Kentucky American Water
Lexington, Kentucky

RECEIVED
MAR 30 2007
PUBLIC SERVICE
COMMISSION

Case No. 2007 - 00134

Kentucky River Pool 3 Water Treatment Plant

Basis of Design Report

June 13, 2006

Revised March 2007

Exhibit A – Specifications
Volume III

GANNETT FLEMING
Harrisburg, Pennsylvania

Kentucky American Water
Lexington, Kentucky

Kentucky River Pool 3 Water Treatment Plant

Basis of Design Report

June 13, 2006

Revised March 2007

3/5/07

GF Project No. 45260

Gannett Fleming, Inc.
Harrisburg, Pennsylvania

KENTUCKY AMERICAN WATER
KENTUCKY RIVER POOL 3 WATER TREATMENT PLANT
BASIS OF DESIGN REPORT

CONTENTS

Tables

KENTUCKY AMERICAN WATER
KENTUCKY RIVER POOL 3 WATER TREATMENT PLANT
BASIS OF DESIGN REPORT

CONTENTS

Appendices

Exhibits

A. Background

The need for additional source of supply and/or water treatment capacity to meet future demands has long been recognized by Kentucky American Water (KAW). In 1998, KAW began final planning and design of an Ohio River supply project, which would include bulk purchase of treated water from the Louisville Water Company and transmission of the water to the KAW system through a large-diameter main; however, this project met with significant public opposition and work was eventually halted.

The Bluegrass Water Supply Consortium (BWSC) was formed in 1999 to identify and implement a regional solution to the area's water supply deficiencies. A report in February 2004 documented a conceptual network of treated water pipelines, construction of a new water treatment plant (WTP) to treat water from the Kentucky River Pool 3, and a supplemental raw water supply pipeline from the Ohio River as the solution to the regional water supply deficiencies. KAW supports a regional solution to the water supply problem, actively participating and providing resources to the BWSC. Under regulatory and customer pressure, KAW committed to present its plan to the PSC by Spring 2007, announcing it would build a treatment plant and transmission line for adequate water supply by 2010. KAW is continuing to work with the BWSC on a partnership for the new facilities.

During the design of the proposed water treatment plant, KAW decided to incorporate into the design an additional 5 MGD capacity module. To accomplish this, the design is being supplemented to accommodate an additional 5 MGD capacity for the BWSC. The facility requirements for this capacity are described in Addendum 1 to this document. The decision as to whether to construct the additional capacity will be made at a later date.

B. Proposed KAW WTP

The proposed pumping and treatment facilities are designed with an initial treatment capacity of 20 mgd and a hydraulic capacity of 30 mgd. The facilities are to be configured so that future treatment expansion to 30 mgd is possible. Treatment expansion could be accomplished by high rating the proposed process units or constructing new parallel process units.

A process flow diagram schematically representing the pumping and treatment facilities schematically is shown on Exhibit 1.

The new WTP will be constructed on recently acquired property that is located in Owen County just north of the dividing line between Owen and Franklin counties. The raw water intake will be located at Pool 3, with water flowing by gravity approximately 150 feet to the Raw Water Pumping Station, with an operating floor elevation located above the 500 year flood elevation. Water will be pumped approximately 1,300 feet to the water treatment plant. A clarification and filtration process will be provided to remove suspended and colloidal particles, including iron and manganese, natural organic matter (NOM), and pathogenic microorganisms in the raw water. Chemical treatment will be provided for oxidation of soluble iron and manganese, taste and odor control, pH adjustment, coagulation, corrosion control, disinfection, and emergency mitigation of chemical spills in the river. The proposed clarification and filtration processes are highly effective in removing pathogenic cysts such as *Giardia* and *Cryptosporidium* when chemical pretreatment is optimized. There will also be provisions to add granular activated carbon (GAC) as a filter media in place of anthracite in the filters, to further provide taste and odor control, if necessary.

Post-filtration disinfection with chlorine will be provided as an additional primary barrier to *Giardia* and viruses. The cast in place concrete finished water storage clearwell will be designed to provide disinfection contact time (CT) for no less than 4 log virus and 1 log *Giardia* inactivation and backwash and equalization storage. Provisions are included for future installation of ultraviolet light disinfection, should it become necessary to enhance disinfection and provide an added barrier against *Giardia* and *Cryptosporidium.* Finished water will be pumped to the transmission system via a new high service pump station.

Process wastewater facilities will include wastewater clarification, sludge thickening, and dewatering with belt filter presses. Clarified wastewater will be discharged to the Kentucky River in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. Dewatered sludge will be utilized for beneficial use, either onsite or at a nearby site recently acquired by KAW and located just above the floodplain near Pool 3 of the Kentucky River.

A. KAW Water Demands

Recently, KAW updated its demand projections. This projection included 2005 actual data and includes water demand projections for both normal weather conditions and hot, dry weather conditions, including drought events. Presented below in Table 2.1 is a summary of the water demand projections for 2005, 2010, 2020, and 2030. The numbers presented for 2005 are the actual usage.

Table 2.1: KAW Water Demand Projections, mgd

Flow Condition	2005	2010	2020	2030
Normal Weather				
Average Day	44.2	40.1	43.8	46.5
Maximum Day	56.9	70.1	76.2	80.8
Hot, Dry Weather				
Average Day	41.0	42.7	46.6	49.5
Maximum Day	74.5	77.7	80.9	85.6
Drought Average Day		54.0	59.0	62.0

B. KAW Existing Supply

KAW has two existing water treatment facilities. These facilities have a combined reliable capacity of 65 mgd. The sources of supply for these two existing facilities are Pool 9 of the Kentucky River and the Jacobson Reservoir. The withdrawal permit from Pool 9 (permit 0200) is 63.0 mgd between May and October if the river flows are in excess of 140 cfs (90 mgd). The permitted withdrawal is reduced based on river flows and is 45 mgd when the river flows are between 0 and 29.99 cfs (19.4 mgd). The lower limit of the permit, occurring if Drought Phase 6 is reached, is 30 mgd.

Due to the installation of sluice gates in upper pools of the Kentucky River (Pools 10-14), the Kentucky Division of Water has on an annual basis increased the lower limit of permit 0200 from 30 mgd to 35 mgd. Since 2001, KAW has received this increase annually each time it has requested it. In the report titled "Water Supply Study" dated September 2005 and prepared by Gannett Fleming, a safe yield analysis was done to confirm the permit limits on Pool 9. Based on the referenced study and the annual permit increases, 35 mgd will be used as the current reliable supply in determining the required capacity for the new WTP.

C. WTP Capacity

Per Table 2.1, the 2020 projected drought average day demand is 59 mgd. Given the existing reliable supply of 35 mgd, the new WTP would need to supply the difference of 24 mgd. By the year 2030, the difference in projected drought demand and existing supply increases to 27 mgd.

In addition to the anticipated plant production during drought conditions, the required production during non-drought hot, dry conditions needs to be considered. In the year 2020, the expected maximum day demand is 80.9 mgd. Considering the reliable capacity of the existing plants is 65 mgd, a plant capacity of 15.9 mgd is needed. By the year 2030, this value grows to 20.6 mgd.

The plant capacity proposed for this project is 20 mgd. This value was selected to balance the 2020 shortfall in supply during droughts of 24 mgd and the smaller shortfall in treatment capacity of 15.9 mgd, while avoiding oversizing the plant for the majority of the demand conditions.

Provisions for producing the additional 4 mgd in case of a drought are included in the WTP design. Since the state of Kentucky requires that all water treatment facilities be designed with a certain amount of reliability, the pumping and filtration capacity will be provided so that if the largest unit is out of service, the WTP can still produce 20 mgd. There will be five filters at the WTP, so with all filters in service the WTP could produce 25 mgd at reasonable surface loading rates. The pumps are also sized to reliably produce 24 mgd with one unit out of service, so it is possible for the WTP to be safely operated at flows up to 24 mgd. Generally, this approach would not be taken if the WTP were to be the only plant in the system, but because this WTP will be the third and smallest WTP in the system, the other two WTPs would be in a position to supply the additional 4 mgd. It is extremely unlikely that the largest unit would be out of service at all three plants at the same time.

D. Anticipated WTP Production, mgd

1.	Minimum	4.0
2.	Winter Average	6.0
3.	Summer Average	15.0
4.	Maximum	20.0
5.	Ultimate	30.0

E. Hydraulic capacity of underground piping and other facilities not easily expandable, mgd 40.0

3.0 Water Treatment Requirements

Based upon present and recently promulgated drinking water regulations and the surface water classification and raw water characteristics of the Kentucky River, the treatment requirements indicated in Tables 3.1 and 3.2 must be consistently maintained.

Table 3.1: Applicable Drinking Water Regulations and Requirements

Regulation	Requirement
Surface Water Treatment Rule (SWTR)	A clarification/filtration system that achieves 2.5-log removal of *Giardia* cysts based on compliance with turbidity requirements of the SWTR.
SWTR	A disinfection system which achieves a 3.0-log removal and inactivation of *Giardia* cysts and 4.0-log inactivation of viruses.
Kentucky Department of Water	A disinfection system that is operated so as to provide 1.0-log inactivation of *Giardia* cysts, with a recommendation that the log inactivation is achieved after filtration.
Interim Enhanced Surface Water Treatment Rule (IESWTR)	A clarification/filtration system that achieves 2.0-log removal of *Cryptosporidium* cysts.
IESWTR	A clarification/filtration system which achieves a turbidity reduction below 0.30 NTU in 95% of all samples from all filters combined and less than 1.0 NTU in 100% of all samples.
Stage 1 - Disinfectant/Disinfection Byproduct Rule (Stage 1 D/DBPR)	Total trihalomethane (TTHM) concentration in the distribution system less than 80 µg/l. Haloacetic acid (HAA5) concentration in the distribution system less than 60 µg/l. Compliance values based on a running four-quarter average of all samples.
Stage 1 D/DBPR	Quarterly running annual average total organic carbon (TOC) removal percentage below those indicated in Table 3.3 based upon raw water alkalinity and TOC and combined filter effluent TOC.
Safe Drinking Water Act (SDWA)	Finished water with primary contaminant concentration less than all Primary Drinking Water Standards
SDWA	Finished water with secondary contaminant concentration less than the Secondary Drinking Water standards.
Lead and Copper Rule	Production of stable non-corrosive water that will comply with the Lead and Copper Rule and minimize corrosion, precipitation and deposition within the distribution system.
Total Coliform Rule	Finished water in distribution system with zero total and fecal coliform and E. Coli.

Table 3.2: Recently Promulgated Drinking Water Regulations and Requirements

Regulation	Requirement
Long Term 2 Enhanced Surface Water Treatment Rule	The combined *Cryptosporidium* log inactivation/removal from the proposed process shall be designed and operated to achieve the 3 log *Cryptosporidium* removal necessary for Bin 1 classified source waters with provisions for future implementation of enhanced disinfection to achieve greater than a total of 5.5 log *Cryptosporidium* inactivation/removal necessary for a Bin 4 classified surface water source. While current sampling indicates the WTP is likely to fall in the Bin 1 category, if the WTP is placed in Bin 2, treatment for 4 log removal will include clarification and filtration facilities designed and operated to maintain combined filter effluent turbidity less than 0.15 NTU and individual filter effluent turbidity less than 0.15 NTU 95% of time. Provisions for enhanced disinfection with ultraviolet light will be included for future installation.
Stage 2 Disinfectant and Disinfection Byproduct Rule	The running annual average from each sample location in the distribution system shall not exceed 80 µg/l TTHM and 60 µg/l HAA5.

Table 3.3: Total Organic Carbon (TOC) Removal Requirements

Alkalinity, mg/L	0 – 60	> 60 - 120	> 120
TOC	**% Removal**	**% Removal**	**% Removal**
>2 - 4	35	25	15
>4 - 8	45	35	25
>8	50	40	30

In addition to the regulatory requirements stated in the preceding section, the following water quality and treatment technique goals are established to furnish a consistent high quality and aesthetically pleasing drinking water meeting or exceeding existing recently promulgated regulations. These treatment objectives are not to be understood as regulatory requirements, but are established as goals to better assure consistent compliance with regulatory limits.

1. Maintain clarified water turbidity less than 1.0 NTU on a consistent basis with maximum levels no greater than 2.0 NTU.
2. Maintain turbidity levels from each filter continuously below 0.10 NTU, following the ripening period.
3. Maintain turbidity from each filter during the ripening period after backwash less than 0.2 NTU and accomplish this in less than a 15 minute period of filtering to waste.
4. Maintain monthly TOC removal at or below percent removal requirements shown in Table 3.3.
5. Maintain combined filter effluent Specific Ultraviolet Absorbance (SUVA) below 2.0 L/mg-m on a monthly basis to utilize as an alternative compliance criteria and indicator of effective enhanced coagulation.
6. Limit formation of disinfection byproducts by minimization of prechlorination.
7. Limit TTHM concentrations from all sample locations in the distribution system to less than 80 μg/l.
8. Limit HAA5 concentration from all sample locations in the distribution system to less than 60 μg/l.
9. Produce finished water with zero viable *Giardia* cysts, *Cryptosporidium* oocysts, *Legionella, E. Coli* and viruses.
10. Produce finished water with iron consistently less than 0.01 mg/L and manganese less than 0.02 mg/L.
11. Produce finished water that minimizes solubility of lead, copper and other metals in distribution and household plumbing systems by maintaining pH and alkalinity in a range to optimize use of corrosion inhibition chemicals and a phosphate

residual of approximately 0.2 mg/L in the extremities of the distribution system.

12. Produce finished water that consistently has pleasing taste and odors below 3 threshold odor number (TON).

5.0 Raw Water Quality and Anticipated Chemical Usage

A. Kentucky River Pool 9 Raw Water Quality - January 1, 2005 to November 27, 2005

Parameter	Minimum	Average	Maximum
Turbidity, ntu	2	26	567
pH	7.3	7.8	8.5
Alkalinity, mg/L	42	84	150
Hardness[1], mg/L	104	147	229
Iron[1], mg/L	0.07	0.77	1.67
Manganese[2], mg/L	0.04	0.24	1.10
TOC[1], mg/L	1.27	2.71	4.75

[1]Based on monthly data from January 2002 to June 2005.

[2]From reported USGS data collected at Kentucky River Pool 2 from 1972 to 1995.

B. Kentucky River Pool 3 Raw Water Quality Sample - August 2006

1.	Turbidity, ntu	18
2.	pH	8.0
3.	Alkalinity, mg/L	124
4.	Hardness, mg/L	127
5.	TOC, mg/L	3.79
6.	*Cryptosporidium*, oocysts/L	None detected

C. Existing Chemical Usage at the Kentucky River Station WTP (Pool 9) - January 2005 to November 2005

Chemical	Concentration (mg/L)		
	Minimum	Maximum	Average
Coagulant - Ferric Chloride[1]	14.4	96.3	40.4
Coagulant - Polyaluminum Chloride[1]	1.0	106.4	22.1
Coagulant – Cationic Polymer	0.90	3.75	2.14
Coagulant Aid[1]	0.10	0.38	0.19
Chlorine[2]	2.46	9.68	6.40
Ammonia	0.38	2.06	1.14
Fluoride[3]	0.90	6.81	4.11
Carbon[1]	0.4	2.9	2.2
Caustic Soda[1]	0.09	21.02	9.26
Corrosion Inhibitor[3]	1.55	15.64	2.90

[1]These chemicals were fed intermittently. Concentrations are based on the periods when they were applied. Carbon was applied only three days. Design dose will be provided to allow treatment of taste and odor and chemical spills.

[2] Pre-chlorine is normally applied with no post-chlorination. This facility will minimize pre-chlorination, apply a low filter influent dose, apply pre-clearwell dose to achieve target disinfection CT and apply a post clearwell dose with ammonia to form a total chlorine residual.

[3]Maximum reported fluoride and corrosion inhibitor doses at the Kentucky River Station WTP are higher than recommended for water treatment. The design maximum doses for fluoride and corrosion inhibitor at the Kentucky River Pool 3 WTP are 1.3 mg/L and 5.0 mg/L, respectively.

[4] Potassium permanganate was not applied during the period of record but will be provided to provide an alternate pre-oxidant to pre-chlorine.

A. Design Concept

Source water is to be withdrawn from the Kentucky River at Pool 3. Intake screens will be wedge wire basket screens in a tee configuration. Screens will be manifolded together and located within the river, approximately 25 feet offshore. The facility will be designed for addition of future screens to support the ultimate design capacity.

Two intake mains will be hard-piped from the screen manifold to the pumping station, where flow will split to four raw water pumps. Access shall be provided to allow intake main maintenance.

An air burst backwash system will be provided for automated screen cleaning based on time or differential pressure.

B. Intake Facilities

1. Flow, mgd

a.	Minimum	4.0
b.	Winter average	6.0
c.	Summer average	15.0
d.	Maximum	20.0
e.	Ultimate	30.0

2. River levels

a.	Lock and Dam 3 weir level	457.13
b.	Upstream sill elevation	448.52
c.	Downstream sill elevation	437.47
d.	Minimum water level	455.13
e.	100 year flood level (GF HEC Study)	493.21
f.	500 year flood level	499.40
g.	Maximum barge draft (based on upper sill)	8.61

3. Intake Screens

a.	Type	Wedgewire tee screens
b.	Material	Stainless steel

c. Number of screens — 2, and1 future

d. Capacity per screen, mgd — 15

e. Diameter, feet — 3.5

f. Maximum through slot velocity, fps — 0.5

g. Screen slot opening, inches — 1/8

h. Number of intake levels — 1

i. Minimum screen submergence — one screen diameter

j. Centerline screen elevation (Upper sill minus screen diameter / 2) 446.50
(Set top of screen at sill level to ensure intake will be below barge draft)

k. Provide buoy, alarm horns and screen protection

C. Airburst Backwash System

1. Design air burst compressor, receiver and piping system to deliver 3 screen volumes of air to each individual screen over a period of 1 to 2 seconds.

2. The air compressor system shall be designed to recharge the receiver system in no greater than 30 minutes.

3. Provide individual pneumatically operated valve and air supply line for each screen. Provide connections for future screen air supply.

4. Air supply piping to be type 304 stainless steel.

5. Location

a. Compressor — Raw water pumping station

b. Receivers — Raw water pumping station

c. Air burst valves — Raw water pumping station

d. Control station — Raw water pumping station

6. Compressor

a. Type — Skid mounted rotary screw or reciprocating

b. Number — 2

c. Controls — Backboard mounted control panel, HOA switch for each compressor, auto alternation, low pressure alarm, normal pressure/receiver ready lights

d. Pressure, psi — 140

e. Horsepower — 10

7. Receiver

a. Number — 1, with an auxiliary receiver for valve control

b. Capacity, gallons 660

c. Auxiliary receiver capacity, gallons 12

d. Configuration Vertical

8. Valves

a. Type Pneumatic operated bubble tight butterfly

b. Size, inches 6

c. Controls

1) Auto timer with adjustable duration between bursts

2) Automatic head loss control based on setpoint differential water level

3) Remote manual control

4) Local manual control

5) Solenoid valves for air burst valves to allow manual operation

D. Chemical feed Points

1. Future Zebra Mussel polymer, at each screen
2. Potassium permanganate, at each screen
3. Include provisions for extending chemical feed to future screen

E. Intake Main

1.	Velocity, fps	3-5
2.	Material	Ductile iron, cement lined
3.	Number	2
4.	Diameter, inches	30
5.	Flow within velocity criteria, mgd	10-16, single main 19 - 30 dual main
6.	Velocity at minimum flow, fps	1.3

F. Intake Main Flushing

1. Provide capability to back flush main from raw water pumping station to intake.
2. Provide reduced pressure flushing water from raw water main.
3. Provide discharge capability at intake without backflow through screens.

G. Raw Water Monitoring

1. Provide raw water sample upstream of chemical addition. Pump to raw water pumping station for turbidity and pH monitoring.
2. Provide stilling well for river level transmitter.

A. Design Concept

1. Vertical turbine pumps drawing water from a wet well formed by the foundation caisson.
2. Ultimate capacity to be provided with additional pump in spare location.
3. Fully flood proofed facility with electrical and mechanical equipment no less than 2 feet above worst flood of record.
4. Maximum discharge pressure, psi — 120±

B. Facilities - Raw Water Pumping Station

1. Elevations, ft.
   a. 500-year flood level (GF HEC Study) — 499.40
   b. Pump room floor elevation, feet — 502
   c. Pump suction hydraulic grade, ft. Elev.
      1) Normal water level — 457.13
      2) Low water level — 455.13
   d. Water treatment plant influent hydraulic grade, ft. Elev. — 762.67±
2. Raw water pumps
   a. Type — Vertical turbine with open line shaft and clean water pre-lube
   b. Number — 4 plus 1 future
   c. Overall pumping requirements, mgd
      1) Minimum Flow — 4
      2) Winter Average Flow — 6
      3) Summer Average Flow — 15
      4) Maximum Flow — 20
      5) Ultimate Flow — 30
      6) Firm Capacity, largest unit out of service
         i) Initial design — 24
         ii) Ultimate design — 30

d. Pump design criteria

	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Pump No. 5
Type	**Vertical Turb.**	**Vertical Turb.**	**Vertical Turb.**	**Vertical Turb.**	**Future**
Rated Capacity (MGD)	10	10	7	7	6
Rated Head (feet)	325	325	325	325	325
Horsepower	700	700	500	500	500
Nominal Motor Speed	1,200	1,200	1,200	1,200	1,200
Motor Voltage	4160	4160	4160	4160	4160
Constant Speed or VFD	VFD	VFD	Constant	Constant	Constant
Discharge Diameter (inches)	20	20	16[2]	16[1]	16[1]
Discharge Centerline Elevation (feet)	505 +/_	505 +/_	505 +/_	505 +/_	505 +/_

[1]Increase to 20-inch connection at discharge isolation valve for future pump change-out to larger capacity

1) Pump design to provide a flow continuum from 4 mgd to 24 mgd based on pump selected and speed control

2) Motors - 4160 V, 3 phase, 60 hz motors

3. Pump discharge

a. Discharge maximum velocity, fps 8

b. Manifold maximum velocity, fps 5

c. Material flanged ductile iron

d. Appurtenances

1) Vacuum/air release valve

2) Pressure gauge, psi range 0-200

3) Discharge check valve Tilting disk

4) Isolation valve Butterfly

5) Surge facilities Surge anticipator valve

6) Pressure switch, high, normal, low, each discharge header

7) Pump pre-lube water, potable, with flow switch.

4. Pump discharge manifold appurtenances

a. Appurtenances

1) Pressure transmitter

5. Appurtenances for pump station

   a. Raw water sample to analyzers from submersible pump
   b. Raw water turbidimeter
   c. Raw water pH meter
   d. Raw water temperature transmitter
   e. Traveling bridge crane
   f. Ultrasonic level transmitter for wet well
   g. Temperature controlled environment as required for variable frequency drives
   h. Plant service water setting with pressure reducing valve (80 psi) for pump lube water, chemical feed facilities, washdown/flushing and eyewash/shower.
   i. Eyewash and shower
   j. Electrical room
   k. Space for air burst equipment
   l. Potassium permanganate day tank and feed area with spill containment.

6. Chemical Application

   a. Potassium permanganate – points of application within raw water intake screens and into raw water wet well. Volumetric feeder and chemical storage facilities are to be located at the WTP, while a day tank and chemical feed pumps are to be located at the RWPS.

A. General Design Criteria for Chemical Storage and Feed Facilities

1. Bulk Storage: 30-day storage at ultimate average flow and average feed rate which is equivalent to 20 mgd flow and average feed rate.
2. Day Tanks/ Hoppers: 24-hour storage at ultimate flow (30 mgd) and maximum dose.
3. Transfer - transfer to day tanks
   a. Size for transfer in 2 minutes for smaller day tanks with manual pushbutton control
   b. Size for transfer in 20 minutes for larger day tanks with fully automated, manually initiated transfer
4. Provide spill protection and containment for chemical storage and transfer.
5. Provide flexible connectors at all piping connections to bulk storage tanks
6. Chemical Feeders
   a. Size for maximum flow and feed rate, initial capacity
   b. Sized to handle minimum flow/minimum feed rate within the manufacturer's recommended turn-down limits
   c. Control – Automatic flow pacing or compound loop pacing
   d. Chemical feed pumps to be single head
7. Redundancy
   a. Provide single feeder for each primary application point and one standby feeder. When possible a common spare feeder can be used.
   b. Provide secondary application points, where appropriate, to provide treatment flexibility.
   c. Provide redundant feed lines for critical chemicals when lines are difficult to access.
8. Future Chemical:
   a. Provide space in plant layout for future chemical feed room, with provisions for containment.

B. General – Pretreatment Chemicals

A series of pre-treatment chemicals will be fed to the process stream between the raw water intake and the filters. These chemicals and feed rates were determined based on the

Kentucky River water quality, the treatment goals established for the WTP, and past chemical usage at the Kentucky River Station, which treats water from Pool 9 of the Kentucky River.

Chemical feed points are shown on the Process Flow Diagram in Exhibit 1. As shown in Exhibit 1, alternative feed points for some of the chemicals are provided for flexibility. The purpose and application points of selected treatment chemicals and the chemical facilities are tabulated in the following articles. The detailed chemical dosages, daily usage rates, chemical feed system and bulk and daily storage requirements are included in Appendix A.

C. Purposes and Application Points of Pre-treatment Chemicals

Chemical	Purpose	Feed Points	Control
Potassium Permanganate $KMnO_4$	Primary • Oxidation of iron and manganese • Zebra mussel control Secondary • Oxidation of some tastes and odors	Primary: Raw water pumping station wet well, just after intake pipe entrance Secondary: Raw water intake screens	Flow paced based on raw water flow
Powdered Activated Carbon (PAC) C	Primary • Taste and odor control Secondary • Adsorption of color • Adsorption of NOM • Spill control	Primary: Raw water pipe, as far upstream from WTP as practical (Provide multiple access points along feed line route for maintenance of feed hose - leave secondary containment ends open into access chamber for leak detection)	Flow paced based on raw water flow
Chlorine Cl	Primary • Disinfection • Inhibit microorganism growth in filter media and enhance particle removal Secondary • Oxidation of iron and manganese	Primary: Common filter influent (provide redundant feed lines) Secondary: Raw water main, upstream of rapid mixers.	Flow paced based on filter effluent flow and trimmed based on filter influent sample Flow paced based on raw water flow
Caustic Soda NaOH	Primary • See post-treatment chemicals, below Secondary • pH adjustment and alkalinity • Addition for coagulation • Oxidation catalyst	Secondary: Raw water main, upstream of rapid mixers Secondary: Common filter influent	Raw water flow paced and trimmed based on mixed water pH analyzer Flow paced based on filter effluent flow
Polyaluminum chloride[1] (PACl)	• Coagulation	Primary: Rapid mixer No. 1 Secondary: Rapid mixer No. 2	Flow paced based on raw water flow and trimmed based on streaming current
Ferric Chloride[1] FeCl	• Coagulation	Primary: Rapid mixer No. 1 Secondary: Rapid mixer No. 2	Flow paced based on raw water flow and trimmed based on streaming current
Coagulant Aid Polymer	• Enhance coagulation process	Primary: Rapid mixer No 2 Secondary: Rapid mixer No. 1 Secondary: Downstream of pre-treatment rapid mixer	Flow paced based on raw water flow
Filter Aid Polymer	• Enhance filter performance	Primary: Common filter influent	Flow paced based on filter effluent flow

[1]The WTP will not be feeding PACl and FeCl simultaneously, but will have multiple tanks to allow switching between the two coagulants as water quality necessitates.

D. General – Post Treatment Chemicals

The post-treatment chemicals that are added to the filtered water or clearwell effluent include chlorine, ammonia, caustic soda, fluoride and corrosion inhibitor. Provisions are also included for adding polyaluminum chloride to the washwater and sodium thiosulfate to dechlorinate process wastewater. The purposes and the feed points for each are summarized in the following articles. The points of application are also depicted in Exhibit 1 (Process Flow Diagram). The detailed chemical dosages, daily usage rates, chemical feed systems, and storage requirements are described in Appendix A.

E. Purposes and Locations of Post Treatment Chemicals

Chemical	Purpose	Feed Points	Controls
Chlorine Cl	Primary • Disinfection	Primary: Clearwell Influent, normally fed (provide redundant feed line) Primary: Clearwell effluent, boost residual Secondary: Influent to second cell of the clearwell.	Clearwell influent flow paced based on filter effluent flow and trimmed based on clearwell influent chlorine analyzer Flow paced based on finished water flow and total chlorine residual Flow paced based on filter effluent flow
Caustic Soda NaOH	Primary • pH adjustment • Corrosion control	Primary: Clearwell Effluent (provide redundant feed lines) Secondary: Clearwell Influent	Flow paced based on finished water flow and trimmed based on finished water pH analyzer Flow paced based on filter effluent flow and trimmed based on finished water pH analyzer
Aqua Ammonia NH_3	• Formation of chloramines to minimize DBP formation and provide total chlorine residual	Primary: Clearwell effluent (provide redundant feed lines) Secondary: Clearwell influent Secondary: Influent to second cell of the clearwell	Flow paced based on finished water flow and trimmed based on ammonia and total chlorine residual Flow paced based on filter effluent flow and trimmed based on total chlorine residual
Fluoride (Hydrofluosilicic Acid)	• Fluoridation of the water to prevent dental cavities	Primary: Clearwell effluent, downstream of the washwater withdrawal, but upstream of the high service pumps (provide redundant feed lines) Secondary: Clearwell influent	Flow paced based on finished water flow Flow paced based on filter effluent flow
Corrosion Inhibitor (CI)	• General corrosion control • Lead and copper solubility reduction	Primary: Clearwell effluent, downstream of the washwater suction, but upstream of the high service pumps (provide redundant feed lines)	Flow paced based on finished water flow
Sodium Thiosulfate	• Dechlorinating process wastewater	Primary: Clarified wastewater discharge pipe, at point where pipe enters WTP	Flow paced based on wastewater discharge flow and trimmed based on wastewater discharge chlorine residual
Polyaluminum chloride (PACl)	• Assist in ripening filters	Primary: Filter washwater	Washwater coagulant based on concentration target, filter basin volume, and low wash rate
Wastewater Polymer	• Enhance settling of residuals	Primary: Wastewater drain Primary – Common sed basin blowdown	Flow paced based on backwash flow Flow paced based on sedimentation basin blow down
Dewatering Polymer	• Improve dewatering	Primary: Belt filter press feed	Manually adjusted at the Dewatering Building

D. Chemical Facilities

The primary components of the chemical systems are listed in the table below. Tank and pump capacities are listed in Appendix A.

Chemical System	Feed Equipment	No.	Location
Potassium Permanganate One drum-fed volumetric feeder, dissolver tank and mixer with a drum inverter at WTP with solution transfer to RWPS	a. Storage – Drums (330 lb net weight) b. Volumetric feeder, tank, mixer (WTP) c. Transfer Pump to WTP batch tank d. Batch tank 550 gallons (WTP) e. Transfer pumps to RWPS (WTP) f. Day tank 1400 gal (RWPS) f. Scale (WTP) g. Metering pumps (RWPS)	20 1 1 1 2 1 1 2	Potassium Permanganate area at WTP and Raw Water Pumping Station
Chlorine Gas phase vacuum chlorinator system with cylinder mounted vacuum regulators, Auto switchover and remote eductors at feed points	a. Ton cylinder storage b. Two-ton scales c. Chlorinators (Filt Inf, CW Inf, and CW Eff Feeders with Pre-Common Spare) d. Chlorine scrubber e. Space for future evaporator	10 2 4 1 1	Chlorine Storage Room Chlorine Storage Room Chlorine Feed Room Exterior Installed dry scrubber Chlorine Storage Room
Powdered Activated Carbon Frame mounted Super Sacks with volumetric feeders and eductor pumps	a. Super sack storage; 15,000 lbs. b. Super sack unloading system c. Hopper with vibration system d. Dry volumetric feeder e. Future dry volumetric feeder f. Educting system g. Slurry tank h. Load cells	1 1 1 1 1 1 1 4	Carbon Storage Room, 2nd Floor WTP Carbon Feed Room, 1st Floor WTP
Caustic Soda Bulk storage of 50% caustic soda with auto transfer system to day tank and one post, one pre, and one spare chemical feed pump	a. Bulk tanks; 5,000-gal. (50% caustic soda) b. Transfer pumps, 50 gpm c. Day tanks; 1000 gal. d Diaphragm metering pumps (size for 25% caustic soda) e. Hot water for flushing feed lines	2 2 1 3	Caustic Soda Room (1 pre, 1 post, 1 spare)
Polyaluminum chloride Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 12,000-gal.[2] b. Transfer pumps, 125 gpm c. Day tanks; 2,100-gal. d. Diaphragm metering pumps[1] e. Washwater diagphragm metering pumps	2 2 2 3 2	Coagulant Room
Ferric Chloride Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 12,000-gal.[2(3)] b. Transfer pumps, 75 gpm c. Day tanks; 1,500-gal. d. Diaphragm metering pumps[1]	2 2 1 3	Alternate Coagulant Room
Coagulant Aid Polymer Direct drum fed liquid polymer blending units with common spare feeder with Filter Aid System	a. Drum storage b. Polymer blending units c. Drum scale d. Drum mixer	4 2 1 1	Polymer Room
Filter Aid Polymer Direct drum fed liquid polymer blending units with common spare feeder with Coagulant Aid System	a. Drum storage b. Polymer blending units c. Drum scale d. Drum mixer	1 1 1 1	Polymer Room
Ammonia Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 8,000-gal. pressure CS b. Transfer pumps, 125 gpm c. Day tanks; 150-gal. pressure CS d. Diaphragm metering pumps e. Water softener for chase water	1 2 1 2 1	Ammonia Room

Chemical System	Feed Equipment	No.	Location
Fluoride Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 6,000-gal. b Transfer pumps, 30 gpm c. Day tanks; 150-gal. d. Diaphragm metering pumps	1 2	Fluoride Room
Corrosion Inhibitor Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 5,000-gal. b. Transfer pumps, 30 gpm c. Day tanks; 150-gal. d. Diaphragm metering pumps	1 2	Corrosion Inhibitor Room
Sodium Thiosulfate Bulk storage with manual transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 5,000-gal. b. Transfer pumps, 25 gpm c. Day tanks; 50-gal. d. Diaphragm metering pumps	1 1 1 2	Sodium Thiosulfate Room
Wastewater Polymer	a. Drum storage b. Polymer blending units c. Drum scale d. Drum mixer	2 2 1 1	Polymer Room
Dewatering Polymer	a. Bulk tank; 6,300-gal. b. Recirculation pump c. Transfer pump d. Day tank, 100-gal. e. Spare pump	1 1[4] 1[4] 1 1	Residuals Dewatering Building Residuals Dewatering Building, not installed

[1]Pumps to be sized so that two pumping together will provide the maximum feed rate
[2]Tank to be designed for storing either coagulant or alternate coagulant.
[3] One ferric chloride tank shall not be equipped or piped.
[4]Recirculation pump and transfer pump to be piped to allow both pumps to be used for either purpose.

A. Design Concept

Provide a two stage vertical turbine type flash mixer to disperse pre-treatment chemicals into the process stream, three-stage tapered flocculation, and plate settler clarification to provide settling of the flocculated materials.

B. Regulatory Design Criteria (Kentucky DOW and Ten State Standards, 2003 Edition)

1. Flash mixing
   a. Number — 2
   b. Detention time, seconds — <30
2. Flocculation
   a. Number — N+1
   b. Detention time, minutes — >30
   c. Horizontal velocity, fps — >0.5, <1.5
   d. Mixer peripheral paddle speed, fps — >0.5, <3.0
3. Plate Settler Sedimentation
   a. Surface loading rate, gpm/sf of projected plate surface area — <0.5 at 80% efficiency

C. Flash Mixing

1. Description

   Two stage rapid mixing basins, with vertical turbine mixers
2. Type mixer — Vertical turbine
3. Number — 2
4. Number of impellers, each shaft — 2
5. G value, sec^{-1} at 0.5 degrees centigrade — 1,000
6. Detention time, seconds
   a. Minimum flow, 4.0 mgd — 38 (with one mixer out of service)
   b. Winter average flow, 6.0 mgd — 26 (with one mixer out of service)
   c. Summer average flow, 15.0 mgd, two basins in service — 20
   d. Maximum flow, 20.0 mgd, two basins in service — 15

	e.	Ultimate flow, 30.0 mgd, two basins in service	10
7.	Basin dimensions		
	a.	Width, feet	5.0
	b.	Length, feet	5.0
	c.	Depth, mixing zone, feet	9.5
	d.	Effective mixing volume, cubic feet	238
	e.	Influent pipe diameter, feet	3.5
	f.	Lower level influent/effluent zone depth, feet	4.5
	g.	Upper level influent/effluent zone depth, feet	4.0
	h.	Total depth, feet	28.5

8. Chemical feed points
   a. Chlorine, upstream of the rapid mixers
   b. Caustic soda, upstream of the rapid mixers
   c. Coagulant and alternate coagulant
   d. Coagulant aid polymer

9.	Motor		
	a.	Horsepower, HP	20
	b.	Speed control	variable frequency drive

10. Controls
    a. Local manual speed control from variable frequency drives located in adjacent electrical room
    b. Start / stop control at VFD, mixer, and Distributed Process Control System (DPCS)
    c. Speed control at VFD and DPCS
    d. Drive status and run time monitored via DPCS
    e. Automatic speed control based on raw water temperature
11. Design concepts
    a. Mixers to be outside with no superstructure
    b. Chemical feed lines to penetrate basin walls from inside plant, above normal water surface
    c. Top of mixer to be open UV resistant FRP grating with steel support structure.

d. Provide slot openings in outside wall for overflow.

e. Rapid Mixer No. 1 to flow from low to high; Rapid Mixer No. 2 to flow from high to low. Normal flow in series.

D. Flocculation

1. Influent Flume

a. Lower level influent channel with influent flume on top

b. Dimensions, ft

1) Width 4.0

2) Depth

a) Lower level channel 7.8

b) Sidewater depth, upper flume 6.8±

c. Mud valves between lower channel and upper flume

1) Design for head loss to accommodate flow split to each of four basins. Design for initial capacity, with consideration of potential future high rating.

2) Number per flocculator 2

3) Diameter, inches 18

d. Provide UV resistant FRP grating on top of flume for access.

e. Include provisions for cleaning and draining lower channel and upper flume

2. Process Units

a. Number 4

b. Flow per basin, mgd

	All Units in Service	One Unit Off-Line
Minimum	1.0	1.3
Winter Average	1.5	2.0
Summer Average	3.8	5.0
Maximum	5.0	6.7

c. Description

1) Three stage basins with ported baffle walls separating each stage, and two parallel compartments per stage. Each

compartment to have one horizontal paddle wheel assembly oriented parallel to flow.

d. Flocculation stages per basin 3

e. Overall Dimensions, ft.

1) Width

a) Total 30.0

b) Each parallel flocculation compartment 14.7

2) Total length, excluding baffle walls 47.5

3) Sidewater depth 14.7

4) Flocculation stage length, each 15.8

f. Volume per basin, gal.

1) Each flocculation compartment 25,500

2) Each stage 51,000

3) Total 153,000

g. Detention time, min.

	All basins in service	One basin out of service
Minimum Flow	220	165
Winter Average Flow	147	110
Summer Average Flow	59	44
Maximum Flow	44	33

3. Mixing

a. G-Values, seconds^{-1}

1) Stage 1 75

2) Stage 2 50

3) Stage 3 35

b. Mixers

1) Type horizontal reel

2) Shaft and paddle orientation to flow parallel

3) Drives

a) Variable frequency drive speed control

b) One drive for both Stage 1 mixers

c) One drive common to all Stage 2 and Stage 3 mixers per basin

c. Controls

1) Local manual speed control from variable frequency drives
2) Start / stop control at VFD, flocculator drive, and DPCS
3) Drive status and run time monitored via DPCS
4) Automatic speed control based on setpoint G-value and water temperature via DPCS

4. Baffle Walls

a. Type — Ported
b. Material — Concrete
c. Velocity gradient through ports, $seconds^{-1}$
   1) Influent — 75
   2) Stage 1 effluent — 60
   3) Stage 2 effluent — 45
   4) Stage 3 effluent — 15
d. Install flow diffusers on Stage 3 effluent openings

5. Appurtenances

a. Drain via slide gate connection to sedimentation basins

E. Plate Settler Sedimentation

1. Number of settling basins — 4
2. Flow per basin, mgd

	All Units in Service	One Unit Off-Line
a. Minimum	1.0	1.3
b. Winter Average	1.5	2.0
c. Summer Average	3.8	5.0
d. Maximum	5.0	6.7

3. Basin dimensions - each, ft

a. Width — 30.50
b. Length — 36.08

c. Sidewater depth 19.00

4. Volume - each basin

a. Cubic feet 20,900

b. Gallons 156,000

5. Detention time, min.

	Flow Rate (mgd)	All Units in Service (minutes)	One Unit Off-line (minutes)
a. Minimum	4.0	225	168
b. Winter Average	6.0	150	112
c. Summer Average	15.0	60	45
d. Maximum	20.0	45	34

6. Plates (based on MRI plates with effluent troughs on side)

a. Number

1) Rows per basin 5

2) Packs per row 2

3) Plates per pack 50

4) Total plates per basin 500

5) Total plates 2,000

b. Dimensions

1) Plate width, ft 4.5

2) Plate length, ft 10.0

c. Angle of incline, deg. 55

d. Effective surface area, % 80

7. Surface area, sf

a. Projected surface area per plate 25.81

b. Effective surface area per plate (at 80% efficiency) 20.65

c. Effective surface area per basin 10,324

d. Total 41,296

8. Plate surface overflow rate, gpm/sf

	Flow Rate (mgd)	All Units in Service (gpm/sf)	One Unit Off-line (gpm/sf)
a. Minimum	4.0	0.07	0.09
b. Winter Average	6.0	0.10	0.13
c. Summer Average	15.0	0.25	0.34
d. Maximum	20.0	0.34	0.45

9. Sludge Collection

   a. Type — Hoseless vacuum sludge collection and motor operated plug valves

   b. Number of units per basin — 2

   c. Discharge flow per basin, gpm — 250

   d. Total discharge flow, all basins, gpm

      a. 20 mgd — 1,000

      b. 30 mgd — 1,500

10. Appurtenances

   a. Inclined plates, system supports, and hardware — Stainless steel

11. Influent velocity between plate rows

   a. Maximum, fps — 0.5

12. Effluent trough velocity

   a. Maximum, fps — 2.0

13. Operation controls

   a. Sludge blowdown control

      Provide local manual control on valves in pipe gallery. Provide remote manual control via SCADA. Provide automatic control via SCADA. In automatic mode, operation of blowdown valves will be time based for interval and duration.

F. Monitoring and Control

1. Streaming current detector (downstream of mixer)
2. pH analyzer (downstream of mixer)
3. Mixed sample pumped to lab; include manual tap at sample location.
4. Settled water turbidimeter - each basin

A. Design Concept

Dual media filters with silica sand and anthracite are to be constructed. The filters shall be designed with adequate depth to install granular activated carbon in lieu of anthracite in the future, if necessary, for taste and odor control. Each filter is designed with adequate area so as not to exceed the maximum surface loading rate assuming one filter is out of service. Future expansion from the WTP design capacity of 20 mgd to 30 mgd may, however, be accomplished by high rating the filters. Therefore, piping shall be designed for possible high rating. Structural provisions shall also be included for future filters.

Water will flow from the sedimentation basins to the filters through a flume. The flume will be configured with a center wall to form a serpentine flow path and a single location for application of filter influent chemicals. An overflow will be provided in the flume. Provisions will be included to manually clean the flume.

The filters shall be designed in accordance with the Ten States Standards 2003 Edition

B. Regulatory Design Criteria (Kentucky DOW and Ten State Standards (2003 Edition))

1.	Maximum surface loading rate, gpm/sf	5
2.	Number of units	>2
3.	Minimum depth, feet	>8.5
4.	No structural cross connections	
5.	Maximum horizontal wastewater travel to trough, feet	3
6.	Media depth, inches	>24
7.	Media size	
a.	Silica sand, mm	0.45 to 0.55 D_{10} and $D_{60}/D_{10} < 1.65$
b.	Anthracite, mm	0.80 to 1.20 D_{10} and $D_{60}/D_{10} < 1.85$

C. Filter Sizing

1.	Type of filter	Dual cell rapid gravity filter with dual media
2.	Number of filters	5
3.	Maximum surface loading rate with one filter out of service, gpm/sf	5.0
4.	Filter box material	Cast in place concrete
5.	Filter dimensions	

a.	Surface area, sf				
	1)	Each filter unit (total of 2 cells)			702
	2)	Total			3,510
b.	Filter dimensions, filter area only				
	1)	Length, ft			27
	2)	Width per cell, ft			13
	3)	Depth, inches (Bottom of filter El. 745)			
		a)	Underdrain		6±
			(Alternate 12 inches, ±)		
		b)	Media		
			(1)	Support Gravel (Alternate media support cap with 3" torpedo sand)	12
			(2)	Silica sand	12
			(3)	Anthracite	18
			(4)	Additional depth for GAC (Total future GAC media depth of 54", >10 minute empty bed contact time, with all filters in service at average flow; with 6" of sand)	30
		c)	Depth - media to bottom of trough		
			(1)	30" sand and anthracite (initial)	71
			(2)	60" deep bed configuration (50% Expansion)	41
		d)	Trough depth		21
		e)	Water depth above trough (>8 feet to sand anthracite interface)		18
		f)	Free board		34
	4)	Filter depth, ft.			16.0

6. Filter media characteristics

a. Filter media

Type of Media	Depth (inch)	Effective Size (mm)	Uniformity Coefficient
1) Anthracite	18	0.95 to 1.05	≤1.4
2) Silica sand	12	0.45 to 0.55	≤1.4

7. Filtration rate

	Plant Flow (mgd)	Surface Loading Rate (gpm/sf)	
		All Filters In Service	One Filter Off-line
1) Minimum	4.0	0.79	0.99
2) Winter Average	6.0	1.19	1.48
3) Summer Average	15.0	2.97	3.71
4) Maximum	20.0	3.96	4.95

8. Filter Underdrain System

a. Low profile water only underdrain

b. Air System — Fixed air grid

9. Filter Washwater Troughs

a. Design flow (25 gpm/sf x 1 cell at 351 sf), gpm — 8,780

b. U-shape fiberglass trough

c. Approximate dimensions, inches

1) Width — 18

2) Depth — 21

d. Number per filter cell — 4

10. Overflow protection

Provide filter box overflow openings between filter and influent flume

11. Filter Control and Monitoring

a. Filter flow equally split among online filters while maintaining constant influent level

b. Total loss of head transmitter with high alarm for each filter

c. Flow meter/transmitter for each filter – venturi

d. Effluent turbidimeters with high alarm for each filter

e. Effluent particle monitor, each filter

f. Turbidimeter for combined filter effluent

g. Common filter effluent sample piped to lab; with manual sample tap

h. Common filter influent sample piped to lab; with manual sample tap

i. Common filter influent turbidimeter

j. Combined filter influent level transmitter

k. Filter backwash program

   1) Auto or manually initiated on:

      a) Loss of head

      b) Filter effluent turbidity

      c) Time

k. Filter control stations

   1) Single local control station with touch screen interface

   2) Main control station in main control room

   3) Manual via individual valves

l. Motor operated control valves

1)	Influent (maximum velocity 2.0 fps)	30-inch BFV
2)	Wash (25 gpm/sf and < 6.5 fps)	24-inch BFV
3)	Waste (25 gpm/sf)	30-inch BFV
4)	Air (3 scfm/sf and < 3000 fpm)	8-inch BFV
5)	Effluent (< 6.5 fps)	16-inch BFV
6)	Filter to waste (< 6.5 fps)	16-inch BFV

m. Discharge filter to waste into common header and discharge to drain with air gap located outside

n. Filter level transmitter for backwash sequencing

o. Filter backwash turbidimeter, each filter

12. Filter backwash system

   a. Method - Air scour and upflow water wash, sequential or combined

b. Backwash design (Wash one half filter in sequence)

1) Design for collapse pulse concurrent air water wash
2) Design for 30% expansion during high wash using D_{90} particle size and 30 degree centigrade backwash water temperature.
3) Design for concurrent air water wash flow at 50% minimum fluidization velocity
4) Design for future 25 gpm/sf wash flow for GAC media (8,775 gpm).
5) Source of backwash water -finished water from clearwell directly via backwash pumps, one duty, one standby
6) Backwash water supply line provided with coagulant feed point for feed of coagulant during second low wash cycle.
7) Typical backwash rates under warm water conditions

		30 degrees centigrade	
	Time (Minutes)	**Wash Rate (gpm/sf)**	**Flow Rate (gpm)**
a) Air scour (overlap low wash rate)	5	3 scfm/sf	1,053 scfm
b) Concurrent air water low rate wash	4	5	1,755
c) High rate wash	6	20	7,020
d) Low wash rate	4	5	1,755

c. Air Scour Blower

1) Air flow rate, scfm/sf — 3
2) Blower capacity, scfm — 1,053
3) Discharge pressure, psig — 6.0
4) Discharge pipe, inches (less than 3,000 fpm) — 8
5) Horsepower — 60
6) Number — 1, space for 1 future
7) Locate in High Service Pump Station
8) Controls
   a) Air flow meter
   b) Pressure switches; high, low, normal

C. Filter Influent Flume

1. Maximum velocity, fps (at ultimate flow) <2.0

D. Other Features

1. Full superstructure covering filters and control room.
2. Filter cells enclosed in room separate from control floor.
3. Filter influent flume overflow weir with discharge to wastewater facilities.
4. Provide lighting and ventilation in the filter area and filter operating floor.
5. Provide dehumidification in the filter pipe gallery.
6. Provisions to clean influent flume.

E. Chemical Feed

1. Filter influent - feed between sedimentation basin effluent flume and filter influent flume
    a. Chlorine
    b. Filter aid polymer
    c. Caustic soda
2. Filter effluent - feed in combined filter effluent pipe, after future UV connections
    a. Chlorine
    b. Caustic soda
    c. Ammonia
    d. Fluoride
3. Provide access hatch above filter influent chemical feed points
4. Provide base and mid level diffusers to mix filter influent chemicals

11.0 Disinfection CT and Additional Removal/ Inactivation of Pathogens

A. Description

Current regulations will require that treatment techniques be provided and operated for surface water sources to achieve the following levels of disinfection as a minimum:

- 3-log *Giardia* removal/ inactivation
- 4-log virus inactivation
- 3-log *Cryptosporidium* removal/inactivation

The clarification-filtration process is designed with the capability to meet the following filter effluent turbidity requirements:

- Less than 0.3 NTU combined filter effluent turbidity in 95% of the samples recorded every 4 hours on a monthly basis

The clarification-filtration process is also designed with the capability to exceed the filter effluent turbidity requirements in order to attain 1 additional log removal credit in accordance with the LT2ESWTR:

- Less than 0.15 NTU combined filter effluent turbidity in 95% of the samples recorded every 4 hours on a monthly basis
- Less than 0.15 NTU individual filter effluent turbidity in 95% of the samples recorded on a monthly basis

In doing so, the following disinfection credit is acknowledged by regulation:

- 3.5-log *Giardia* removal
- 4.0-log *Cryptosporidium* removal (3 log by filtration and 1 log via clarification)

The chemical disinfection system is designed with the following capability to meet the remaining disinfection requirement under normal operations when filtration performance achieves the turbidity requirements.

- 1.0-log *Giardia* inactivation with free chlorine, with contact time in the clearwell
- 4.0-log virus inactivation with free chlorine, with contact time in the clearwell

The LT2ESWTR may increase the disinfection requirements for *Cryptosporidium* if source water monitoring results in classification greater than Bin 2, so it is necessary to design options for increasing the removal and inactivation of this pathogen. The actual level of disinfection required will be determined based upon the bin classification of the source water following 24 months of source water sampling for *Giardia*, *Cryptosporidium*, and E. Coli. If needed, additional *Cryptosporidium* and *Giardia* disinfection capability may be provided by future UV disinfection.

To assure compliance with future regulations, the facility will be designed with provisions to provide future additional log inactivation as follows:

- 3.0-log *Giardia* inactivation by UV
- 3.0-log *Cryptosporidium* inactivation by UV

The design will assure the capability of achieving a total of 3.0-log *Giardia* inactivation in the event of filter failure by disinfection with free chlorine through the entire process train and clearwell. A pre-chlorine chlorinator will be supplied to allow chlorine feed rates in excess of normal operating levels. Ammonia will typically be fed at the end of Clearwell No. 2, to form chloramines for carrying residual through the distribution system, with free chlorine residual carried through the clearwells. There are provisions to allow ammonia to be fed at the beginning of Clearwell No. 1 or the beginning of Clearwell No. 2, to minimize DBP formation when water quality and flows will allow the required *Giardia* and virus disinfection to be met with chloramine in one or both of the clearwells.

Disinfection contact time calculations are included in Appendix B.

B. Disinfection Contact Time (CT)

1. Normal operations, post-filtration CT

a.	Minimum *Giardia* inactivation required	1.0-log
b.	Worst-Case Disinfection CT conditions	
	1) pH	8.0
	2) Temperature, °C	0.5
	3) Minimum free chlorine residual, mg/L	2.0
c.	Clearwell baffle factor	0.7

d.	Disinfection CT required, mg-min/L		
	1)	Worst case condition	116
e.	Effective clearwell volume required for disinfection, gal.		
	1)	20 mgd capacity	802,000
	2)	30 mgd capacity	1,208,000
f.	Gross clearwell volume required for disinfection based on 0.7 baffle factor		
	1)	20 mgd capacity, gal.	1,150,000
	2)	30 mgd capacity, gal	1,726,000

2. Operations with CT capability through entire process

a.	Minimum temperature, °C		0.5
b.	Maximum pH		
	1)	Pre-treatment and filters	8.0
	2)	Clearwell	8.0
c.	Chlorine Residual, mg/L		
	1)	Pre-treatment processes	2.5
	2)	Filters	3.5
	3)	Clearwell	3.7
d.	Baffle Factor		
	1)	Flocculation Basins	0.5
	2)	Clarification Basins	0.5
	3)	Filters	0.7
	4)	Clearwell	0.7

e. Volume - total, gal.

1) Flocculation Basins 611,200

2) Clarification Basins 269,700[1]

3) Filters 231,800[2]

4) Clearwell 1,393,700[3]

f. Effective Detention Time, min.

	Flocculation Basins	Clarification Basins	Filters	Clearwell	Total
Minimum Flow	110	49	58	351	568
Winter Average Flow	73	32	39	234	378
Summer Average Flow	29	13	16	94	152
Maximum Flow	22	10	12	70	114

g. Disinfection CT, mg-min/L

	Flocculation Basins	Clarification Basins	Filters	Clearwell	Total
Minimum Flow	275	121	205	1,300	1,901
Winter Average Flow	183	81	136	866	1,266
Summer Average Flow	73	32	55	347	507
Maximum Flow	55	24	41	260	380

h. *Giardia* Inactivation, log inactivation

	Flocculation Basins	Clarification Basins	Filters	Clearwell	Total
Minimum Flow	2.26	1.00	1.61	10.22	15.09
Winter Average Flow	1.51	0.67	1.07	6.81	10.06
Summer Average Flow	0.60	0.27	0.43	2.72	4.02
Maximum Flow	0.45	0.20	0.32	2.04	3.01

[1] Clarifier CT is based on the volume from the water surface to the bottom of the plates, where clarification primarily occurs. The area below the plates is predominantly a sludge settling zone.
[2] Does not include media and underdrain volume.
[3] Using a water depth of 17.25 feet to allow for volume reduction for filter backwash water.

A. Description

Space is provided for future installation of a ultraviolet (UV) disinfection facility within the WTP. The ultraviolet (UV) disinfection facility would be provided to assure a disinfection system capable of meeting or exceeding LT2 ESWTTR requirements for pathogen inactivation and removal. The UV system will be designed to generate the design dose under maximum flow conditions, with minimum UV transmittance and one unit out of service. It will be capable of being expanded or replaced to treat the ultimate flow of 30.0 mgd.

Current design should consider hydraulic, electrical, and space requirements for locating the future units in a separate UV area treating the combined filter effluent.

B. UV Disinfection Criteria

1. *Cryptosporidium*	3.0-log inactivation

C. Facility Design Criteria

1. Capacity of system, mgd	
a. Initial	20
b. Ultimate	30
2. Number of reactors	N+1
3. UV transmittance, %	90
4. UV dose, mJ/cm^2	42
5. Maximum head loss through each unit, feet	2.0
6. Lamp cleaning rate	adjustable

D. Appurtenances

1. Valves
   a. Isolation valves
2. Flow monitoring – Sum of filter effluent meters
3. Ballasts
4. PLC controls with connectivity to the Process Control and Monitoring System (PCMS)

5. Provisions for equipment removal

A. Concept

A clearwell located on the plant site partially below the filters will provide finished water storage for disinfectant contact time (CT), filter backwash water and pump flow equalization. Distribution system operating storage will be provided in additional storage along the proposed transmission route. The clearwell will have two cells in series with interior baffles to minimize short-circuiting and maximize the effective CT. The CT criteria for clearwell sizing includes volume for 1.0-log inactivation of *Giardia* cysts.

B. Disinfection CT

1. Disinfection Conditions (worst-case)

a.	pH	8.0
b.	Water temperature, °C	0.5
c.	Minimum free chlorine residual, mg/L	2.0
d.	Flow rate, mgd	20.0

2. Baffling

a.	Length-to-width ratio	57:1
b.	Baffling factor	0.7[1]

3. Requirements for1.0-log *Giardia* inactivation under worst-case conditions

a.	Minimum CT, min-mg/L	116
b.	Effective volume, gal	802,000
c.	Total volume, gal	1,150,000

C. Filter backwash water

1.	Volume per filter (25 gpm/sf for 10 minutes and 6 gpm/sf for 10 minutes), gal.	217,600

[1] Based on research presented in AWWARF's "Improving Clearwell Design for CT Compliance", 1999.

D.	Pump Equalization Storage (>2.0 feet of clearwell depth)		175,200
E.	Clearwell Design		
	1.	Volume, gal.	
	a.	Disinfection CT	1,212,000
	b.	Filter backwash	217,600
	c.	Equalization	186,400
	d.	Total design capacity	1,616,000
	2.	Interior Dimensions	
	a.	Cells	2
	b.	Length, feet	99.25
	c.	Width – each cell, feet	54.42[1]
	d.	Side water depth, feet	20
	3.	Construction Materials	
	a.	Walls and floor	concrete, cast-in-place
	b.	Roof	concrete, pre-cast or cast-in place
	c.	Baffle walls	Concrete
	d.	Roof liner	waterproof membrane

4. Controls
   a. Ultrasonic level transmitter, each cell
   b. High level alarm based on level switch, each cell

5. Appurtenances
   a. Overflow
   b. Access hatches and ladders
   c. Vents

6. Chemical Feed Points - Between Clearwell No. 1 and Clearwell No. 2
   1) Chlorine
   2) Ammonia

7. Sample Point - Between Clearwell No. 1 and Clearwell No. 2
   1) Provide one pump to draw sample either from this point or the clearwell effluent, depending on manual valve settings

[1] Does not include baffle wall width.

A. Description

Four finished water and two washwater pumps will be housed in the High Service Pump Station. The filter backwash air blower will also be located in the High Service Pump Station. All pumps will be vertical turbine configuration. Each pumping system will be sized to provide required pumpage with the largest unit out of service.

2. Finished Water Pumps

a. Type — Vertical turbine with hard piped suction

b. Number — 4

c. Total dynamic head (TDH) — 324

d. Overall pumping requirements, mgd

1) Minimum Flow — 4

2) Winter Average Flow — 6

3) Summer Average Flow — 15

4) Maximum Flow — 20

5) Ultimate Flow — 30

6) Firm Capacity, largest unit out of service

i) Initial design — 24

ii) Ultimate design — 30

e. Pump design criteria

	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Pump No. 5
Type	Vertical Turb.	Vertical Turb.	Vertical Turb.	Vertical Turb.	Future
Rated Capacity (MGD)	10	10	7	7	6
Rated Head (feet)[1]	324	324	324	324	324
Motor Horsepower (HP)	700	700	500	500	500
Nominal Motor Speed	1200	1200	1200	1200	1200
Motor Voltage	4160	4160	4160	4160	4160
Constant Speed or VFD	VFD	VFD	Constant	Constant	Constant
Discharge Diameter (inches)	20	20	12[1]	12[1]	12[1]
Discharge Centerline Elevation (feet)	745.50	745.50	745.50	745.50	745.50

[1]Increase to 20-inch upstream of isolation valve for future pump change-out to larger capacity

1) Pump design to provide a flow continuum from 4 mgd to 24 mgd based on pump selected and speed control

2) Motors - 4160 V, 3 phase, 60 hz motors

3. Pump discharge

a.	Discharge maximum velocity, fps	8
b.	Manifold maximum velocity, fps	5
c.	Material	flanged ductile iron
d.	Appurtenances	
1)	Vacuum/air release valve	
2)	Pressure gauge, psi range	0-200[1]
3)	Check valves	
a)	High Service Pump Nos. 1 and 2	tilting disk
b)	High Service Pump Nos. 3 and 4	Hydraulic ball type
4)	Isolation valve	Butterfly
5)	Surge facilities	Surge anticipator valve
6)	Pressure switches, each discharge header	
a)	Normal	
b)	High	

4. Pump discharge manifold appurtenances

a. Appurtenances

1) Pressure transmitter

2) Finished water meter and flow transmitter

[1] Confirm maximum pressure exceeds shut off pressure rating of the hydraulic ball type check valve

5. Appurtenances for pump station

   a. Finished water sample to laboratory and analyzers

   b. Finished water analyzers

      1) pH meter

      2) Temperature transmitter

      3) Ammonia analyzer

      4) Free chlorine analyzer

      5) Monochloramine/ total chlorine analyzer

      6) Fluoride analyzer

      7) Turbidimeter

      8) Phosphate analyzer

   c. Monorail and hoist or traveling bridge crane

   d. Temperature controlled environment as required for variable frequency drives

   e. Rollup or other suitable removable door or window openings large enough to pass pump and motor components

   f. Finished water chemical feed points - after point of washwater withdrawal

      1) Chlorine

      2) Caustic soda

      3) Fluoride

      4) Ammonia

      5) Corrosion Inhibitor

A. Design Concept

Install two washwater pumps in the High Service Pumping Station adjacent to the clearwell to pump to the filter backwash system. One unit will be duty and the other standby.

B. Washwater Supply Facilities

1. Washwater pumps

a.	Number	2
b.	Type	Vertical turbine with hard-piped suction
c.	Capacity, gpm	8,780
d.	Head, ft.	44
e.	Motor	
	1) Horsepower, hp	150

2. Backwash Rate Control - venturi meter and rate of flow control valve.
3. Provide pressure relief valve upstream of flow control valve with discharge to pump suction to blowoff during low wash.

C. Piping Appurtenances

1. Butterfly isolation valves
2. Swing check valve
3. Combination air/vacuum, air release valve
4. Pressure gauges (0-60 psi)
5. Low and high pressure switches
6. Flow transmitter

A. Design Concept

All flows into and out of the plant are to be metered for accounting. Filter, washwater, and air wash flows are to be metered for process control.

B. A listing of expected flows to be monitored follows:

Description	Quantity and Max. Flow	Type	Function	Location
Raw Water	1 - 24 mgd (provisions for parallel 6 mgd meter)	Magmeter	Measure raw water	Raw Water Meter Chamber
Filter Effluent	5 - 7.5 mgd	Venturi	Measure filter effluent and rinse flow	WTP - Filter Pipe Gallery
Filter Washwater	1 – 9,000 gpm	Venturi	Measure filter washwater flow	WTP – High Service Pump Station
Filter Air Wash	1 - 1,100 scfm	Pitometer	Measure filter wash air flow	WTP - High Service Pump Station
Plant Effluent	1 - 24 mgd (provisions for parallel 6 mgd meter)	Venturi	Measure finished water flow to system	WTP – High Service Pump Station
Clarified Wastewater	1 - 6,000 gpm	Magmeter	Measure wastewater discharge	Wastewater Pumping Station
Plant Service	1 – 900 gpm	Turbine	Measure plant service	WTP - High Service Pump Station

17.0 Plant Service Water

A. Design Concept

Provide plant service supply to raw water pumping station, chemical building, process building, wastewater facilities, and finished water pumping station from plant effluent. Provide common meter and backflow preventer.

B. Appurtenances

1. Reduced pressure backflow preventer
2. Plant service meter
3. Pressure reducing valve (verify requirement during final design)

a.	Reduced pressure water treatment plant, psig	100+/-
b.	Reduced pressure to RWPS, psig	20 +/-
c.	Reduced pressure at RWPS	80 +/-

4. Provide water softener for supplies indicated in Section C.

C. Plant Water Service Demands (Verify during final design)

System	Purpose	Flow, gpm	
		Constant[(1)]	Intermittent
Raw Water Pumping Station			
Pump pre-lube			25*
Domestic water			
Hose connection	Cleaning		20*
Emergency shower	Rinse chemical contamination		25*
Subtotal			**70**
Water Treatment Plant			
Potassium permanganate	Solution tank makeup water	5	
Carbon slurry tank	Solution tank makeup water	5	
Carbon eductor system	Eduction and carrier water	45	
Coagulant aid polymer	Make-up and carrier water	10	
Filter aid polymer	Make-up and carrier water	10	
Backwash wastewater polymer	Make-up and carrier water		10*
Sludge blowdown polymer	Make-up and carrier water		10*
Fluoride	Carrier water	5	
Corrosion inhibitor	Carrier water	5	
Sodium thiosulfate	Carrier water		5*
Chlorine	Eductor drive water		
Raw water feed point			50*
Filter influent feed point		40	
Clearwell influent		75	
Clearwell effluent			50*
Clearwell midpoint			75
Caustic soda	Carrier water (softened)		
Raw water			5*
Filter influent			5
Clearwell influent		5	
Clearwell effluent			5
Ammonia	Carrier water (softened)		
Clearwell influent			5
Clearwell midpoint			5
Clearwell effluent		5	
Basin washdown	Flush basins		50*
Subtotal		**210**	**225**
Wastewater Facilities			
Basin washdown	Flush basins		50*
Pump lube	Lubricate bearings	15	
Floor washdown	Maintenance		10
Belt filter press washdown	Maintenance		300*
Subtotal		**15**	**360**
TOTAL		**225**	**655**

(1) Verify in final design

D. Fire Service

Provide separate supply connection from plant effluent

E. Potable

1.	Laboratory	10*
2.	Sinks, toilets, showers	45*
3.	Hoses - floor washdown	20*

F. Total Estimated Plant Service Flows, gpm

1.	Continuous	225
2.	Peak (sum of continuous flows and those marked with *)	875
3.	Meter design flow	900
4.	Backflow preventor design flow (meter flow less potable water use)	825

A. Description

The wastewater treatment system will include two circular batch wastewater clarifiers for filter backwash and rinse water, one residuals thickener for clarifier blowdown sludge, and a residuals dewatering facility. The filter backwash and rinse water will be directed to the active wastewater clarifier. The supernatant decanted from the wastewater clarifiers will be pumped to the Kentucky River, while the wastewater clarifier settled sludge will be directed to the sludge thickener. Sludge from the thickener will be pumped to the dewatering facility. Thickener supernatant will be pumped to the Kentucky River. Thickened residuals will be dewatered and land applied onsite. Filtrate from the dewatering process will flow by gravity the thickener.

The primary components proposed for residuals waste handling are depicted on Exhibit 2- Wastewater Process Flow Diagram. Detailed design data and computations related to residuals production and process unit sizing are included in Appendix C.

B. Residual Sources

1. Residual solids
    a. Suspended solids in the raw water
    b. Oxidation and precipitation of iron and manganese in the raw water
    c. Treatment chemicals
        1) Powdered Activated Carbon
        2) Coagulant
        3) Polymers
2. Process Wastewater
    a. Overflow of process basins
    b. Drainage from process basins
    c. Filter backwash wastewater
    d. Filter to waste (rinse)
    e. Sedimentation basin blowdown sludge
        1) Expected sludge solids concentration
            a) At average solids production 1.0%
            b) At maximum solids production 2.0%

f. Sample line discharges

g. Laboratory sample streams

C. Design Concept

1. Sanitary waste is to be collected separately from process wastes and sent to the sanitary system. A separate system will be provided for disposal of laboratory chemically contaminated wastes.
2. Filter backwash water and filter rinse water are to be directed to the wastewater clarifiers. These discharges will be piped separately to a common point outside the building where an air gap will be provided to protect the rinse system from backflow from the wastewater drain system. Each of the two basins will be sized to hold the wastewater from one filter backwash and rinse, with an additional 2-foot deep solids settling zone at the bottom. The solids will be settled and removed with a circular sludge collection system and pumped to the thickener. Following settling, the supernatant is to be pumped to the Kentucky River.
3. Clarifier blowdown sludge will be discharged by gravity to the residuals thickener for equalization and settling. From there, thickened sludge will be pumped to the dewatering system. Supernatant from the residuals thickener will be pumped to the Kentucky River. Clarified wastewater from the thickener and wastewater clarifiers will be de-chlorinated in the discharge main, which will be routed beside the WTP on the way to the river.
4. Drain water from the flocculators and clarifiers will be discharged to the wastewater clarifiers.
5. Filtrate and wash water from the dewatering building will flow by gravity into the residuals thickener.
6. When draining water from the clearwell for maintenance, this water will be pumped and discharged to a wastewater clarifier and pumped to the Kentucky River using the decant pumps.
7. Sample line discharges without analyzer chemical addition are to be directed to the wastewater clarifiers. Others will be sent to the sanitary system.
8. Plant floor drains will be sent to the sanitary system.
9. Valves and pumps for distribution of wastewater and residual flows will be located in a wastewater pumping station building common to the clarifiers and thickener.

D. Residuals Waste Handling Facilities

1. Wastewater Clarifiers

   a. Type — Circular concrete tank with sludge scraper

   b. Number — 2

   c. Basin dimensions, each

      1) Diameter, feet — 60

      2) Side water depth, feet

         a) Clarification zone — 12

         b) Sludge settling zone — 2

         c) Total — 14

      3) Volume, gal.

         a) Clarification — 253,800

         b) Sludge settling zone — 42,300

         c) Hopper (Slope 0.083 ft/ft) — 17,600

         d) Total — 313,700

   d. Supernatant collection and discharge

      1) Provide decant lines at three elevations

      2) Decanted water pumped to the Kentucky River

      3) Clarified wastewater pumps

         a) Number — 2

         b) Type — horizontal centrifugal end suction

         c) Capacity, gpm (253,800 gallons in 1.5 hours) — 2,820

         d) Total dynamic head, ft — 48 (confirm upon final design)

         e) Motor horsepower, HP — 50

         f) Isolation valves — Rubber lined plug

         g) Check valves — Rubber flapper, swing type

         h) Pressure switches and gauges with diaphragm seals

            i. Low

            ii. Normal

            iii. High

   e. Other features

      1) Decant instrumentation

a) Chlorine residual analyzer

b) Turbidimeter

c) pH analyzer

d) Flowmeter and flow transmitter

e) Pump and valve control based on basin level transmitter

f. Wastewater clarifier sludge transfer

1) Pumped to thickener

2) Isolation valves — Plug

3) Pipe size, inches — 8

2. Wastewater clarifier sludge transfer pumps

a. Number (one duty, one standby) — 2

b. Type — Centrifugal non-clog sewage type pump

c. Pump capacity, gpm (42,300 gallons in 1 hour) — 705

d. Total dynamic head, ft. — 13

e. Pump horsepower, HP — 5

f. Discharge pipe size, inches — 8

g. Isolation valves — Rubber lined plug

h. Check valves — Rubber flapper, swing type

i. Pressure switches and gauges with diaphragm seals — Low, normal, high

j. Pump and valve control based on basin level transmitter

3. Residuals Thickener

a. Design Criteria

1) Solids loading, lb/sf/day — < 5.0

2) Hydraulic loading, gpm/sf — < 0.50

3) Provide storage for solids exceeding dewatering processing capacity during maximum 10-day event

b. Solids Production

1) Average day, lb/MG — 888

2) Average day at winter average flow (6 mgd), lb/day — 5,350

3) Average day at summer average flow (15 mgd), lb/day — 13,300

4) Maximum day, lb/MG — 13,300

5) Maximum day at maximum flow (20 mgd), lb/day — 266,000

c.	Required storage, gal.		1,362,000
d.	Dimensions		
	1)	Diameter, ft.	113
	2)	Sidewater Depth, ft.	22.50
	3)	Hopper slope, ft/ft	0.25
e.	Volume, gal.		
	1)	Straight-walled portion	1,688,000
	2)	Hopper	353,200
	3)	Total	2,041,000
	4)	Available for sludge storage[1]	1,338,000
f.	Surface area, sf		10,029
g.	Solids loading, lb/sf/day		5.0
h.	Flow (maximum day solids at maximum flow plus wastewater clarifier sludge transfer at 705 gpm), gpm		1,705
i.	Surface overflow, gpm/sf		0.17
j.	Thickener supernatant trough		
	1)	Located along inside of thickener wall	
	2)	Width, ft	1.5
	3)	Maximum sidewater depth, ft	4.0
	4)	Bottom elevation, ft	731.75
	5)	Weir elevation, ft	735.97
	6)	Volume, gal.	15,720
	7)	Trough provides equalization between thickener supernatant flow and thickener supernatant transfer pump flow	
k.	Thickener Sludge Transfer Pumps		
	1)	Number	3 (2 active, 1 spare), plus space for one future
	2)	Type	Progressing cavity
	3)	Pump capacity, gpm	200
	4)	Total dynamic head, ft.	120

[1] Assumes 4' sludge settling zone at top of thickener.

5) Motor horsepower, HP — 20

6) Motor drive — VFD

7) Discharge pipe size, inches — 3

8) Isolation valves — Rubber lined plug

9) Check valves — Rubber flapper, swing type

10) Pressure switches and gauges with diaphragm seals

a) Low

b) Normal

c) High

l. Thickener Supernatant Pumps

1) Number — 3 (2 active, 1 spare), plus 1 future pump

2) Type — horizontal centrifugal end suction

3) Capacity, gpm — 955

4) Total dynamic head, ft — 41 (confirm upon final design)

5) Motor horsepower, HP — 10

6) Motor drive — VFD

7) Isolation valves — Rubber lined plug

8) Check valves — Rubber flapper, swing type

9) Pressure switches and gauges with diaphragm seals

a) Low

b) Normal

c) High

10) Pump speed and start/stop control based on effluent trough level

5. Residuals Dewatering Building

a. See Section 22.0 for architectural treatment

b. One story building

c. Floor elevation, ft — 739.0

d. Dewatered sludge conveyed from belt filter presses to truck located outside the building

e. Equipment

1) Belt filter presses

a) Number of units — 2, plus space for one future

b) Minimum capacity per unit

i) Lb/hr 1,045

ii) Gal/min 100

c) Solids concentration, %

i) Influent 1.2 - 5.5

ii) Dewatered residuals, minimum 20.0

d) Include space and provisions for future addition of one additional belt filter press

e) Provide additional 3 ft section at front of each press for gravity dewatering.

2) Polymer feed system

a) Feed polymer to the belt filter press influent

b) Dose, active lb/ton dry solids 8-14

c) Provide hot water for polymer blending

3) Provide conveyor transfer system to evenly distribute solids into bed of truck

a) Bed length, ft. 10

b) Truck type Ford F700 or International 4700

4) Provide water heater for polymer blending water and for cleaning presses.

a) Maximum temperature, °F 140

b) Consider on-demand heater

f. Provide connection for future transfer of thickened sludge from temporary sludge storage.

1) Diameter, inches 6

6. Future Sludge Thickener

a. Type circular concrete

b. Storage capacity at 30 mgd, gallons 655,000

c. Include provisions to send sludge to and from the future thickener

A. Design Concept

Provide on site sanitary disposal system per County requirements. See Appendix C for detailed flows.

A. General

Facilities will be provided for administrative personnel, laboratory for water quality analyses, central control room for facilities monitoring, operator locker and restrooms, janitorial facilities, storage room, maintenance shop, garage, mechanical rooms, and unloading areas.

B. Main Building Facilities and Approximate Areas

1. Vestibule — 120 sf
2. Reception Area — 300 sf
3. Control Room — 360 sf
    a. Design Concept: Totally enclosed room with glass windows overlooking flocculator/clarifiers. Provide door connecting wet laboratory directly to the control room.
4. Laboratories
    a. Wet Chemistry Lab — 550 sf
        1) Include sample sink large enough to accommodate samples from all specified locations.
        2) Include refrigerator
    b. Microbiology Lab — 200 sf
    c. Lab storage — 120 sf
5. Supervisor's Office — 330 sf
6. Secondary Office — 290 sf
7. Lunch / Conference Room — 715 sf
    a. Table
    b. Sink
    c. Space for refrigerator, microwave, and two burner stove top
8. Restrooms
    a. Separate men's and women's locker rooms — 290 sf each
    b. Public unisex restroom — 38 sf
9. Janitorial Supply Closet — 60 sf

10.	Storage Room	330 sf
11.	File Storage Room	180 sf
12.	Maintenance Shop	600 sf
13.	Mechanical Room	370 sf
14.	Electrical Rooms	
	a. First Floor	200 sf
	b. Second Floor	320 sf
	c. High Service Pump Station	2000 sf
15.	LAN and UPS Room	100 sf

C. Two Bay Garage

1. Locate separate from main building, near chlorine scrubber system
2. Provide space for:
    a. One forklift
    b. One Gator™ vehicle
    c. Two forklift fuel propane tanks
    d. Scrubber controls

A. General

Provide in-plant laboratories for wet chemistry and microbiological work.

B. Wet Chemistry Laboratory

1. Contain plenty of storage space for glassware, containers, office supplies, books, journals, etc.
2. Space for the following equipment:
    a. pH meter
    b. Turbidimeter
    c. Alkalinity titrator
    d. Hardness titrator
    e. Chlorine titrator
    f. On-line instrumentation
    g. Distillation unit and collection tank
    h. Analytical scale
    i. Jar testing apparatus
    j. HACH spectrophotometer
    k. Hot plates and magnetic stirrers
    l. Under counter vacuum pump
3. Plenty of countertop working space
4. Integral cabinet work surface/fume hood
5. Eye wash and safety shower
6. Temperature control
7. Chemical storage room or cabinet
8. Utility sink for washing dishes, etc.
    a. One tap for plant service water
    b. One tap for de-ionized (DI) water

9. Sample Sink - adequate to accommodate samples from following locations:

    a. Raw water

    b. Mixed water

    c. Combined filter influent (after chemical addition)

    d. Combined filter effluent

    e. Clearwell influent (after chemical addition)

    f. Plant effluent

10. Full height refrigerator, with double sliding glass doors

C. Microbiological Laboratory

1. Plenty of countertop working space

2. Cabinets with see-through doors for chemical and glassware storage

4. Full height refrigerator/freezer

5. Dishwasher

6. Desk

7. File storage

8. Space for the following equipment:

    a. Computer

    c. Autoclave

    d. Undercounter incubator

    e. Membrane filtration equipment

    f. Colony counter

    g. Water bath

    h. Analytical scale

    i. pH meter

    j. Turbidimeter

    m. Spectrophotometer

    n. HACH spectrophotometer

    o. Biohazard storage containers

    p. First-aid kit

q. On-line instrumentation readouts

9. Eyewash station and safety shower

10. Utility sink for washing dishes, etc.

    a. One tap for plant service

    b. One tap for DI water

D. Laboratory Storage

1. Provide space for DI water system

The following description is provided as a minimum standard. During the course of final design, alternate materials may be selected to provide improved heating and cooling system performance and energy efficiency. Consideration will also be given to selection of materials that provide minimum life cycle costs and use of recycled or natural materials.

A. Exterior Materials

1. Walls

a. Architectural face concrete masonry units (split-face and/or matte face of colors and scoring patterns as selected during design development).

b. Exterior walls to be concrete masonry insulating unit (CMIU) design with architectural face for exterior Wyeth and gypsum wallboard or normal cmu (depending on location) for inner Wyeth.

2. Doors and Frames and Windows

a. Doors and frames to be aluminum with organic finish. Doors will be of "flush type" design except for main entrance doors which will be glass doors of "narrow-stile" or "medium stile" design.

b. Windows to be constructed with aluminum frames with organic finish (color to match doors and frames) and 1 inch insulating glass. Operable sashes will be provided if required.

c. Overhead coiling doors to be electrically operated with insulated steel slates and with vision windows if desired.

3. Roofs

a. EPDM membrane roof system with tapered insulation.

b. Aluminum coping with fluoropolymer finish on top of parapet walls.

B. Interior Materials

1. Floors

a. Lobby and administrative corridors to be determined.

b. Seamless epoxy flooring for laboratory and lunch room.

c. Carpet for control room, conference room and offices.

d. Concrete with hardener for chemical, process areas, garage and workshop floor.

e. Concrete with sealer for wastewater pump room, electrical rooms, pipe gallery and process areas.

f. Ceramic tile in restroom/locker room facilities.

g. Special materials for secondary containment areas for chemicals.

2. Walls

   a. Gypsum wall board with vinyl for control room, administrative and hallway areas, and conference room.

   b. Ceramic tile for laboratory and restroom/locker room facilities.

   c. Gypsum wallboard for offices, control room and lunch room.

   d. Painted CMU in chemical and process areas.

   e. Sound attenuation CMU for the pump station.

3. Doors and Frames

   a. Hollow metal doors and frames in chemical and process areas.

   b. FRP doors and frames for corrosive areas

4. Ceilings

   a. Exposed structure in chemical and process areas.

   b. Suspended acoustical ceilings in administrative areas.

23.0 Site Design

The following provides describes pertinent site design coverage and heights, as designed. Owen County Kentucky does not currently have zoning and land development requirements.

A.	Building setbacks (distance from right-of-way line)		As indicated on drawings
B.	Access Roads		
	1.	Width, feet	20
	2.	Paving	Bituminous
C.	Coverage		
	1.	Buildings and structures	+/_ 90,000 sf
	2.	Impervious	<10 %
D.	Building Height		
	1.	Water treatment plant	38 ft
	2.	Raw water pumping station	46 ft
E.	Parking Lot Space		
	1.	Number of spaces	14

28.1 Design Concept

To the extent possible, the WTP will be designed to operate fully automated with the ability to manually override the control system locally (Local Manual) or manually through the control system (Remote Manual). Control of processes will be based on the use of Programmable Logic Controllers (PLCs – Bristol Babcock Controlwave)) with supervisory control and data acquisition through desktop computer based Human Machine Interfaces (HMI's) and touch screen based Operator Interface Terminals (OITs).

The HMI's and OITs will be located throughout the facility to allow easy access to the system. Communication between PLCs, HMIs and OITs will be via an Ethernet network with fiber optic communications between buildings. Remote access to the system will be via a dialup telephone line and the use of remote access software.

28.2 Operation Philosophy

The supply, treatment, and pumping operations are to be automated to the extent that operation of the facilities is by exception. Continuous operator attention is not required for basic functions such as operating pumps.

Where it is deemed necessary for the operator to oversee an automated operation, manual initiation, through a local pushbutton, will be required. Some areas requiring manual initiation could include filter washing and chemical transfer to day tanks.

Four levels of security are provided on the HMIs and OITs:

A. Guest: View screens only. No control.

B. Operator: Capabilities of Guest plus the ability to operate equipment (open or close valves, start and stop pumps), select mode of operation (automatic, remote manual, etc.), trend process variable/ review data, and the ability to acknowledge alarms.

C. Supervisor: Capabilities of Operator, plus the ability to change setpoints.

D. Administrator: Capabilities of Supervisor plus the ability to modify HMI and PLC programs.

28.3 Automatically Controlled Operations

The following list briefly describes process elements that can be controlled automatically by the Process Monitoring and Control System (PMCS).

A. Chemical adjustments based on operator setpoints, raw water flow, and feed back from analytical instruments.

B. Raw water flow can be established by operator input setpoint and trimmed based on clearwell level. Flow is monitored via raw water meter and controlled by two variable frequency drive raw water pumps.

C. Rapid mixer and flocculator mixing speed control based on water temperature and raw water flow.

D. Flow equalization through the online filters. Filter effluent flow is adjusted to maintain a constant filter influent level and simultaneously equal flow through each filter.

E. Filter backwash is based on time, loss of head, and turbidity triggers. Filter backwash duration is adjusted based on backwash wastewater turbidimeter signal. Filter to waste duration is based on time, effluent turbidity or volume discharged equivalent to a filter box volume.

F. The future ultraviolet (UV) disinfection system will be PLC controlled to provide a setpoint intensity time (IT) based on flow monitoring upstream of each UV reactor and intensity signal based on UV radiometers in each reactor.

G. Post treatment chemicals applied to the clearwell influent are flow paced based on sum of filter effluent meter flows and trimmed based on water quality analyzers.

H. Post treatment chemicals applied to the clearwell effluent are flow paced based on plant effluent meter flow and trimmed based on water quality analyzers.

I. Disinfection CT is monitored and calculated based on filter effluent flow, clearwell level (volume), temperature, clearwell effluent pH, and free chlorine residual.

J. Finished water pumping is controlled based on transmission system tank levels.

K. Water quality monitoring and documentation is provided based on online analyzers throughout the process.

L. Wastewater clarification is based on timer control, basin level signals, and decant water metering.

M. Wastewater sludge removal is controlled based on time.

N. Sludge transfer is controlled based on time and metered flow.

28.4 Modes of Operation

A. Automatic Mode: Automatic mode refers to control and sequencing of a process operation by the PMCS. Automatic modes require operator inputs for specific setpoints that include parameters such as time, level, dosage, flow, etc.

B. Remote Manual Mode: In PMCS Remote Manual Mode, an operator at a HMI or OIT can start or stop equipment, operate valves, or manually pace chemicals. This mode overrides automatic mode.

C. Local Manual Mode: In local manual mode, an operator can control equipment at its local control panel or at the equipment itself. This mode overrides remote-manual and automatic modes.

28.5 System Architecture

A. PMCS Major Components

1. PMCS (Process Monitoring and Control System): PMCS consists of the entire control system including Programmable Logic Controllers (PLC), Human Machine Interface (HMI), Operator Interface Terminal (OIT), networking equipment and software.
2. PLC's (Programmable Logic Controllers Bristol babcock Controlwave): Microprocessor based controllers located in control panels or consoles

throughout the plant to control various processes. PLCs are wired to process instrumentation and controls.

3. HMI (Human Machine Interface): Graphical software (Iconics Gen32) running on a PC used as a "window" into the process for monitoring, supervisory control, trending and alarming.
4. HMI Server: Microsoft Windows based computer running HMI server software. Servers communicate directly with the PLCs and collect data for control, alarming and trending.
5. HMI Client: Microsoft Windows based computer running HMI client software. Client computers communicate with HMI Servers.
6. OIT (Operator Interface Terminal): Industrial Grade PC with touch screen located in various control panels and consoles running graphical software similar to HMI software.
7. Report Printer: Laser printer used to print reports.
8. Alarm Printer: Traction feed dot-matrix printer used to print alarm events as they occur one line at a time.
9. POP (Point Of Presence): Communications rack housing communication electronics and termination equipment.

B. Network/Communications

1. The plant-wide Ethernet network uses two types of media, unshielded twisted pair (UTP) copper wires and fiber optic cables. The HMIs, PLCs and OITs located in close proximity to each other in the same building are networked together over UTP. Building to building connections and PLCs are networked together over a fiber optic ring. This configuration provides for redundant fiber optic communications so that any one break in the fiber optic ring will not interrupt the PMCS.
2. Off site access to the PMCS system is via a dial up telephone line. The access requires a username and password and remote access software on the remote computer. Once connected, the remote computer will function like a local HMI computer.
3. Communications with remote facilities: Leased line, private radio, and cellular technologies will be evaluated for communications.

C. Network Computers

1. Networked computers for access to the local area network will be provided in the Operator's Office and Laboratory.

D. HMI

1. Plant operation, control, alarm monitoring, report generation, and trending are provided by two redundant HMI servers located in the control room. The alarm printer is a dedicated printer that will automatically print any alarm generated by the system. The color report printer is used to print shift, daily, weekly, and monthly reports and can be used to print HMI screens and historical trends.

2. A client HMI computer is located in the Operator's Office. This HMI computer is to provide the same functionality as the HMI servers, but requires HMI server access to operate.

E. PLC Control Panels and Consoles

1. Each major process area is controlled and monitored by a PLC. Where possible, the control logic for the process area resides in the local PLC. If operator interaction is necessary locally, an OIT has been provided. Default graphics for the local OIT are specific for that process area but graphics for other areas of the plant will also be available. OITs can connect directly to the local PLC should the plant Ethernet be unavailable. Control panels will be located in the following areas:

- Raw water pumping station
- Chemical feed/rapid mixer area
- Finished Water Pumping Station
- Wastewater Facilities
- Dewatering Facilities

2. Filter Control Consoles (FCCs)

Filter process monitoring and control shall be provided by hub connections on both the filter operating floor and the filter pipe gallery. No filter control consoles, touch screens, OIT, and FCC is being provided in the filter area. All filter valve operations in manual or automatic are controlled via serial communication to the valves. In the event of a communications failure to the valves, the valves are controlled by local selector switches located at the valves. Where the valves are inaccessible, the selector switches will be located at ground level.

28.6 Special Systems

The following security related systems shall be included with remote control and monitoring from the control room

- Access control system for remote operation of doors and gates
- Intrusion detection system including motion sensors and magnetic door switches, etc.
- Closed circuit television at WTP and remote sites.

A. Codes and Standards

Electrical design will be in accordance with:

- NFPA 70, National Electrical Code, Latest Edition
- NFPA 72, National Fire Alarm Code, Latest Edition
- NFPA 497, Explosive Materials Code, Latest Edition
- NFPA 780, Identification of the Fire Hazards of Materials, Latest Edition
- Kentucky Utility requirements for electric service
- IES Lighting Handbook, 8th Edition
- IEEE Standards (as applicable) including:
    - IEEE 141 Electrical Power Distribution for Industrial Plants (Red Book)
    - IEEE 241 Grounding of Industrial and Commercial Power Systems (Green Book)
    - IEEE 1100 Powering and Grounding of Sensitive Electronic Equipment
- Local and State Building Codes, including all requirements which provide amendments to or supersede the above listed references

B. Power Distribution

The electrical power distribution system for the WTP will utilize 4160 voltage service and distribution equipment. The utility service location will provide for a single 4160 volt, 3 phase, 4 wire grounded secondary service obtained via an outdoor pad-mounted transformer and associated equipment. The primary power delivered by the utility and the method for primary power delivery, underground vs. aerial, will be coordinated with the utility.

The transformer and electric meter will be provided by the utility but located on KAW property. A pre-cast transformer foundation/vault built to electric utility specifications will be provided for the transformer. The electric service meter will be placed on a free standing pedestal at the transformer pad.

Normal and standby power for the raw water pumping station will be provided via two feeders from the WTP. The proposed electrical distribution system will be configured with a utility service entrance stepped down to 4160 volt and one stationary diesel powered standby 4160 volt power generator. A plug receptacle for a mobile generator connection will also be provided. The raw water pumping station loads will be sub-fed with dual power feeds from multiple 4160 volt switchboards providing redundancy of feed in the event a switchboard is out of service for maintenance. Likewise, the water treatment plant loads will be sub-fed with dual power feeds to provide similar redundancy with the exception of the sludge dewatering facility which will only have a single feed. Automatic transfer capability will be provided for the standby power generator, through the use of an automatic transfer switch in the event of loss of normal utility power. This "main-standby" power arrangement allows for several operational features and benefits from the emergency power as outlined below:

- Carry approximately 33% of ultimate raw water pumping station and water treatment plant load via standby power generation.
- Transfer load necessary to operate one 10 mgd raw water pump, one 10 mgd high service pump, one washwater pump, and all other critical water treatment plant loads.
- Transfer load necessary to operate one 7 mgd high service pump and one 7 mgd raw water pump and critical water treatment plant loads from the mobile generator.
- Loading of the generator will be administratively controlled through the SCADA System, if required.

Surge suppression will be designed for the incoming service entrance using the appropriate level of transient protection as defined in ANSI/IEEE Standard C62.41, Category C requirements. A coordinated transient voltage surge suppression system will be provided to mitigate the damaging effects to plant electrical equipment due to incurred lightning strikes or off-site power line disturbances including switching surge contributions from a nearby capacitor bank located on the utility distribution system line. In addition, downstream transient voltage surge suppression devices will be employed to further protect sensitive process instrumentation power sources and telecommunications data lines from induced transients. Also, a relay protection and monitoring scheme will be developed to ensure that the transfer switch and other items (such as induction pumping motors) are adequately protected from voltage unbalance, phase loss, phase reversal, over/under frequency, and over/under voltage.

The electrical distribution system will be designed in accordance with recommendations of IEEE 141 Red Book.

The service entrance main distribution switchboard will utilize individually mounted molded case solid-state and thermal-magnetic trip circuit breakers in lieu of group mounted circuit breakers for improved protection in the event of a breaker failure. A Style 3, dead front, front accessible switchboard will be physically configured to provide feeders to motor control centers (MCCs) in each of the facility buildings (RWPS and WTP).

From the main distribution switchboard, feeders will distribute power to motor control centers in the plant pump room and chemical areas of the water treatment building. These MCCs will provide 480/277V, 3 phase, 4 wire power distribution to the associated equipment within these areas. This low voltage distribution equipment will serve all large three phase motor and equipment requirements as well as provide a stepdown transformer based 208/120V, 3 phase, 4 wire power distribution subsystem serving smaller single and three phase general power loads within each building.

Low voltage motor control will generally consist of full voltage non-reversing, reduced voltage solid-state, or variable frequency drive motor starting equipment unit mounted within the respective MCCs. The determination as to starter type will be based on the relative horsepower, starting current load and operational criteria required for the equipment. Dedicated instrument power panels will be provided to all of the PLC's, analyzers, etc. that require power. No other general, process, or HVAC loads will be placed on these panels.

C. Lighting

Interior lighting will utilize high efficiency, T-8 fluorescent lamps with high power factor electronic ballasts, where possible. Fixture types and enclosure designs will be selected based on the physical, environmental and aesthetic parameters associated with the area of installation. Special use fixtures will be provided in areas where required.

Due to the increased potential for transient voltage conditions being seen on the 480/277 V system, all fixture voltage selections will be standardized to 120 VAC for the remote buildings. However, evaluate initial costs and design considerations for lighting systems of 120VAC versus lighting systems of 277VAC with transient voltage protection for the main building fixture use. Provide means to protect the lamp and ballast equipment from the switching transients on the system, provide for better voltage regulation to reduce flicker potential and standardize the materials which will be required for spare parts and maintenance.

Exterior lighting will be provided for security and general safety of the plant personnel. Provide high pressure sodium type lamp/fixtures for this application due to their high efficiency and long life. Provided building mounted, vandal-proof perimeter fixtures where possible and limit use of pole mounted area lights.

Foot candle illumination levels will be designed based on the recommendations of Illuminating Engineering Society of North America (IES) for the areas and tasks associated with each facility. Nominal foot candle levels are outlined below at nominal 2.5 ft. work plane, unless otherwise noted.

- Exterior lighting: 0.5 fc at 10 feet from building
- Office/administrative areas: 50-70 fc
- Bulk storage areas: 20-40 fc
- Equipment rooms: 30-40 fc
- Operating floor/filter areas: 20-40 fc
- Laboratory areas: 70-100 fc
- Special purpose locations: As recommended by I.E.S.

Opportunities to improve energy efficiency will be pursued including use of high efficiency ballast designs and smart controls for reduced lighting during hours of unmanned and/or non-occupancy operation.

D. Essential Services

- Facility essential services will be provided to meet the operational and code/regulatory requirements for such systems being provided.
- Means-of-egress lighting will be provided from emergency, battery powered lighting units, integral emergency ballasts installed within select fluorescent fixtures, or a combination of both, based on the final design evolution. Where

required, internally illuminated exit signage will utilize LED technology in order to provide a long life and low energy consumption.

- A facility wide fire alarm system will be provided for the various facility structures in accordance with the requirements of NFPA 72. This system will be centrally reported through the PCMS equipment. The fire alarm system will comply with ADA alarm signaling requirements for all areas as determined by the respective Architectural requirements for the building(s).

- Access control systems will be provided at various facility structures and reported through the SCADA system.

- The communications (telephone) system being provided under this design will be limited to a raceway/cable/outlet system only and the coordination of telephone service with the serving utility, including fax service. No hardware associated with the phone equipments is being provided under this design. In addition, there are no provisions for paging included in the design.

- An electrically operated access gate with security card reader and intercom and sign lighting will be provided at the main entrance.

- Provision to interface with existing or proposed telemetry equipment will be made for future implementation.

E. Special Considerations for Design

- <u>Grounding</u>

  The design will provide for a solidly grounded system; in conjunction with both the electrical power distribution system (NFPA 70, IEEE 142 Green Book) and the instrumentation system (IEEE 1100 Emerald Book) grounding requirements. Use of grounding electrodes and exterior ground grids will be considered in the design for this system.

- <u>Lightning, Surge and Transient Protection</u>

  We will assess and provide a building lightning protection system in accordance with NFPA 780 as outlined in the Design Criteria.

  The electrical distribution system will be provided with a surge suppression devices for distribution equipment protection. Additionally, transient surge suppression equipment will be provided to maximize the protection of sensitive solid state equipment from the switching transients anticipated to be associated with an industrial power system.

- <u>Uninterruptible Power Supply (UPS) Equipment</u>

  Where required by the nature of the equipment associated with the design for these facilities; PWM or ferro resonant type UPS equipment will be provided to ensure power quality to the system(s).

- <u>Power Factor Correction</u>

  Provide capacitors on all large motors as required for power factor correction.

A. HVAC Design Guidelines

This section presents the design criteria for the heating, ventilating and air conditioning (HVAC) systems.

The HVAC systems will be designed in accordance with the latest 2000 International Mechanical Code, applicable portions of the codes in effect in the state of Kentucky and applicable portions of the latest National Fire Protection Association (NFPA) design standards. Where differences exist between standards, the more stringent standards will take precedence.

The HVAC calculations will be prepared using the following:

1. Outside Conditions: (ASHRAE 1993 Fundamentals Volume)
   Winter: 10 degrees F dry bulb (DB), 99% value.
   Summer: 89 degrees F dry bulb; 74 degrees F coincident wet bulb.
2. Inside Design Conditions:
   Winter: As noted in the HVAC/Electrical Design Criteria Table.
   Summer: 75 degrees F; 50% relative humidity..
3. Ventilation:
   Minimum Outdoor Air - 20 cfm per person (Offices and Conference Rooms)
4. Equipment Loads:
   The sensible and latent heat gains from appliances in the Lunch Room, computer equipment in the Offices and Control Room and laboratory equipment will be used in the final HVAC loads.
5. Heat Gain or Loss: An allowance will be made for duct heat gain or loss for that portion of the duct in unconditioned spaces. This allowance will not exceed 10 to 15% of the total air conditioning load.

Miscellaneous allowances for fan heat, duct heat pickup, duct leakage and safety factors will be included in the air conditioning load calculations and will not Exceed 15% of the total.

B. Heating Systems

The heating system was determined based on economic analysis of available heat sources.

The recommended systems for the plant are a direct expansion cooling system with electric heat for the air conditioned spaces and electric unit heaters for the heating only areas of the plant. The direct expansion system will consist of an air cooled condensing unit located outside and an air handling unit located either on the roof or inside the building. The heating system will consist of electric unit heaters with integral thermostats.

C. Air Conditioning Systems

An air conditioning system is proposed to serve the administrative, control room and laboratory areas of the plant. The air handling system will be either rooftop mounted or be inside the building. The air handling units will be equipped with filters, cooling and heating coils, and an economizer.

The air distribution systems will consist of, but not be limited to, galvanized steel ductwork, supply air diffusers, return registers, volume dampers, fire dampers, supports and hangers. Areas designated as corrosive will utilize corrosion resistant materials for ductwork and related accessories.

The equal friction method and the following parameters will be used in the final design of the air distribution system:

1. Ductwork Airflow Friction Rate:

Airflow Up to 1000 CFM 0.08 inches WG per 100 feet.

Airflow 1000 CFM and above 0.10 inches WG per 100 feet.

2. Duct Velocities for Low Velocity Air Conditioning Systems:

Designation	**Recommended Velocity (FPM)**	**Maximum Velocity (FPM)**
Main Ducts	1000 - 1300	1100 - 1600
Branch Ducts	600 - -00	800 - 1300
Branch Risers	600 - 700	800 - 1200
Fan Outlets	1300 - 2000	1500 - 2200
Heating Coils	300 - 500	600
Cooling Coils	300 - 500	500
Outside Air Intake for Net Free Area*	500	Per AMCA Ratings
Filters	300 - 400	

3. Aspect Ratio: The ductwork will be designed at an aspect ratio less than or equal to three to one.

4. Recommended Noise Level Design Goals:

NC Range	Communication		Typical Application
20-25	Excellent	30-50 ft.	Executive Offices
20-30	Excellent	20-40 ft.	Board Rooms, Class Rooms, Conference Rooms
30-35	Good	10-30 ft.	Private Offices, Libraries
35-40	Fair	6-12 ft	Open-Plan Areas, Halls, Corridors, Computer Equipment Rooms
40-45	Fair	4-9 ft.	Service/Support Areas

D. Ventilation Systems

The plant areas and pump stations will be ventilated to:

1. Provide summer ventilation.

2. Dilute and remove chemical odors and fumes.

3. Remove hazardous fumes from the laboratories.

4. Remove excessive equipment heat.

The ventilation rates for the chemical areas will be set based on the following table:

Chemical Area Ventilation Rates	
Chemical	Ventilation Rate (CFM PER SQ FT)
Ammonia	1
Carbon Room	1
Caustic Soda	1
Chemical Feed Room	1
Chlorine Facilities	1*
Corrosion Inhibitor	1
Ferric Chloride	1
Fluoride Room	1
Polyaluminum Chloride	1
Sodium Bisulfate	1

* Normal ventilation at 1 cfm per square foot with an independent 60 Air Change Hour system for ventilation while space is occupied.

The chemical area ventilation system will run continuously. The spaces will be provided with heated make-up air. The chlorine storage area ventilation systems will consist of a normal ventilation system, occupied mode system, and chlorine scrubber system. The ventilation systems associated with normal and occupied modes of operation will be interlocked with the chlorine scrubber system. When the chlorine scrubber system is activated, the normal and occupied ventilation systems will be disabled. The occupied mode ventilation system for the chlorine storage will not have heated make-up air.

Individual power ventilation systems will, typically, consist of supply and exhaust fans with either gravity intake dampers, motor-operated intake dampers or counterbalanced intake dampers.

E. Dehumidification Systems

Individual room size dehumidifiers will be utilized in certain areas. The dehumidifiers will have separate controls and will be supported from walls or floor. Dehumidification will be provided in pipe galleries with wetted walls.

F. Automatic Temperature Controls

The plant will be provided with a direct digital controls (DDC) automatic temperature control (ATC) system. The main control terminal will be located in the Control Room. The ATC system will monitor the operation of all HVAC systems.

G. Plumbing Systems

Plumbing systems will include domestic cold and hot water, sanitary, vent, natural gas and other piping systems in support of the laboratory gas systems. Plumbing fixtures will include water closets, urinals with flush valves, showers, utility sinks, emergency eyewash and showers, and stainless steel sinks. The sanitary drainage system will be coordinated with process elements so that drains are placed in appropriate locations. Each of the lavatories and locker/shower rooms will have a floor drain. Emergency eyewash and showers will be located in areas where there are potential hazards from chemical exposure. Plumbing systems will be designed in compliance with the Kentucky State Plumbing Code.

Drainage from laboratory sample sinks will be separated and directed to the process drainage system. The drainage system shall be designed for approximately 2 gpm flow per sample faucet.

Sample faucets shall be provided for the following samples:

1. Raw water
2. Mixed water
3. Combined settled water
4. Combined filter influent (after chemical addition)
5. Combined filter effluent
6. Clearwell influent (after chemical addition)
7. Plant effluent

A dedicated drainage system and holding tank will be provided for storage of chemical waste from the environmental laboratory.

H. Fire Suppression Systems

Fire suppression system will include wet pipe sprinkler systems in spaces where required by code. The spaces equipped with sprinkler systems are indicated in the NBMA WTP Expansion - HVAC/Fire Suppression Requirements table in Appendix F. The sprinkler system design will be performance based. Each of the sprinklered chemical rooms will have systems designed specifically for the hazard level present in the space. All fire suppression systems will be in compliance with the current applicable sections of the NFPA and the International Fire Code.

27.0 Conceptual Planning for Potential Future Facilities

1. The new WTP is being designed with a process capacity of 20 mgd and hydraulic capacity of 30 mgd. Provisions are to be included to expand to 30 mgd. The following process expansion provisions shall be included.

   A. Adding fifth 6 mgd raw water pump.

   B. Extending flocculator influent flume to two more basins

   C. Constructing two new flocculation basins

   D. Constructing two more sedimentation basins with plate settlers.

   E. Installing additional plates in initial sedimentation basins to allow expansion or improve performance.

   F. Extending filter influent flume for two new filters

   G. Constructing two new filters

   H. Adding UV reactors, if required based on source water classification in accordance with LT2 ESWTR

   I. Expanding clearwell

   J. Adding fifth 6 mgd finished water pump

   K. Replacement of anthracite filter media with GAC

   L. Adding thickened sludge transfer pumps and second thickener

   M. Add a third belt filter press

Appendices

KENTUCKY AMERICAN WATER COMPANY

20 MGD WATER TREATMENT PLANT
AND RELATED FACILITIES

DESIGN MEMORANDUM

APPENDIX A

CHEMICAL FEED SYSTEM COMPUTATIONS

CHEMICAL FEED
DATA INPUT FORM

PROJECT NO.:	45260	By:	WWA
PROJECT NAME:	Kentucky River Pool 3	Checked:	LLK
CLIENT:	Kentucky American Water Company		

	PLANT DESIGN FLOW			
	MIN	AVE	MAX	ULT
MGD	4.00	15.00	20.00	30.00
CFS	6.192	23.220	30.960	46.440

	CHEMICAL DATA:					
	S.G. or BULK DENSITY (#/cuft)	ACTIVE CHEMICAL STRENGTH (#/gal)	DOSAGE (ppm) MIN	AVE	MAX	
COMMONLY USED CHEMICALS						
Potassium Permanganate	95.00	0.20	0.44	1.32	2.64	Based on 0.44 x cl2 dose
Chlorine - Pre	91.70	N/A	1.00	3.00	6.00	
Chlorine - filter influent	91.70	N/A	0.50	1.00	3.00	Low residual or clearwell residual
Activated Carbon	12.00	1.00	1.00	3.00	25.00	Rarely applied
Coagulant - Ferric Chloride	1.40	4.40	15.00	40.00	100.00	
Hydrofluosilicic Acid (23%)	1.20	1.77	0.80	1.00	1.30	Based on residuals
Chlorine - Post	91.70	N/A	1.00	2.00	4.00	
Sodium Hydroxide -50%	1.53	6.38	1.00	10.00	21.00	Rounded
Zinc Orthophosphate	1.58	13.20	1.00	3.00	5.00	Disregarded maximum of 15.64 mg/l
Polymer - Liq. Coag. Aid	1.00	8.50	0.10	0.20	0.50	
Polymer - Liq. Filter Aid	1.00	8.50	0.02	0.05	0.10	
OTHER MISC. DRY CHEMICALS						
OTHER MISC. LIQUID CHEMICALS						
Coagulant - PolyAlCl	1.20	3.30	5.00	22.00	110.00	
Sodium Hydroxide -25%	1.28	2.66	1.00	10.00	21.00	
Sodium Thiosulfate (30% by weight)**	1.27	3.20	3.00	5.25	6.00	
*** calcs based on washwater flow						
Aqua Ammonia	0.93	1.47	0.44	0.78	0.89	
OTHER MISC. GAS CHEMICALS						
Ammonia	40.00	N/A	0.25	0.50	1.00	

Bisulfite Calculations

Free Residua	Ratio	
3.5	1.5	average
2	1.5	Minimum
4	1.5	maximum

1.46 stoichiometric ratio Bisulfite to CL2 Residual

Ammonia Calculations

Free Residual	Ratio	
3.5	4.5	average
2	4.5	Minimum
4	4.5	maximum

target 3.5 mg/L total

Free chlorine divided by CL/NH3 ratio Between 3 and 5 to 1

Use 4 or 4.5 to 1 to favor monochloamine and avoid dichloramine

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Activated Carbon

BATCH STRENGTH: 1.00 #/Gal
BULK DENSITY: 12.00 #/CuFt

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE (ppm)		MIN 4	AVE 15	MAX 20	ULT 30
MIN	1.00	#/DAY	33.36	125.10	166.80	250.20
		CF/DAY	2.78	10.43	13.90	20.85
		CF/HR	0.116	0.434	0.579	0.869
		GAL/HR	1.39	5.21	6.95	10.43
AVE	3.00	#/DAY	100.08	375.30	500.40	750.60
		CF/DAY	8.34	31.28	41.70	62.55
		CF/HR	0.348	1.303	1.738	2.606
		GAL/HR	4.17	15.64	20.85	31.28
MAX	25.00	#/DAY	834.00	3127.50	4170.00	6255.00
		CF/DAY	69.50	260.63	347.50	521.25
		CF/HR	2.896	10.859	14.479	21.719
		GAL/HR	34.75	130.31	173.75	260.63

MINIMUM STORAGE REQUIREMENTS:
- 20 Days @ Ult Q /Ave Rate 15012 Lbs.
- 10 Days @ Max Q /Max Rate 41700 Lbs.
- 10 Days @ Ult Q /Max Rate 62550 Lbs.

DISSOLVER TANK (Dt= 15min)
- @ Max Q 43 Gal.
- @ Ult Q 65 Gal.

Average storage based on Ultimate flow average dose divided by 1.5 peaking factor

MINIMUM HOPPER REQUIREMENTS: Fill 1 Time/

	8 Hr Shift	Day
Max. Feed/ Max Q Requirements (CuFt):	115.83	347.50
Max. Feed/ Ult Q Requirements (CuFt):	173.75	521.25

REQUIRED FEED RANGE: 0.12 to 21.72 CF/HR

EQUIPMENT SELECTION:

Feeder:	Volumetric, 1 duty, 1 future
Slurry tank	100 gallons
Storage	15000 lbs
Eductor	Educt to raw water main at WTP
Hopper:	Single hopper with dual discharge
Misc:	Load cells
	Monorail and hoist
	Pneumatically-operated knife gate valves at hopper discharge

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Potassium Permanganate

BATCH STRENGTH: 0.20 #/Gal
BULK DENSITY: 95.00 #/CuFt

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE (ppm)		MIN 4	AVE 15	MAX 20	ULT 30
MIN	0.44	#/DAY	14.68	55.04	73.39	110.09
		CF/DAY	0.15	0.58	0.77	1.16
		CF/HR	0.006	0.024	0.032	0.048
		GAL/HR	3.06	11.47	15.29	22.94
AVE	1.32	#/DAY	44.04	165.13	220.18	330.26
		CF/DAY	0.46	1.74	2.32	3.48
		CF/HR	0.019	0.072	0.097	0.145
		GAL/HR	9.17	34.40	45.87	68.81
MAX	2.64	#/DAY	88.07	330.26	440.35	660.53
		CF/DAY	0.93	3.48	4.64	6.95
		CF/HR	0.039	0.145	0.193	0.290
		GAL/HR	18.35	68.81	91.74	137.61

MINIMUM STORAGE REQUIREMENTS:
30 Days @ Ult Q /Ave Rate 9908 Lbs.
10 Days @ Max Q /Max Rate 4404 Lbs.
10 Days @ Ult Q /Max Rate 6605 Lbs.

DISSOLVER TANK (Dt= 15min)
@ Max Q 23 Gal.
@ Ult Q 34 Gal.

Storage based on 30 days Ultimate flow average dose divided by 1.5 peaking factor
REQUIRED FEED RANGE: 0.01 to 0.29 CF/HR

EQUIPMENT SELECTION:
Storage: 30 330 lb drums
Dissolver 50 gallon minimum
Feeder type: Volumetric Screw Feeder, 1 duty 1 spare
Feed pumps: 2 metering pumps at RWPS
Hopper: Carus drum invertor - 330 lbs net weight
Misc: Provide scales for monitoring tare weight
Mechanical mixer with jet agitator
1 - 500 gallon batch tank at WTP
1 - 1400 gallon day tank at RWPS
1 Transfer pump at WTP
2 Transfer pumps at RWPS

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3

CHEMICAL: CHLORINE GAS

PRE - CHLORINE

FEED RATES:

FEED RATE	DOSAGE (ppm)		PLANT FLOW (mgd) MIN 4.00	AVE 15.00	MAX 20.00	ULT 30.00
MIN	1.00	#/DAY	33.36	125.10	166.80	250.20
AVE	3.00	#/DAY	100.08	375.30	500.40	750.60
MAX	6.00	#/DAY	200.16	750.60	1000.80	1501.20

FILTER INFLUENT - CHLORINE

FEED RATES:

FEED RATE	DOSAGE (ppm)		PLANT FLOW (mgd) MIN 4.00	AVE 15.00	MAX 20.00	ULT 30.00
MIN	0.50	#/DAY	16.68	62.55	83.40	125.10
AVE	1.00	#/DAY	33.36	125.10	166.80	250.20
MAX	3.00	#/DAY	100.08	375.30	500.40	750.60

20

POST - CHLORINE

FEED RATES:

FEED RATE	DOSAGE (ppm)		PLANT FLOW (mgd) MIN 4.00	AVE 15.00	MAX 20.00	ULT 30.00
MIN	1.00	#/DAY	33.36	125.10	166.80	250.20
AVE	2.00	#/DAY	66.72	250.20	333.60	500.40
MAX	4.00	#/DAY	133.44	500.40	667.20	1000.80

MINIMUM STORAGE REQ Volumetric, 1 duty, 1 future

30 Days @ Ult Q /Ave Rate	22518	LB. =	11.3	Ton Containers
10 Days @ Max Q , 15000 lbs	17514	LB. =	8.8	Ton Containers
10 Days @ Ult Q /Max Rate	17514	LB. =	8.8	Ton Containers

Average storage based on Ultimate flow average dose divided by 1.5 peaking factor

REQUIRED FEED RANGE:

Pre-Chlorinator:	33.36	To	1501.20	#/DAY
Post-Chlorinator:	33.36	To	1000.80	#/DAY
Filt inf Chlorinator	33.36		750.60	#/DAY

EQUIPMENT SELECTION:

Chlorinator: Pre 1500 #/DAY Common spare and boost chlorinator
Influent 1000 #/DAY
Post 1000 #/DAY

Misc: Two-ton weigh scales 2
Active Cylinders 2 with automatic switchover
Storage cylinders 14 (10 in storage, 4 on scales)
Cylinder mounted vacuum regulators
Remote eductors at feed points
Future evaporator

CHEMICAL FEED COMPUTATIONS

SODIUM HYDROXIDE
(CAUSTIC SODA)

PROJECT NO.: 45260
PROJECT NAME: Kentucky River Pool 3

By: WWA
Checked: LLK

CHEMICAL: Sodium Hydroxide -50%

ACTIVE STRENGTH: 6.38 #/Gal
SPECIFIC GRAVITY: 1.53

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE		MIN	AVE	MAX	ULT
	(ppm)		4	15	20	30
MIN	1.00	#/DAY	33.36	125.10	166.80	250.20
		GAL/DAY	5.23	19.61	26.14	39.22
		GAL/HR	0.218	0.817	1.089	1.634
AVE	10.00	#/DAY	333.60	1251.00	1668.00	2502.00
		GAL/DAY	52.29	196.08	261.44	392.16
		GAL/HR	2.179	8.170	10.893	16.340
MAX	21.00	#/DAY	700.56	2627.10	3502.80	5254.20
		GAL/DAY	109.81	411.77	549.03	823.54
		GAL/HR	4.575	17.157	22.876	34.314

MINIMUM STORAGE REQUIREMENTS:

30 Days @ Ult Q /Ave Rate 11765 Gal.
10 Days @ Max Q /Max Rate 5490 Gal.
10 Days @ Ult Q /Max Rate 8235 Gal.

Average storage based on Ultimate flow average dose divided by 1.5 peaking factor

REQUIRED FEED RANGE:

0.22 to 34.31 GPH

MIN. DAY TANK SIZING:

Fill 1 Time/ @ Max Q/Max Rate
Shift 238 Gal.
Day 604 Gal.

Fill 1 Time/ @ Ult Q/Max Rate
Shift 357 Gal.
Day 906 Gal.

EQUIPMENT SELECTION:	Number	Size	Transfer Time (min)
Bulk Tank:	2	5000 gallons	
Transfer pump	2	50 gpm	20
Day Tank:	1	1000 gallons	
Feed Pump:	2		

Min Rate: 0.22 Max Rate: 34.31 GPH

Misc
Temperature controlled room
Continuous level monitors, each tank
High level switches, each tank

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Coagulant - PolyAlCl

ACTIVE STRENGTH: 3.30 #/Gal
SPECIFIC GRAVITY: 1.20

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE		MIN	AVE	MAX	ULT
	(ppm)		4	15	20	30
MIN	5.00	#/DAY	166.80	625.50	834.00	1251.00
		GAL/DAY	50.55	189.55	252.73	379.09
		GAL/HR	2.106	7.898	10.530	15.795
AVE	22.00	#/DAY	733.92	2752.20	3669.60	5504.40
		GAL/DAY	222.40	834.00	1112.00	1668.00
		GAL/HR	9.267	34.750	46.333	69.500
MAX	110.00	#/DAY	3669.60	13761.00	18348.00	27522.00
		GAL/DAY	1112.00	4170.00	5560.00	8340.00
		GAL/HR	46.333	173.750	231.667	347.500

MINIMUM STORAGE REQUIREMENTS:

30 Days @ Ult Q /Ave Rate	50040	Gal.
10 Days @ Max Q /Max Rate	55600	Gal.
10 Days @ Ult Q /Max Rate	83400	Gal.
20 Days @ Ult Avg Q /Ave Rate	33360	Gal.

REQUIRED FEED RANGE:
2.11 to 347.50 GPH

MIN. DAY TANK SIZING:

Fill 1 Time/ @ Max Q/Max Rate
Shift 2409 Gal.
Day 6116 Gal.

Fill 1 Time/ @ Ult Q/Max Rate
Shift 3614 Gal.
Day 9174 Gal.

EQUIPMENT SELECTION:	Number	Size		
Bulk Tank:	2	12,000	gallons	Transfer Time (min)
Transfer pump	2	105	gpm	20
Day Tank:	2	2100	gallons	
Feed Pump:	2			

Volumetric, 1 duty, 1 futur Max Rate:
2.11 347.50 GPH

Misc 15000 lbs
Continuous level monitors, each tank
High level switches, each tank

PROJECT NO.: 45260 By: WWA

PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Coagulant - Ferric Chloride

ACTIVE STRENGTH: 4.40 #/Gal

SPECIFIC GRAVITY: 1.40

FEED RATE	DOSAGE (ppm)		PLANT FLOW (mgd) MIN 4	AVE 15	MAX 20	ULT 30
MIN	15.00	#/DAY	500.40	1876.50	2502.00	3753.00
		GAL/DAY	113.73	426.48	568.64	852.95
		GAL/HR	4.739	17.770	23.693	35.540
AVE	40.00	#/DAY	1334.40	5004.00	6672.00	10008.00
		GAL/DAY	303.27	1137.27	1516.36	2274.55
		GAL/HR	12.636	47.386	63.182	94.773
MAX	100.00	#/DAY	3336.00	12510.00	16680.00	25020.00
		GAL/DAY	758.18	2843.18	3790.91	5686.36
		GAL/HR	31.591	118.466	157.955	236.932

MINIMUM STORAGE REQUIREMENTS:

30 Days @ Ult Q /Ave Rate	68236	Gal.
10 Days @ Max Q /Max Rate	37909	Gal.
10 Days @ Ult Q /Max Rate	56864	Gal.
30 Days @ Ult Avg Q /Ave Rate	45491	Gal.

REQUIRED FEED RANGE:

4.74 to 236.93 GPH

MIN. DAY TANK SIZING:

Fill 1 Time/ @ Max Q/Max Rate

Shift	1643	Gal.
Day	4170	Gal.

Fill 1 Time/ @ Ult Q/Max Rate

Shift	2464	Gal.
Day	6255	Gal.

EQUIPMENT SELECTION:

	Number	Size	Transfer Time (min)
Bulk Tank:	2	12,000 gallons	
Transfer pump	2	75 gpm	20
Day Tank:	1	1500 gallons	
Feed Pump:	2		

Min Rate: 4.74 Max Rate: 236.93 GPH

Misc

Continuous level monitors, each tank
High level switches, each tank

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Polymer - Liq. Coag. Aid

ACTIVE STRENGTH: 8.50 #/Gal
SPECIFIC GRAVITY: 1.00

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE (ppm)		MIN 4	AVE 15	MAX 20	ULT 30
MIN	0.10	#/DAY	3.34	12.51	16.68	25.02
		GAL/DAY	0.39	1.47	1.96	2.94
		GAL/HR	0.016	0.061	0.082	0.123
AVE	0.20	#/DAY	6.67	25.02	33.36	50.04
		GAL/DAY	0.78	2.94	3.92	5.89
		GAL/HR	0.033	0.123	0.164	0.245
MAX	0.50	#/DAY	16.68	62.55	83.40	125.10
		GAL/DAY	1.96	7.36	9.81	14.72
		GAL/HR	0.082	0.307	0.409	0.613

MINIMUM STORAGE REQUIREMENTS:
30 Days @ Ult Q /Ave Rate 177 Gal.
10 Days @ Max Q /Max Rate 98 Gal.
10 Days @ Ult Q /Max Rate 147 Gal.

REQUIRED FEED RANGE:
0.02 to 0.61 GPH

MIN. DAY TANK SIZING:
Fill 1 Time/ @ Max Q/Max Rate
Shift 4 Gal.
Day 11 Gal.
Fill 1 Time/ @ Ult Q/Max Rate
Shift 6 Gal.
Day 16 Gal.

EQUIPMENT SELECTION:

Polymer feed system

Type	Liquid polymer blending system, direct drum feed
Number	2 Common spare with FA Polymer
Capacity	0.02 to 0.61 GPH
Storage	4 55-gal. drums
Misc.	Weigh scales
	Drum mixers

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3 Checked LLK

CHEMICAL: Polymer - Liq. Filter Aid

ACTIVE STRENGTH: 8.50 #/Gal
SPECIFIC GRAVITY: 1.00

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE (ppm)		MIN 4	AVE 15	MAX 20	ULT 30
MIN	0.02	#/DAY	0.67	2.50	3.34	5.00
		GAL/DAY	0.08	0.29	0.39	0.59
		GAL/HR	0.003	0.012	0.016	0.025
AVE	0.05	#/DAY	1.67	6.26	8.34	12.51
		GAL/DAY	0.20	0.74	0.98	1.47
		GAL/HR	0.008	0.031	0.041	0.061
MAX	0.10	#/DAY	3.34	12.51	16.68	25.02
		GAL/DAY	0.39	1.47	1.96	2.94
		GAL/HR	0.016	0.061	0.082	0.123

MINIMUM STORAGE REQUIREMENTS:
30 Days @ Ult Q /Ave Rate 44 Gal.
10 Days @ Max Q /Max Rate 20 Gal.
10 Days @ Ult Q /Max Rate 29 Gal.

REQUIRED FEED RANGE:
0.00 to 0.12 GPH

MIN. DAY TANK SIZING:
Fill 1 Time/ @ Max Q/Max Rate
Shift 1 Gal.
Day 2 Gal.
Fill 1 Time/ @ Ult Q/Max Rate
Shift 1 Gal.
Day 3 Gal.

EQUIPMENT SELECTION:
Polymer feed system
Type Liquid polymer blending system, direct drum feed
Number 1 Common spare with CA Polymer
Capacity 0.00 to 0.12 GPH
Storage 1 55-gal. drums
Misc. Weigh scales
Drum mixers

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Aqua Ammonia

ACTIVE STRENGTH: 1.47 #/Gal
SPECIFIC GRAVITY: 0.93

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE (ppm)		MIN	AVE	MAX	ULT
			4	15	20	30
MIN	0.44	#/DAY	14.83	55.60	74.13	111.20
		GAL/DAY	10.09	37.82	50.43	75.65
		GAL/HR	0.420	1.576	2.101	3.152
AVE	0.25	#/DAY	8.34	31.28	41.70	62.55
		GAL/DAY	5.67	21.28	28.37	42.55
		GAL/HR	0.236	0.886	1.182	1.773
MAX	0.89	#/DAY	29.65	111.20	148.27	222.40
		GAL/DAY	20.17	75.65	100.86	151.29
		GAL/HR	0.841	3.152	4.203	6.304

MINIMUM STORAGE REQUIREMENTS:
30 Days @ Ult Q /Ave Rate 1277 Gal.
10 Days @ Max Q /Max Rate 1009 Gal.
10 Days @ Ult Q /Max Rate 1513 Gal.
20

REQUIRED FEED RANGE:
0.42 to 6.30 GPH

MIN. DAY TANK SIZING:
Fill 1 Time/ @ Max Q/Max Rate
Shift 44 Gal.
Day 111 Gal.
Fill 1 Time/ @ Ult Q/Max Rate
Shift 66 Gal.
Day 166 Gal.

EQUIPMENT SELECTION:	Number	Size		
Bulk Tank:	1	8,000 gallons	SS Pressure tank	
Transfer pump	2	125 gpm	Transfer Time (min)	5
Day Tank:	1	150 gallons	SS Pressure tank	
Feed Pump:	2			

Min Rate: Max Rate:
Volumetric, 1 duty, 1 futur 6.30 GPH

Misc
15000 lbs
High level switches, each tank

CHEMICAL FEED COMPUTATIONS FLUORIDE

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Hydrofluosilicic Acid (23%)

ACTIVE STRENGTH: 1.77 #/Gal
SPECIFIC GRAVITY: 1.20

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE (ppm)		MIN 4	AVE 15	MAX 20	ULT 30
MIN	0.80	#/DAY	26.69	100.08	133.44	200.16
		GAL/DAY	15.08	56.54	75.39	113.08
		GAL/HR	0.628	2.356	3.141	4.712
AVE	1.00	#/DAY	33.36	125.10	166.80	250.20
		GAL/DAY	18.85	70.68	94.24	141.36
		GAL/HR	0.785	2.945	3.927	5.890
MAX	1.30	#/DAY	43.37	162.63	216.84	325.26
		GAL/DAY	24.50	91.88	122.51	183.76
		GAL/HR	1.021	3.828	5.105	7.657

MINIMUM STORAGE REQUIREMENTS:

30 Days @ Ult Q /Ave Rate 2120 Gal.
10 Days @ Max Q /Max Rate 1225 Gal.
10 Days @ Ult Q /Max Rate 1838 Gal.
20

REQUIRED FEED RANGE:

0.63 to 7.66 GPH

MIN. DAY TANK SIZING:

Fill 1 Time/ @ Max Q/Max Rate
Shift 53 Gal.
Day 135 Gal.
Fill 1 Time/ @ Ult Q/Max Rate
Shift 80 Gal.
Day 202 Gal.

EQUIPMENT SELECTION:	Number	Size	
Bulk Tank:	1	6,000 gallons	Transfer Time (min)
Transfer pump	2	30 gpm	5
Day Tank:	1	150 gallons	
Feed Pump:	2		

Min Rate: Max Rate:
Volumetric, 1 duty, 1 futur 7.66 GPH

Misc

15000 lbs
High level switches, each tank

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Zinc Orthophosphate

ACTIVE STRENGTH: 13.20 #/Gal
SPECIFIC GRAVITY: 1.58

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE (ppm)		MIN 4	AVE 15	MAX 20	ULT 30
MIN	1.00	#/DAY	33.36	125.10	166.80	250.20
		GAL/DAY	2.53	9.48	12.64	18.95
		GAL/HR	0.105	0.395	0.527	0.790
AVE	3.00	#/DAY	100.08	375.30	500.40	750.60
		GAL/DAY	7.58	28.43	37.91	56.86
		GAL/HR	0.316	1.185	1.580	2.369
MAX	5.00	#/DAY	166.80	625.50	834.00	1251.00
		GAL/DAY	12.64	47.39	63.18	94.77
		GAL/HR	0.527	1.974	2.633	3.949

MINIMUM STORAGE REQUIREMENTS:
30 Days @ Ult Q /Ave Rate 1706 Gal.
10 Days @ Max Q /Max Rate 632 Gal.
10 Days @ Ult Q /Max Rate 948 Gal.

REQUIRED FEED RANGE:
0.11 to 3.95 GPH

MIN. DAY TANK SIZING:
Fill 1 Time/ @ Max Q/Max Rate
Shift 27 Gal.
Day 70 Gal.
Fill 1 Time/ @ Ult Q/Max Rate
Shift 41 Gal.
Day 104 Gal.

EQUIPMENT SELECTION:	Number	Size	Transfer Time (min)
Bulk Tank:	1	5,000 gallons	
Transfer pump	2	30 gpm	5
Day Tank:	1	150 gallons	
Feed Pump:	2		

Min Rate: 0.11
Max Rate: 3.95 GPH

Misc

Continuous level monitors, each tank
High level switches, each tank

PROJECT NO.: 45260 By: WWA

PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Coagulant - PolyAlCl

ACTIVE STRENGTH: 3.30 #/Gal

SPECIFIC GRAVITY: 1.20

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE (ppm)		MIN	AVE	MAX	ULT
			5	5	5	7
MIN	1.00	#/DAY	42.04	42.04	42.04	58.85
		GAL/DAY	12.74	12.74	12.74	17.83
		GAL/HR	0.531	0.531	0.531	0.743
AVE	5.00	#/DAY	210.18	210.18	210.18	294.25
		GAL/DAY	63.69	63.69	63.69	89.17
		GAL/HR	2.654	2.654	2.654	3.715
MAX	7.00	#/DAY	294.25	294.25	294.25	411.96
		GAL/DAY	89.17	89.17	89.17	124.84
		GAL/HR	3.715	3.715	3.715	5.201

MINIMUM STORAGE REQUIREMENTS:

30 Days @ Ave Q /Ave Rate 2 Gal.
10 Days @ Max Q /Max Rate 6 Gal.
10 Days @ Ult Q /Max Rate 8 Gal.

REQUIRED FEED RANGE:

0.53 to 5.20 GPH

MIN. DAY TANK SIZING:

Fill 1 Time/ @ Max Q/Max Rate
Shift 39 Gal.
Day 98 Gal.

Fill 1 Time/ @ Ult Q/Max Rate
Shift 54 Gal.
Day 137 Gal.

PROJECT NO.: 45260 By: WWA
PROJECT NAME: Kentucky River Pool 3

CHEMICAL: Sodium Thiosulfate (30% by weight)***

ACTIVE STRENGTH: 3.20 #/Gal
SPECIFIC GRAVITY: 1.27

FEED RATE			PLANT FLOW (mgd)			
	DOSAGE		MIN	AVE	MAX	ULT
	(ppm)		1.920	1.920	1.920	1.920
MIN	3.00	#/DAY	48.04	48.04	48.04	48.04
		GAL/DAY	15.01	15.01	15.01	15.01
		GAL/HR	0.626	0.626	0.626	0.626
AVE	5.25	#/DAY	84.07	84.07	84.07	84.07
		GAL/DAY	26.27	26.27	26.27	26.27
		GAL/HR	1.095	1.095	1.095	1.095
MAX	6.00	#/DAY	96.08	96.08	96.08	96.08
		GAL/DAY	30.03	30.03	30.03	30.03
		GAL/HR	1.251	1.251	1.251	1.251

Flow rate based on 160,000 gal/ 120 minutes Usage rate 0.4167

Storage based on 7 washes per day or 1,120,000 gallons

MINIMUM STORAGE REQUIREMENTS:

30 Days @ Ave Q /Ave Rate	460	Gal.
10 Days @ Max Q /Max Rate	175	Gal.
10 Days @ Ult Q /Max Rate	175	Gal.

MIN. DAY TANK SIZING:

Fill 1 Time/ @ Max Q/Max Rate

Shift	13	Gal.
Day	33	Gal.

Fill 1 Time/ @ Ult Q/Max Rate

Shift	13	Gal.
Day	33	Gal.

REQUIRED FEED RANGE:
0.63 to 1.25 GPH

EQUIPMENT SELECTION:

	Number	Size	Transfer Time (min)
Bulk Tank:	1	5,000 gallons	
Transfer pump	2	25 gpm	2
Day Tank:	1	50 gallons	
Feed Pump:	2		

Min Rate: 0.63 Max Rate: 1.25 GPH

Misc

Continuous level monitors, each tank
High level switches, each tank

KENTUCKY AMERICAN WATER COMPANY

20 MGD WATER TREATMENT PLANT
AND RELATED FACILITIES

DESIGN MEMORANDUM

APPENDIX B

DISINFECTION CT CALCULATIONS

System Name 0
System Number 0
Treatment Plant Name 0
Sequence Description:
Select Contactor Type: Flocculation Basin

Select Disinfectant: Free Chlorine

Click box if basin is compartmented. ☑
Check box if basin is circular. ☐

Vessel Width (ft): 117.333333
Vessel Depth (ft): 17
Vessel Length (ft): 47.5
Applied Baffling Factor: 0.5

Profile for: June-03

Date	Flow Rate (gpm)	Water Depth (ft)	Volumes Total (gal)	Volumes Effective (gal)	Volumes Allowed (gal)	Contact Time Calculated (min)	Contact Time Tracer (min)	Disinfectant Residual (mg/L)	pH	Temperature (°C)	CT Provided (mg*min/L)	CT 3 log (mg*min/L)	Inactivation CT Ratio	Provided Logs
1			708705	0	0	0.0					0.00	0.00	0.00	0.00
2			708705	0	0	0.0					0.00	0.00	0.00	0.00
3			708705	0	0	0.0					0.00	0.00	0.00	0.00
4			708705	0	0	0.0					0.00	0.00	0.00	0.00
5			708705	0	0	0.0					0.00	0.00	0.00	0.00
6			708705	0	0	0.0					0.00	0.00	0.00	0.00
7			708705	0	0	0.0					0.00	0.00	0.00	0.00
8			708705	0	0	0.0					0.00	0.00	0.00	0.00
9			708705	0	0	0.0					0.00	0.00	0.00	0.00
10	13888.8889	14.7	708705	611432	305716	22.0		2.50	8.0	0.5	55.03	364.79	0.15	0.45
11	10416.6667	14.7	708705	611432	305716	29.3		2.50	8.0	0.5	73.37	364.79	0.20	0.60
12	2777.77778	14.7	708705	611432	305716	110.1		2.50	8.0	0.5	275.14	364.79	0.75	2.26
13	4166.66667	14.7	708705	611432	305716	73.4		2.50	8.0	0.5	183.43	364.79	0.50	1.51
14			708705	0	0	0.0					0.00	0.00	0.00	0.00
15			708705	0	0	0.0					0.00	0.00	0.00	0.00
16			708705	0	0	0.0					0.00	0.00	0.00	0.00
17			708705	0	0	0.0					0.00	0.00	0.00	0.00
18			708705	0	0	0.0					0.00	0.00	0.00	0.00
19			708705	0	0	0.0					0.00	0.00	0.00	0.00
20			708705	0	0	0.0					0.00	0.00	0.00	0.00
21			708705	0	0	0.0					0.00	0.00	0.00	0.00
22			708705	0	0	0.0					0.00	0.00	0.00	0.00
23			708705	0	0	0.0					0.00	0.00	0.00	0.00
24			708705	0	0	0.0					0.00	0.00	0.00	0.00
25			708705	0	0	0.0					0.00	0.00	0.00	0.00
26			708705	0	0	0.0					0.00	0.00	0.00	0.00
27			708705	0	0	0.0					0.00	0.00	0.00	0.00
28			708705	0	0	0.0					0.00	0.00	0.00	0.00
29			708705	0	0	0.0					0.00	0.00	0.00	0.00
30			708705	0	0	0.0					0.00	0.00	0.00	0.00
31			708705	0	0	0.0					0.00	0.00	0.00	0.00
												Averages	0.40	1.21

System Name 0
System Number 0
Treatment Plant Name 0
Sequence Description:
Select Contactor Type: Sedimentation Basin

Select Disinfectant: Free Chlorine

Check box if basin includes intra-basin & outlet baffling. ☑
Check box if basin is circular. ☐

Vessel Width (ft): 122
Vessel Depth (ft): 19
Vessel Length (ft): 36.0833333
Applied Baffling Factor: 0.5

Profile for: June-03

Date	Flow Rate (gpm)	Water Depth (ft)	Volumes Total (gal)	Volumes Effective (gal)	Volumes Allowed (gal)	Contact Time Calculated (min)	Contact Time Tracer (min)	Disinfectant Residual (mg/L)	pH	Temperature (°C)	CT Provided (mg*min/L)	CT 3 log (mg*min/L)	Inactivation Provided CT Ratio	Inactivation Provided Logs
1			625636	0	0	0.0					0.00	0.00	0.00	0.00
2			625636	0	0	0.0					0.00	0.00	0.00	0.00
3			625636	0	0	0.0					0.00	0.00	0.00	0.00
4			625636	0	0	0.0					0.00	0.00	0.00	0.00
5			625636	0	0	0.0					0.00	0.00	0.00	0.00
6			625636	0	0	0.0					0.00	0.00	0.00	0.00
7			625636	0	0	0.0					0.00	0.00	0.00	0.00
8			625636	0	0	0.0					0.00	0.00	0.00	0.00
9			625636	0	0	0.0					0.00	0.00	0.00	0.00
10	13888.8889	8.2	625636	269682	134841	9.7		2.50	8.0	0.5	24.27	364.79	0.07	0.20
11	10416.6667	8.2	625636	269682	134841	12.9		2.50	8.0	0.5	32.36	364.79	0.09	0.27
12	2777.77778	8.2	625636	269682	134841	48.5		2.50	8.0	0.5	121.36	364.79	0.33	1.00
13	4166.66667	8.2	625636	269682	134841	32.4		2.50	8.0	0.5	80.90	364.79	0.22	0.67
14			625636	0	0	0.0					0.00	0.00	0.00	0.00
15			625636	0	0	0.0					0.00	0.00	0.00	0.00
16			625636	0	0	0.0					0.00	0.00	0.00	0.00
17			625636	0	0	0.0					0.00	0.00	0.00	0.00
18			625636	0	0	0.0					0.00	0.00	0.00	0.00
19			625636	0	0	0.0					0.00	0.00	0.00	0.00
20			625636	0	0	0.0					0.00	0.00	0.00	0.00
21			625636	0	0	0.0					0.00	0.00	0.00	0.00
22			625636	0	0	0.0					0.00	0.00	0.00	0.00
23			625636	0	0	0.0					0.00	0.00	0.00	0.00
24			625636	0	0	0.0					0.00	0.00	0.00	0.00
25			625636	0	0	0.0					0.00	0.00	0.00	0.00
26			625636	0	0	0.0					0.00	0.00	0.00	0.00
27			625636	0	0	0.0					0.00	0.00	0.00	0.00
28			625636	0	0	0.0					0.00	0.00	0.00	0.00
29			625636	0	0	0.0					0.00	0.00	0.00	0.00
30			625636	0	0	0.0					0.00	0.00	0.00	0.00
31			625636	0	0	0.0					0.00	0.00	0.00	0.00
												Averages	0.18	0.53

System Name 0
System Number 0
Treatment Plant Name 0
Sequence Description:
Select Contactor Type: Filter

Select Disinfectant: Free Chlorine

Check box if basin is circular.
Media Volume (Gallons): 65637
Support Gravel Volume (Gallons): 26254.8
Underdrain Volume (Gallons): 13127.4
Vessel Width (ft): 130
Vessel Depth (ft): 15
Vessel Length (ft): 27
Applied Baffling Factor: 0.7

Profile for: June-03

Date	Flow Rate (gpm)	Water Depth (ft)	Volumes Total (gal)	Volumes Effective (gal)	Volumes Allowed (gal)	Contact Time Calculated (min)	Contact Time Tracer (min)	Disinfectant Residual (mg/L)	pH	Temperature (°C)	CT Provided (mg*min/L)	CT 3 log (mg*min/L)	Inactivation Provided CT Ratio	Inactivation Provided Logs
1			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
2			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
3			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
4			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
5			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
6			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
7			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
8			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
9			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
10	13888.8889	12.8	393822	231917	162342	11.7		3.50	8.0	0.5	40.91	381.52	0.11	0.32
11	10416.6667	12.8	393822	231917	162342	15.6		3.50	8.0	0.5	54.55	381.52	0.14	0.43
12	2777.77778	12.8	393822	231917	162342	58.4		3.50	8.0	0.5	204.55	381.52	0.54	1.61
13	4166.66667	12.8	393822	231917	162342	39.0		3.50	8.0	0.5	136.37	381.52	0.36	1.07
14			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
15			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
16			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
17			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
18			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
19			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
20			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
21			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
22			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
23			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
24			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
25			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
26			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
27			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
28			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
29			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
30			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
31			393822	-105019	-73513	0.0					0.00	0.00	0.00	0.00
												Averages	0.29	0.86

System Name 0
System Number 0
Treatment Plant Name 0
Sequence Description: Clearwell
Select Contactor Type: Clear Well

Select Disinfectant: Free Chlorine

Check box if basin is circular. ☐

Vessel Width (ft): 13.6041667
Vessel Depth (ft): 21
Vessel Length (ft): 794
Applied Baffling Factor: 0.7
State Assigned Baffling Factor: 0.7

Profile for: June-03

Date	Flow Rate (gpm)	Water Depth (ft)	Volumes: Total (gal)	Volumes: Effective (gal)	Volumes: Allowed (gal)	Contact Time: Calculated (min)	Contact Time: Tracer (min)	Disinfectant Residual (mg/L)	pH	Temperature (°C)	CT: Provided (mg*min/L)	CT: 3 log (mg*min/L)	Inactivation Provided: CT Ratio	Inactivation Provided: Logs
1			1696732	0	0	0.0					0.00	0.00	0.00	0.00
2	13889	15.0	1696732	1211952	848366	61.1		2.00	8.0	0.5	122.16	345.81	0.35	1.06
3	13869	15.0	1696732	1211952	848366	61.1		2.35	8.0	0.5	143.54	359.30	0.40	1.20
4			1696732	0	0	0.0					0.00	0.00	0.00	0.00
5			1696732	0	0	0.0					0.00	0.00	0.00	0.00
6	13889	13.5	1696732	1090757	763530	55.0		1.15	7.5	5	63.22	182.32	0.35	1.04
7			1696732	0	0	0.0					0.00	0.00	0.00	0.00
8			1696732	0	0	0.0					0.00	0.00	0.00	0.00
9	13888.8889	17.3	1696732	1393744	975621	70.2		3.70	8.0	0.5	259.91	381.52	0.68	2.04
10	10416.6667	17.3	1696732	1393744	975621	93.7		3.70	8.0	0.5	346.54	381.52	0.91	2.72
11	2777.77778	17.3	1696732	1393744	975621	351.2		3.70	8.0	0.5	1299.53	381.52	3.41	10.22
12	4166.66667	17.3	1696732	1393744	975621	234.1		3.70	8.0	0.5	866.35	381.52	2.27	6.81
13			1696732	0	0	0.0					0.00	0.00	0.00	0.00
14	4166.66667	17.3	1696732	1393744	975621	234.1		3.00	7.8	10	702.45	186.25	3.77	11.31
15			1696732	0	0	0.0					0.00	0.00	0.00	0.00
16			1696732	0	0	0.0					0.00	0.00	0.00	0.00
17			1696732	0	0	0.0					0.00	0.00	0.00	0.00
18			1696732	0	0	0.0					0.00	0.00	0.00	0.00
19			1696732	0	0	0.0					0.00	0.00	0.00	0.00
20			1696732	0	0	0.0					0.00	0.00	0.00	0.00
21			1696732	0	0	0.0					0.00	0.00	0.00	0.00
22			1696732	0	0	0.0					0.00	0.00	0.00	0.00
23			1696732	0	0	0.0					0.00	0.00	0.00	0.00
24			1696732	0	0	0.0					0.00	0.00	0.00	0.00
25			1696732	0	0	0.0					0.00	0.00	0.00	0.00
26			1696732	0	0	0.0					0.00	0.00	0.00	0.00
27			1696732	0	0	0.0					0.00	0.00	0.00	0.00
28			1696732	0	0	0.0					0.00	0.00	0.00	0.00
29			1696732	0	0	0.0					0.00	0.00	0.00	0.00
30			1696732	0	0	0.0					0.00	0.00	0.00	0.00
31			1696732	0	0	0.0								
												Averages	1.52	4.55

KENTUCKY AMERICAN WATER COMPANY

20 MGD WATER TREATMENT PLANT AND RELATED FACILITIES

DESIGN MEMORANDUM

APPENDIX C

RESIDUALS WASTE TREATMENT

A. General

Several process wastewater sidestreams will be generated at the proposed Kentucky River Pool 3 Water Treatment Plant (WTP) from various treatment processes and operations. The primary wastewater sources generated by the water treatment processes are the sedimentation basin sludge and filter backwash wastewater. Additional process wastewater sidestreams include sample sink and water quality analyzer drains, drainage and overflow from process basins, and certain plant floor drains.

Sludge collected from the sedimentation basins will flow by gravity to a sludge thickener. Provisions will be included in the piping to divert the sludge to a wastewater clarifier in case of maintenance required on the thickener. Two wastewater clarifiers will be provided at the plant site for filter backwash wastewater collection, settling and removal of the solids in the wastewater, and storage and discharge of the clarified wastewater to the Kentucky River. A residuals dewatering facility will dewater thickened residuals for beneficial use on the plant site or at a nearby site. A septic system will be provided for sanitary wastes, certain plant floor drains, and chemical contaminated wastes. A separate system will be provided for handling storm water.

B. Wastewater Treatment Process

The facilities proposed at the WTP to process wastewater include two wastewater clarification basins for the filter backwash and rinse water, a residuals thickener for sedimentation basin blowdown sludge and wastewater clarifier sludge, a wastewater pumping station, and a residuals dewatering facility. The operation of these facilities would be as follows:

1. Solids removed from the sedimentation basins will flow by gravity to the residuals thickener, with provisions for it to be directed to one of the wastewater clarifiers in cases where the residuals thickener is out of service for maintenance.
2. The filter backwash wastewater, filter to waste (rinse water), basin drains, sample sink drains and plant overflow will be directed to one of two wastewater clarifiers.
3. Intermittent draining of basins for maintenance will be scheduled on off-peak days and directed to the wastewater clarifiers.
4. The wastewater clarification basins will be operated in batch sequence. Each operating cycle includes filling, settling, sludge removal by pumping, and pumping clarified decant water to the river. The sludge removal step can be deferred until adequate solids have collected at the bottom of the basin.
5. The supernatant from the wastewater clarifiers will be metered and pumped to the top of the bluff and then will flow by gravity to the Kentucky River in a channel.

The settled sludge from the wastewater clarifiers will be pumped to the residuals thickener.

6. Supernatant from the residuals thickener will be pumped to the top of the bluff along with the wastewater clarifier supernatant, flowing by gravity from the top of the bluff to the Kentucky River.

7. Residuals from the residuals thickener will flow by gravity to the dewatering building, and will be treated by two belt filter presses. Dewatered residuals will be conveyed to a truck and then temporarily stored onsite or hauled to a beneficial reuse disposal site nearby. Filtrate will be returned to the thickeners.

8. The wastewater system will be controlled by a programmable logic controller (PLC) interfaced with the Supervisory Control and Data Acquisition (SCADA) system at the water treatment plant.

The solids generation rate is computed based on the expected raw water quality characteristics and pre-treatment chemical addition.

A. Average Solids removed from treated stream, mg/L

1.	Suspended solids (1.9 x avg. turbidity of 44 NTU)	83.6
2.	Iron oxides (iron oxidized by potassium permanganate) (2.64 x average Fe of 0.77 mg/L)	2.03
3.	Manganese oxides (manganese oxidized by potassium permanganate) (2.43 x average Mn of 0.24 mg/L)	0.58
4.	Polyaluminum chloride (0.274 x avg. dosage of 42 mg/L)	11.51
5.	Ferric chloride (1.0 x avg. dosage of 32 mg/L)	32.0
6.	Powdered activated carbon	0.50
7.	Filter aid polymer	0.05
8.	Coagulant aid polymer	0.38
9.	Theoretical average concentration based on historical water quality and assumed chemical feed rates, and application of PACL only	98.7
10.	Average concentration based on historical operating data from Kentucky River Station	106.5

B. Maximum Solids removed from treated stream mg/L

1.	Suspended solids (1.9 x max turbidity of 819 NTU)	1,560
2.	Iron oxides (iron oxidized by potassium permanganate) (2.64 x maximum Fe of 1.67 mg/L)	4.41
3.	Manganese oxides (manganese oxidized by potassium permanganate) (2.43 x maximum Mn of 1.10 mg/L)	2.67
4.	Polyaluminum chloride (0.274 x maximum dosage of 112 mg/L)	30.7
5.	Ferric chloride (1.0 x maximum dosage of 100 mg/L)	100
6.	Powdered activated carbon	25.0
7.	Filter aid polymer	0.10
8.	Coagulant aid polymer	0.50
9.	Theoretical maximum concentration based on historical water quality and assumed chemical feed rates, and application of PACL only.	1623.4

10. Maximum concentration based on historical operating data from Kentucky River Station 1596.3

C. Solids Production

Treated Flow (mgd)		Solids Production – pounds per day (ppd)	
		Average Solids (107 mg/L)	**Maximum Solids (1,596 mg/L)**
Minimum	4.0	3,570	53,240
Winter Average	6.0	5,350	79,860
Summer Average	15.0	13,400	199,700
Maximum	20.0	17,800	266,200
Ultimate	30.0	26,800	399,300

A. Type of Waste Streams

1. Process clarifier sludge
2. Filter backwash and filter to waste (filter rinse water)
3. Sample sink and analyzer drains
4. Process unit overflows
5. Basin cleaning and drainage
6. Chemical unloading area drains
7. Plant floor drains
8. Sanitary waste
9. Stormwater

B. Sedimentation Basin and Wastewater Clarifier Sludge (Total solids)

1. Estimated solids concentration 1.0% - 2.0%
2. Estimated sludge specific gravity 1.0
3. Total sludge volume, gallons per day

	Sludge Production (gpd)	
Solids Concentration	**1.0%** (1)	**2.0%** (2)
a. Minimum Flow	42,800	319,200
b. Winter Average flow	64,100	478,800
c. Summer Average Flow	161,000	1,197,000
d. Maximum flow	213,000	1,596,000
e. Ultimate flow	321,000	2,394,000

(1) Sludge production based on average solids
(2) Sludge production based on maximum solids production

4. Estimated solids removal in sedimentation basins 90%
5. Sludge from sedimentation basin blow down to thickener

	Sludge Production (gpd)	
Solids Concentration	**1.0%** (1)	**2.0%** (2)
a Minimum	38,500	287,300
b. Winter Average	57,700	430,900
c. Summer Average	145,000	1,077,000
d. Maximum	192,000	1,436,000
e. Ultimate	289,000	2,155,000

(1) Sludge production based on average solids
(2) Sludge production based on maximum solids production

6. Estimated solids removal in filters 10%

7. Sludge from wastewater clarifiers to thickener

	Sludge Production (gpd)	
Solids Concentration	**1.0%** (1)	**2.0%** (2)
a. Minimum	4,280	31,920
b. Winter Average	6,410	47,880
c. Summer Average	16,100	119,700
d. Maximum	21,300	159,600
e. Ultimate	32,100	239,400

(1) Sludge production based on average solids
(2) Sludge production based on maximum solids production

8. Thickened sludge from residuals thickener

	Sludge Production (gpd)		Sludge Transferred to Belt Presses (gpd)(3)	Sludge Stored in Thickener (gpd)
Solids Concentration	**3.0%** (1)	**5.0%** (2)	**5.0%**	**5.0%**
a. Minimum	14,300	127,700	119,900	7,800
b. Winter Average	21,400	191,500	119,900	71,600
c. Summer Average	53,700	478,900	119,900	359,000
d. Maximum	71,000	638,400	119,900	518,500
e. Ultimate	107,000	957,600	179,900	777,700

(1) Sludge production based on average solids
(2) Sludge production based on maximum solids
(3) Sludge transfer based on maximum solids processing capacity of 50,000 ppd for the design flow and 75,000 ppd at the ultimate flow. Excess sludge on maximum solids days will be stored temporarily in the residuals thickener.

9. Maximum sludge stored in thickener

a. Based on Kentucky River Station maximum 10-day solids production

b. Maximum 10-day average flow (95% of design flow), mgd 19.0

Day	Solids Production (lb/MG)	Solids Production (lb/day)	Solids Transferred to Belt Presses (lb/day)	Solids Stored in Thickener (lb/day)	Total Solids Stored in Thickener (lbs)	Total Sludge Stored in Thickener (gal at 5.0% solids)
1	4,417	83,920	50,000	33,920	33,920	81,340
2	4,599	87,380	50,000	37,380	71,300	171,000
3	4,643	88,220	50,000	38,220	109,500	262,600
4	6,326	120,200	50,000	70,200	179,700	430,900
5	7,472	142,000	50,000	92,000	271,700	651,600
6	13,310	252,900	50,000	202,900	474,600	1,138,000
7	6,627	125,900	50,000	75,900	550,500	1,320,000
8	3,543	67,320	50,000	17,320	567,800	1,362,000
9	2,538	48,220	50,000	-1,780	566,100	1,358,000
10	2,360	44,840	50,000	-5,160	560,900	1,345,000

c. Maximum sludge stored in thickener, gal. 1,362,000

C. Filter Backwash and Filter Rinse Water - Discharged to Wastewater Clarifiers

1. Number of filters 4
2. Filter area - each, sf 468
3. Minimum filter run length, hours 24
4. Average filter run length, hours 48
5. Maximum filter run length, hours 72
6. Maximum washwater flow per filter wash and filter to waste

	Flow (gpm/sf)	Time (min)	Volume (gal)
a. Low wash	6	5	21,060
b. High wash	25[1]	8	140,400
c. Low wash	6	5	21,060
d. Filter to waste [2]	4	19	53,350
Total		37	235,870

[1] Ultimate maximum flow, if filters are converted to GAC in the future. Maximum flow is 20 gpm/sf for dual media filters.
[2] Approximately one filter volume

7. Number of washes per day at 20 mgd with 5 filters
   a. Minimum 1.7
   b. Average 2.5
   c. Maximum 5.0
8. Washwater and rinse water volume, gpd
   a. Minimum 400,980
   b. Average 589,680
   c. Maximum 1,179,400
9. Solids concentration in backwash, mg/l
   a. Winter average flow/ Average solids 160
   b. Summer average flow/ Average solids 272
   c. Winter average flow/ Max solids 2,388
   d. Summer average flow/ Max solids 4,061
   e. Maximum flow/ Maximum solids 2,706

D. Sample Sink and Analyzers - Discharged to Wastewater Clarifier assuming sample pumps operated 24 hrs per day

1. Total estimated flow, gpd 57,600

E. Plant Overflow - Discharged to Wastewater Clarifier

1. Maximum flow rate, 40 mgd, 10+/- min 278,000

F. Basin Drainage and Cleaning

Assume clean and drain each basin once per year

1. Flocculation Basin Volume, gal 153,000

2. Sedimentation Basin Volume, gal 156,000

NOTE: Each cleaning will drain one train of Flocculation/sedimentation basin unit and discharge 309,000 gallons to waste.

G. Plant Floor Drains

1. Sources

   a. Cleaning and flushing of chemical storage or feed area floors - discharged to sanitary waste system via sump pumps.

   b. Operations and administrative areas - discharged to sanitary waste system.

   c. Process pipe gallery - discharged to process wastewater system.

   d. Pump lubrication water - discharged to process wastewater system.

2. Average estimated daily flow to process wastewater system, gpd 100

3. Maximum estimated daily flow to process wastewater system, gpd 200

H. Chemical Unloading Area Drain

Stormwater - discharged to stormwater catchment through a bypass.

Chemical Spills - maximum discharged to chemical spill containment, gal. 7,000

I. Sanitary Waste - Discharged to sanitary waste system.

1. Average, 5 persons @ 60 gallons/person 300

2. Maximum, 10 persons @ 60 gallons/person 600

J. Analyzer Waste Containing Reagent - Discharged to sanitary waste system

1. Chlorine analyzer flow (5 analyzers), mL/min 1,500

2. Ammonia analyzer flow (1 analyzer), mL/min 300

3. Total estimated flow to sanitary waste system, gpd 685

K. Stormwater - Separate system.

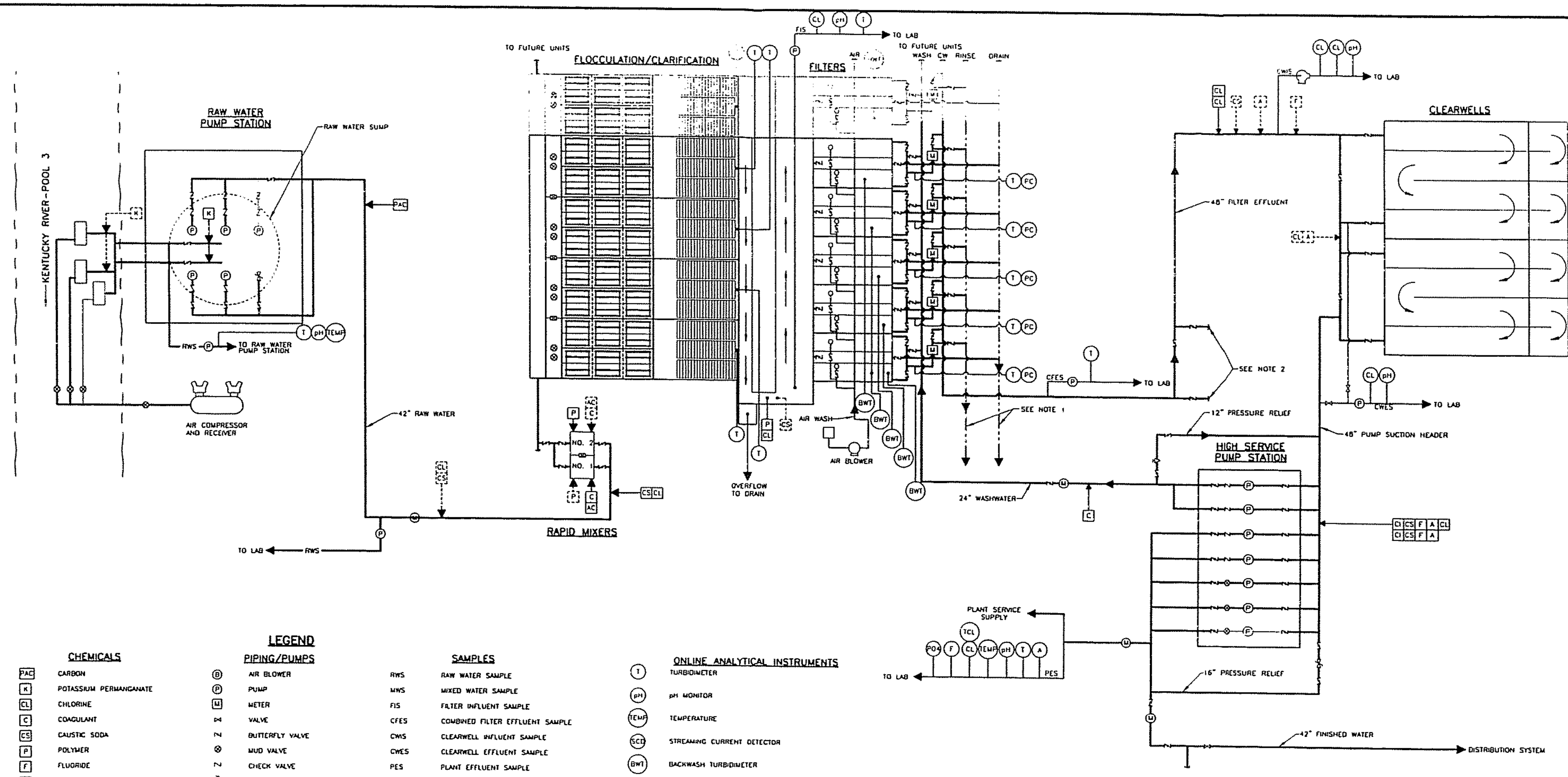
L. Total Wastewater Volumes, gpd.

Items	Winter Average	Summer Average	Maximum	Ultimate Maximum
1. Wastewater directed to wastewater clarifiers				
a. Filter backwash and filter to waste water	400,980	589,680	1,179,400	1,651,100
b. Sample sink and analyzers	57,600	57,600	57,600	57,600
c. Basin cleaning and drainage[(1)]	0	0	259,400	309,000
d. Plant overflow	0	0	138,890	208,330
e. Plant floor drains	100	100	1,000	1,000
Subtotal	458,580	647,280	1,376,890	1,918,030
2. Wastewater directed to residuals thickener				
a. Sedimentation basin sludge	57,700	145,000	1,436,000	2,155,000
b. Wastewater clarifier sludge	6,410	16,100	159,600	239,400
Subtotal	64,110	161,100	1,595,600	2,394,400
3. Sludge directed to belt filter presses				
a. Residuals thickener sludge	21,400	53,700	119,900	179,900
Subtotal	21,400	53,700	119,900	179,900
3. Process wastewater directed to sanitary system				
a. Plant floor drains	100	100	200	200
b. Sanitary waste	300	300	600	600
c. Analyzer waste	685	685	685	685
Subtotal	1,085	1,085	1,485	1,485
4. Process wastewater directed to spill containment basin				
a. Unloading area drain	0	0	7,000	7,000
Subtotal	0	0	7,000	7,000
5. Clarified wastewater directed to Kentucky River				
a. Wastewater clarifier supernatant	452,000	631,000	1,217,000	1,679,000
b. Residuals thickener supernatant	42,710	107,400	1,475,700	2,214,500
Subtotal	494,710	738,400	2,692,700	3,893,500

(1) Flocculator/sedimentation basin would not be drained during maximum wastewater flow event.

				Design	Ultimate
A.	Average dried solids production				
	1.	Solids generated per day, lbs/day			
		a.	Winter average flow	5,530	8,300
		b.	Summer average flow	13,400	20,100
	2.	Solids generated per year, lbs/year (4 months at summer average flow, 8 months at winter average flow)		2,980,000	4,470,000
B.	Sludge volume, ft^3/year				
	1.	15% solids		318,000	478,000
	2.	20% solids		239,000	358,000

Exhibits



LEGEND

CHEMICALS

PAC	CARBON
K	POTASSIUM PERMANGANATE
CL	CHLORINE
C	COAGULANT
CS	CAUSTIC SODA
P	POLYMER
F	FLUORIDE
CI	CORROSION INHIBITOR
A	AMMONIA
——→	PRIMARY CHEMICAL FEED POINT
- - - -→	SECONDARY CHEMICAL FEED POINT
AC	ALTERNATE COAGULANT

PIPING/PUMPS

B	AIR BLOWER
P	PUMP
M	METER
⋈	VALVE
N	BUTTERFLY VALVE
⊗	MUD VALVE
N	CHECK VALVE
	RELIEF VALVE
	GATE
	PLUG VALVE
	BLIND FLANGE
	SURGE ANTICIPATOR VALVE
——	PROPOSED 20 MGD
- -	REQUIRED FOR 25 MGD

SAMPLES

RWS	RAW WATER SAMPLE
MWS	MIXED WATER SAMPLE
FIS	FILTER INFLUENT SAMPLE
CFES	COMBINED FILTER EFFLUENT SAMPLE
CWIS	CLEARWELL INFLUENT SAMPLE
CWES	CLEARWELL EFFLUENT SAMPLE
PES	PLANT EFFLUENT SAMPLE
WWS	WASTEWATER SAMPLE

ONLINE ANALYTICAL INSTRUMENTS

T	TURBIDIMETER
pH	pH MONITOR
TEMP	TEMPERATURE
SCD	STREAMING CURRENT DETECTOR
BWT	BACKWASH TURBIDIMETER
CL	CHLORINE ANALYZER
TCL	TOTAL CHLORINE ANALYZER
F	FLUORIDE ANALYZER
A	AMMONIA ANALYZER
PC	PARTICLE COUNTER
PO4	PHOSPHATE ANALYZER

NOTES:

1. SEE WASTEWATER FLOW DIAGRAM.
2. PROVISIONAL CONNECTIONS FOR UV FACILITIES.

FILE: D:\FC420\47225\HAN\WTP\PROCESS\...DWG
DATE: 02/04/2007 TIME: 2:18:42 pm

NO.	DESCRIPTION	DATE	BY
	REVISIONS		

DESIGNED	DRAWN	SCALE
		AS NOTED
CHECKED	APPROVED	APPROVED
		G.C.K.

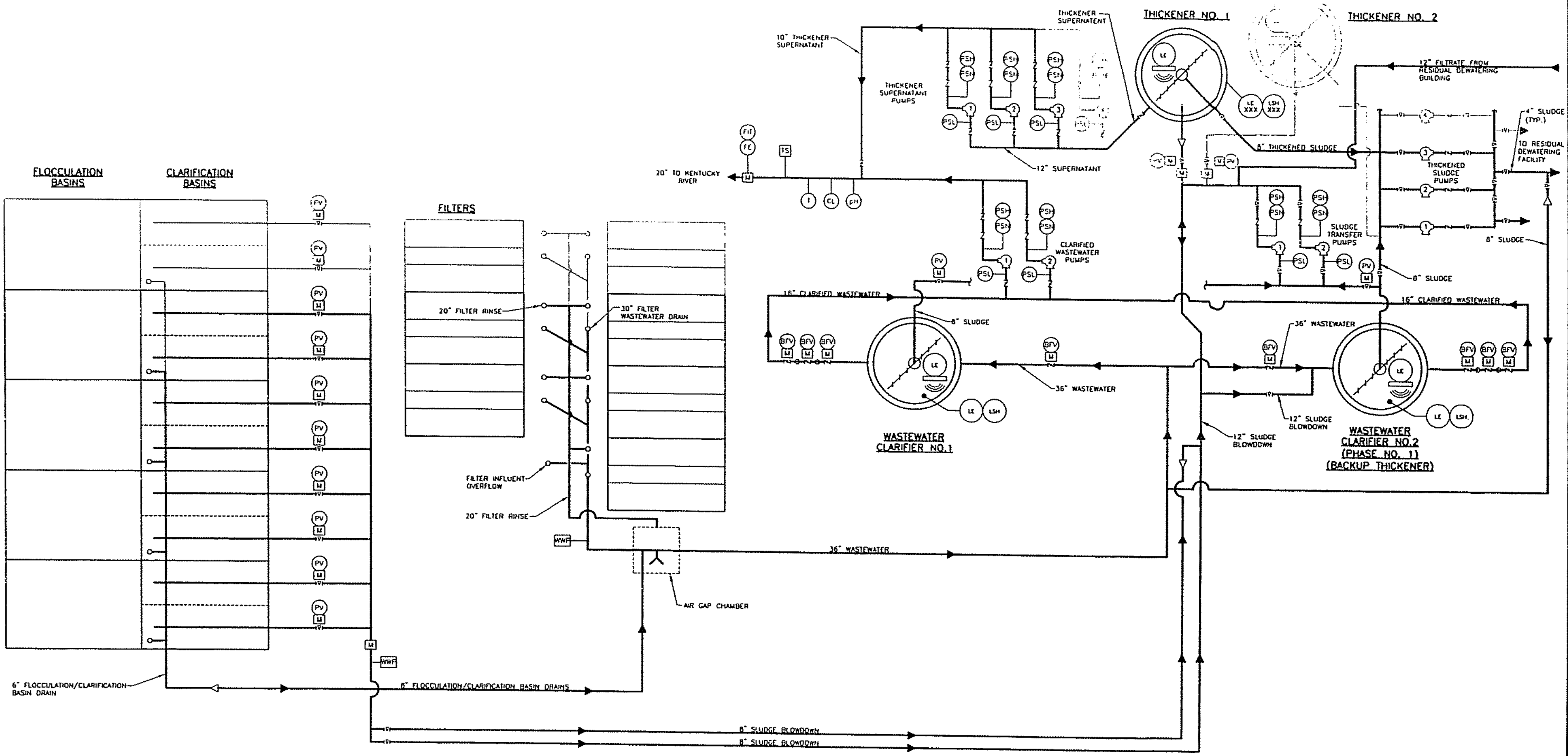
Gannett Fleming
HARRISBURG, PENNSYLVANIA

KENTUCKY-AMERICAN WATER COMPANY
LEXINGTON, KENTUCKY

KENTUCKY RIVER POOL 3
WATER TREATMENT PLANT

WATER TREATMENT PLANT
PROCESS
PROCESS FLOW DIAGRAM

JOB No. 47225
DATE MARCH 2007
SHEET No. EX1



LEGEND

CHEMICALS

WWP WASTEWATER POLYMER

TS DECHLORINATING CHEMICAL-SODIUM THIOSULFATE

PIPING/PUMPS

BFV M MOTOR OPERATED BUTTERFLY VALVE

PV M MOTOR OPERATED PLUG VALVE

— PROPOSED 20 MGD
REQUIRED FOR 25 MGD

ONLINE ANALYTICAL INSTRUMENTS

PSN PRESSSURE SWITCH NORMAL

PSH PRESSURE SWITCH HIGH

PSL PRESSURE SWITCH LOW

REVISIONS	SCALE: AS NOTED	APPROVED: G.C.K.

Gannett Fleming
HARRISBURG, PENNSYLVANIA

KENTUCKY-AMERICAN WATER COMPANY
LEXINGTON, KENTUCKY

KENTUCKY RIVER POOL 3
WATER TREATMENT PLANT

WATER TREATMENT PLANT
PROCESS
WASTEWATER PROCESS FLOW DIAGRAM

JOB No. 47225
DATE MARCH 2007
SHEET No. EX2