlorinator/injector unit rated at 150 PPD for setting the feed rate
- distribution panel to direct the chlorine solution to the rapid mix (pre), settled water (intermediate), and/or filter effluent (post)

A chlorine gas leak detector is in the room and alarms the operators if chlorine gas levels exceed safe limits. The scheduled maintenance on the chlorine feed equipment is current and up to date. Additional safety measures include an operator viewing window, room ventilation system, annual hoist inspection, and isolation from other areas of the WTP.

2.2.3 *Permanganate Feed System*

Potassium permanganate is used to oxidize iron and manganese. The chemical is stored and fed from the Permanganate Feed Room. The permanganate solution is batched in the room and fed into the line upsteam of the Raw Water Meter/Control Valve. The feed system includes a mixing tank, mixer, and metering pump. The room includes its own ventilation system which pulls air from the Superpulsator/Filter area and exhausts to the outside.

2.2.4 *Alum Feed System*



Liquid alum (aluminum sulfate) is the coagulant used at the WTP. The coagulant is fed at the rapid mix basin. Liquid alum is stored and fed from the Chemical Feed Room and the feed system includes two (2) 1,000 gallon bulk storage tanks and metering pump. The room includes its own ventilation system which pulls air from the Superpulsator/Filter area and exhausts to the outside. In the future, consideration should be given to installing a day tank and scales to monitor the feed rate and chemical use more accurately.

2.2.5 *Polymer Feed System*

A polymer (Superfloc) is used to enhance the coagulation and flocculation process. The polymer is fed as the process stream exits the rapid mix basin to the Superpulsator's vacuum chamber. The polymer solution is prepared in a 50 gallon tank with an electric mixer and fed using a metering pump located in the Chemical Feed Room. The shipping drums are also stored in the Chemical Feed Room.

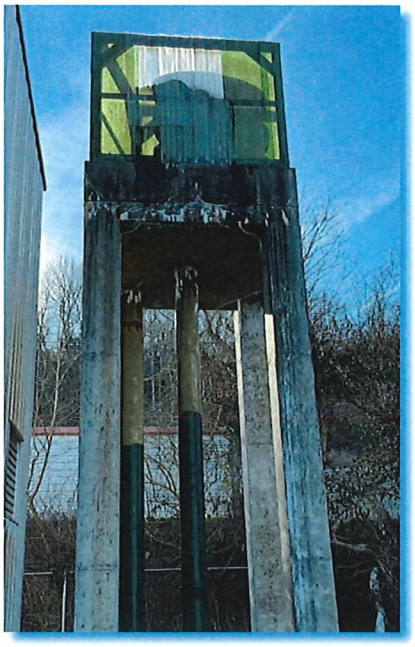
2.2.6 *Caustic Feed System*

Caustic soda (sodium hydroxide) is used for pH control. Caustic soda is stored in the open process area in a 1,000 gallon bulk tank. A transfer pump used to move the chemical to 60 gallon day tank before being fed at the rapid mix using a metering pump. Future consideration should be given to locating the chemical into an isolated room with ventilation or reconfiguring the chemical piping and tanks to be a closed system to prevent fumes from entering the process area.

2.2.7 *Fluoride Feed System*

Fluoride (fluorosilicic acid) is the used to improve dental health. Fluoride is fed into the filter effluent piping prior to the clearwell. The chemical is stored and fed from the Fluoride Feed Room and the feed system includes shipping drums, scales, and metering pump. The room includes its own ventilation system which pulls air from the Superpulsator/Filter area and exhausts to the outside.

2.3 Aerator



Groundwater from the wells is initially delivered to an aeration tower. The tower uses stacked, aspirating multi-stage aerator trays that operate using gravity as the driving force for the aeration. The aerator was designed for oxidation of iron and manganese. The aerator appears to be in good operating condition but Kenvirons staff could not inspect the interior of the aerator due to inaccessibility.

2.4 Rapid Mix

The rapid mix chamber measures 5'-8" x 5'-8" x 18'-6" deep. At the WTP's rated capacaity of 1.72 mgd, the rapid mix has a detention time of 223 seconds which is outside the *Kentucky Division of Water, General Design Criteria for Surface and Groundwater Supplies*. The KDOW criteria stipulates a detention time less than 30 seconds, however this requirement is not adhered to for the proprietary design of the Superpulsator clarifier. No redundant basin is provided as recommended in the KDOW design criteria.

2.5 Superpulsator Clarifier

The Superpulsator is a high-rate solids contact clarification unit. The proprietary design combines coagulation, flocculation, and clarification in one basin. The vacuum chamber generates flow pulsations which produces a homogenous sludge blanket for improved solids contact.

Each Superpulsator basin has dimensions of 26'8" x 12'-0" x 16'-0" deep. Solids contact clarifiers are sized based upon the surface loading rate and the Augusta WTP's Superpulsator basins experience a loading rate of 3.125 gpm/sq. ft at the design capacity with both basins operational. During maintenance periods when one basin is removed from service, the remaining basin should be limited to a loading rate of less than 4.0 gpm/sq. ft. or 1.10 mgd. The controller for the Superpulsator was replaced within the last five years and controls are in good working condition. The vacuum pumps and valves are showing their age and will need replacement in the near future.

2.6 Filters

The WTP has four granular media, gravity filters. Each filter is 12'-3" x 12'-3" x 9'-7" deep with lateral underdrain block, 12" gravel, 12" sand, and 18" anthracite. The filter loading rate at the WTP's design capacity and one filter remove from service is 2.78 gpm/sq. ft. which well below the maximum loading criteria of the 5.0 gpm/sq. ft. established by the KDOW.

Kentucky Rural Water recently took cores of the filter media and that the filters had lost some sand and anthracite and recommended that all media be replaced. The filters basins, gallery piping, and valves are in fair condition due to their age and future plans should include painting the pipes, replacing/rebuilding valve actuators, and replacement of the filter media. Consideration should also be given to the use of green-sand for improved manganese removal.

2.7 Clearwell

The clearwell is located beneath the WTP's main operating floor. The clearwell dimensions are 44'-6" x 36'-6" x 21'-5" deep, which yields a total volume of 260,150 gallons. The clearwell volume is 15% of the plant's rated capacity which meet the KDOW volume criteria. The clearwell is baffled in a serpentine pattern to improve the chlorine contact time and provide adequate disinfection. The condition of the clearwell could not be inspected but it is believed that the concrete tank is in good condition.

There is only one clearwell which does not meet the KDOW current design criteria which stipulates two separate compartments or separate clearwells shall be provided to allow maintenance without interrupting high service pumping.

2.8 Backwash Pumps

Two (2) vertical turbine pumps are used to backwash the filters, one duty and one stand-by. Each pump is designed for 3,000 gpm @ 43 ft. TDH. Review of the WTP piping and elevations indicate that the pumps are adequately sized to backwash the filters and the operators reported no issues with accumulated mud-balls or inadequate filter cleaning. The pumps and piping are in good condition, but the electrical controls are starting to show their age. If a second clearwell is constructed, then one backwash

pump should be moved to the new clearwell.

2.9 High Service Pumps

2.9.1 *Augusta High Service Pumps*

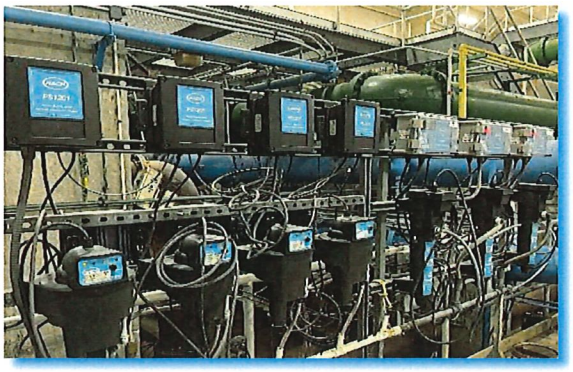
Water is pumped into the Augusta's distribution system using two (2) vertical turbine pumps, one duty and one stand-by. Each pump is designed for 500 gpm @ 171 ft. TDH. A shut-off head test was performed on Augusta HS Pump #2 which indicated the pump is operating closely to the original pump curve. A second pump test was conducted and the pump generated 280 gpm @ 212 ft. TDH, which is slightly more flow than what was expected based upon the performance curve. At an average daily consumption rate of 174,192 gallons per day, the pumps will operate 10.3 hours per day which allows sufficient time for maintenance and/or peak demand periods. The pumps appear to be in good condition, but the electrical controls and piping are starting to show their age.

2.9.2 *Bracken County Water District High Service Pumps*

Water is pumped into the Bracken County Water District's distribution system using two (2) vertical turbine pumps, one duty and one stand-by. Each pump is designed for 700 gpm @ 257 ft. TDH. A shut-off head test was performed on BCWD HS Pump #1 which indicated the pump is not operating according to the original pump curve. A second test was conducted on BCWD HS Pump #1 and the pump generated 510 gpm @ 241 ft. TDH, which is significantly less flow than what was expected based upon the performance curve. At an average daily consumption rate of 479,660 gallons per day, the pumps will operate 15.7 hours per day which still allows sufficient time for maintenance and/or peak demand periods.

BCWD HS Pump #2 was also tested. The pump generated 612 gpm @ 250 Ft. TDH, which is less flow than what expected based upon the pump's performance curve. At the average daily consumption rate for BCWD, the pumps will operate 13.1 hours per day. The pumps appear to be in good condition, but the electrical controls and piping are starting to show their age.

2.10 Process Monitoring



The WTP has equipment to monitor the treatment process and clearwell/tank levels. Turbidimeters continuously monitor the turbidity of the influent groundwater, top-of-filter, individual filter effluent, and combined filter effluent. The chlorine residual is continuously monitored at the top-of-filter and finished water or plant tap. In addition, the pH is monitored continuously, and the laboratory is equipped with desktop colorimeters to analyze for the typical water quality parameters.

2.11 WTP Building

The building envelope is a pre-engineered metal structure that houses concrete process basins and interior chemical rooms constructed using concrete masonry units and concrete floors and ceilings. The roof over the Process Section is a standing seam metal roof with a 2:12 slope. The Administrative Section is a lean-to extension off the Process Section with a metal roof at a 1:12 slope. The building exterior is in good condition and the interior structural steel, purlin and girts are in good condition but the plastic backing of the exposed insulation is brittle and damaged easily when touched.

2.11.1 *Plumbing*

The WTP's plumbing that was visible during our visits appeared to be in satisfactory physical condition and backflow preventers were in place to prevent contamination of the potable water.

2.11.2 *Electrical Panels*

Existing switchboards are in decent condition. The age of the switchboards would suggest replacement in the near future. Components such as circuit breakers, switches, etc. become obsolete overtime and retrofit possibilities are not always available.

2.11.3 *Standby Power*

The WTP is currently not equipped with standby power. Under the current standards, dedicated standby power is required so that water may be treated and pumped to the distribution system during power outages at the average day demand.

Chapter 3
Renewals, Replacements, and Improvements

3.1 General

After reviewing of the Augusta Water Treatment Plant design plans, touring the facility, and discussing the operations with the plant supervisor, we are of the opinion that the water plant is in fair condition for a plant that is 26 years old. We are also of the opinion that the water treatment plant is operated within accepted norms and practices of similar plants located in the Commonwealth of Kentucky.

The WTP went online during 1996 and several components need renewal and/or replacement and, since its original design, the regulations and requirements for treatment facilities have changed and improvements are needed to meet the current standards. The following is a summary of the renewals, replacements, and improvements that need to be considered in the future.

3.2 Groundwater Wells

The groundwater wells are in good operating condition but the electrical disconnects, motor starters, etc. need to be replaced due to the age of the equipment. The following are the specific items associated with the groundwater wells:

- Replace the electrical disconnects, motor starters, and control panels at all four (4) wells.
- Install new telemetry controls for all four (4) wells.
- Paint the electrical service platform for Wells No. 1, 2, and 3.
- Paint the well housing at Wells No. 1, 2, and 3.
- Install bollards or fencing at Wells No. 1, 2, and 3.
- Paint the piping, valves, and casing at Well No. 4.

3.3 Chemical Storage and Feed

The chemical feed systems are functional but it is evident that the operators have made several repairs to the chemical piping over the years and all the metering pumps have been replaced. To bring the chemical feed systems to the current standards, the following items are recommended:

- Replace the existing service water and chemical feed piping with new Sch. 80 PVC and color code all piping.
- Replace the chlorine leak sensor and relay alarms to the plant's SCADA System.

- Paint the chlorine scale and trunnions.
- Replace the metering pumps used for permanganate, liquid alum, polymer, caustic soda and fluoride. Each metering pump to include a pressure relief valve, backpressure valve, and calibration column.
- Refurbish the existing metering pump and store as spare or backup pumps.
- Replace the permanganate mixing tank and mixer. Install the new tank in a spill containment basin.
- Replace the liquid alum bulk tanks and install new day tank
- Replace the polymer blending tank and mixer
- Replace the caustic soda bulk tank and day tank
- Replace the fluoride day tank and scale

3.4 Superpulsator Clarifier

The concrete basins, settling plates, and internal piping are in good operational condition. The following recommendations are made concerning the equipment associated with the Superpulsator:

- Replace the three (3) vacuum pumps and associated valves.
- Vent the pulsation valves and vacuum pumps to the exterior of the building.
- Replace the electrical disconnects for the vacuum pumps and rapid mixer.
- Replace the Superpulsator control panel and motor starter for the vacuum pumps and rapid mixer.
- Replace the blowdown valves and piping.

3.5 Filters

Kenvirons recommends the following improvements be made to the filters:

- New filter control consoles and interface to Main Control Panel
- Replace all media and filter block
- Replace the surface wash arms and piping
- Replace the valve actuators
- Replace the loss-of-head DP cells
- Paint the filter piping

3.6 Clearwell & High Service Pumps

As stated earlier, the current regulations require redundancy at the clearwell and high service pumps so the high service pumps can always deliver water to the distribution system and allow for maintenance.

To correct the deficiency, it is recommended that separate wetwell be constructed with the filter effluent capable being diverted to the basin. New high service pumps will also be installed to pump directly from the wetwell to the distribution system.

3.7 WTP Building

The proposed improvements include items associated with the general renewal of the WTP building. The following are the specific items associated with this renewal and replacement project:

- Paint the interior walls and ceilings
- Install new flooring in the Administration Section

Chapter 4
Opinion of Probable Cost

4.1 Construction Cost Estimate

Rapid Mix	50,000
Pulsator Pumps & Valves	100,000
Clearwell Addition	400,000
Filters	500,000
Internal Piping & Valves	375,000
Instrumentation & Controls	400,000
Chemical Feed Equipment	150,000
High Service Pumps (3)*	175,000
Backwash Pump (2)	150,000
Building Improvements	100,000
Raw Water Wells	TBD
Standby Generator	100,000
TOTAL ESTIMATED CONSTRUCTION COST	**$2,500,000**

4.2 Project Cost Estimate

Construction	2,500,000
Contingency	250,000
Engineering	200,000
Inspection	125,000
Preliminary Engineering Report	25,000
Interest During Construction	100,000
Legal & Administrative & Environmental	50,000
TOTAL	**$3,250,000**