HEARTLAND
ENGINEERING

PROJECT:

KING'S LANDING WASTEAWATER COLLECTION AND TREATMENT SYSTEM - ANTIDEGRADATION REVIEW & FACILITY PLAN

OWNER & CONTINUING AUTHORITY:

Private Developer
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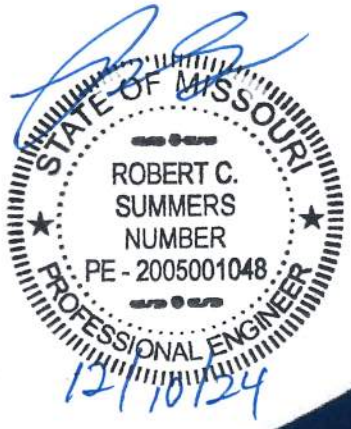


Table of Contents

Executive Summary

This report provides a comprehensive evaluation and design overview for the King's Landing Wastewater Treatment Facility (WWTF) in Cape Girardeau County, Missouri. The King's Landing development is a proposed residential subdivision aiming to meet the community's urgent need for affordable housing by adding approximately 300 new units. This project, led by Cape Land and Development, LLC, seeks to support local economic growth by addressing the housing shortage while prioritizing environmental protection and sustainability.

Project Overview

The King's Landing development, spanning approximately 80 acres, will be situated near the west bank of the Mississippi River and will include apartments, duplexes, and single-family homes. Due to the rural location, no public sewer or treatment systems are available within a feasible distance, necessitating the construction of a new, privately funded WWTF. The proposed system is designed to handle residential wastewater flows from the development and discharge treated effluent into Juden Creek in compliance with Missouri Department of Natural Resources (MoDNR) standards.

Wastewater Treatment Facility Alternatives

Three WWTF alternatives were considered for this project:

1. Sequencing Batch Reactor (SBR): Multiple activated sludge process were reviewed for cost comparision and system capability. This included two SBR options, as well as one extended aeration system. Ultimately, the SBR was chosen due to cost and familiarity through past projects with the material supplier. This system includes primary treatment through batch reactors with ultraviolet (UV) disinfection, offering a proven, reliable, and cost-effective approach to meet MoDNR effluent limits.

2. Traditional SBR with Blowers and Bubble Diffusion: The alternative is similar to Alternate #1 above, except that it would use extenal blowers, retrievable coarse bubble diffusers, and separate decanters. The basins would be slightly larger to accommodate the additiona equipment. The option would provide a very high quality effluent, but the additional costs associated with it make the altnerative non-tenable.

3. SBR with a Process Guarantee to Meet Possible Future EPA Ammonia Limits: This option includes upsizing the SBR and adding additional monitoring equipment. The result is that the manufacturer will provide a process guarantee pushing the ammonia removal to a summertime effluent limit of 0.4 mg/L ammonia for aquatic mussell protection. To do so increases the size of the SBR basin, adds substantial equipment controls, and requires that the UV disinfection increase in size due to the increase in discharge flow. The costs for this alternative are substantially higher than the base alternative and therefore are considered much less viable.

4. Non-Discharge Land Application System: Involving a lagoon and land application system, this alternative requires extensive land, making it impractical given the site's limitations.

5. An Extended Aeration and Clafification System: This system includes primary treatment through an extended aeration unit, followed by redundant clarifiers. The system would require a return activated and waste activiated lift station, followed by a sludge handling basin. Ultraviolet (UV) disinfection would be included for effluent disinfection.

Following a feasibility and cost analysis, Alternative 1 (SBR without tertiary treatment) was selected as the recommended solution due to its cost-effectiveness, ease of operation, and ability to consistently meet stringent effluent requirements.

Design Specifications

The selected WWTF design includes:

- Average Daily Flow: 99,800 gallons per day (GPD), with a peak design flow of 199,600 GPD.
- Treatment Components: The system will feature an influent flow equalization basin, two SBR reactors, a sludge storage tank, UV disinfection, and a control building with laboratory and monitoring facilities. Project specific information for the SBR Cam-D System, automated influent screen, and the UV disinfection system can be found within Appendix I of this report.
- Collection System: Approximately 8,450 linear feet of 8" PVC sewer mains and 26 manholes will collect wastewater from the development to the WWTF.

The facility will be privately operated initially, with long-term ownership transferring to the development's Homeowners Association (HOA).

Environmental and Economic Impact

The proposed WWTF is designed to produce a high-quality effluent with low Biochemical Oxygen Demand (BOD), TSS, and ammonia levels, which will meet MoDNR's anti-degradation requirements. By choosing an efficient and reliable SBR system, the project minimizes environmental impact on Juden Creek, a gaining stream with no current impairments. The development is expected to stimulate the local economy by creating jobs, increasing tax revenue, and addressing housing shortages.

Conclusion

The King's Landing WWTF represents a forward-looking investment in Cape Girardeau County's infrastructure, addressing both community needs and environmental stewardship. The project aligns with state standards, ensuring the treatment facility will support growth without compromising public health or the area's natural resources. With private funding secured, the project will proceed with construction, contributing essential housing and economic support for the community.

I. Anti-Degradation Review

A. Existing Treatment

There is no existing treatment facility involved with this project to be discussed. See Page 2 of this report under "Project Information Summary" for a synopsis of the project.

B. List of Pollutants of Concern

See Page 4 of this report under "WWTF - Proposed NPDES permit & List of Pollutants of Concern" for a list of Pollutants of Concern involved with the proposed project.

C. Receiving Water Body

See Page 5 of this report under "WWTF Receiving Waterbody & Current Impairments" for a description of the receiving water body and concerns relating to the WWTF discharge. In addition, see Appendix II for the geohydrologic evaluation of the proposed WWTF site.

D. Regionalization and Non-Discharge Options

See Page 5 of this report under "Regionalization & No-Discharge Options" for related information. In addition, see the wastewater treatment facility options found on Pages 13-16.

E. Social and Economic Importance Evaluation

The King's Landing project is at the heart of improvements to the local social and economic standard. Information impacting the local economy can be found throughout the remainder of the report. The development will include the following:

1) Measure of employment – Local workers will be hired to construct the development and then provide future maintenance to the facilities. In addition, the 300 proposed housing units provided by the project will benefit local workers who currently find themselves with an affordable housing shortage throughout the area.
2) Increasing or Improving Housing – The project will add approximately 300 proposed housing units helping with the local affordable housing need.
3) Increase Community Tax Base – The project is projected to pull in as many as 300 new families into the area providing increase tax revenue for the area.

F. Wastewater Treatment Facility Alternatives

See Pages 13-16 under "Alternatives Considered" for the five alternatives considered for the project.

G. Wastewater Treatment Facility Chosen Alternative

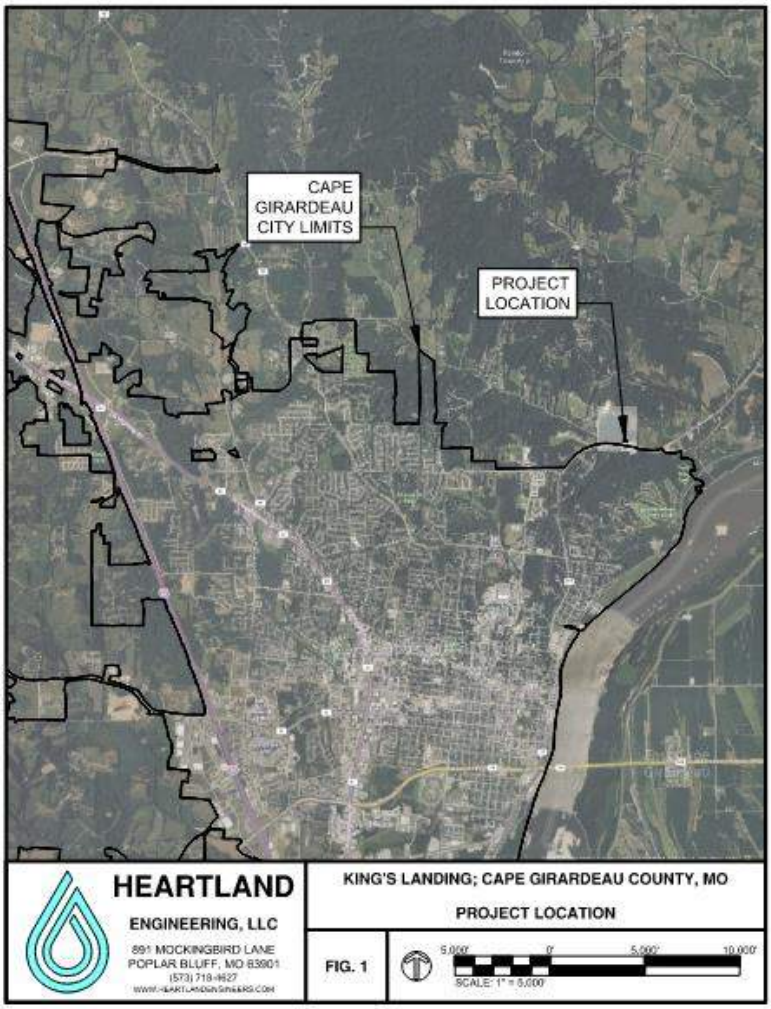
See Page 16 under "Recommended Alternative for Proposed Project" and Page 17 under "Reason For Selection of the Recommended Alternative" for information related to the chosen Alternate for the WWTF.

II. Project Information Summary

The King's Landing development is a planned residential subdivision to be built in rural Cape Girardeau County. The development will be located to the northeast of the junction of Missouri State Highway 177 and Cape Rock Road. The location is approximately two miles northeast of Cape Girardeau, very near the west bank of the Mississippi River.

King's Landing will be built on approximately 80 acres to provide mixed housing including apartments, duplexes, and single-family homes. The development is being constructed by Cape Land And Development, LLC, which is owned by Mr. Brandon Williams. Potable water will be supplied by the Cape County Public Water Supply District #2 and electricity service will be provided through Ameren UE. Wastewater will be collected through an 8" gravity main collection system which will flow to an onsite wastewater treatment facility. The facility will be owned by the developer and is scheduled to be operated by Brian Strickland (Operator #10147). The ultimate ownership of the system is planned to be turned over to the development's Homeowner Association (HOA).

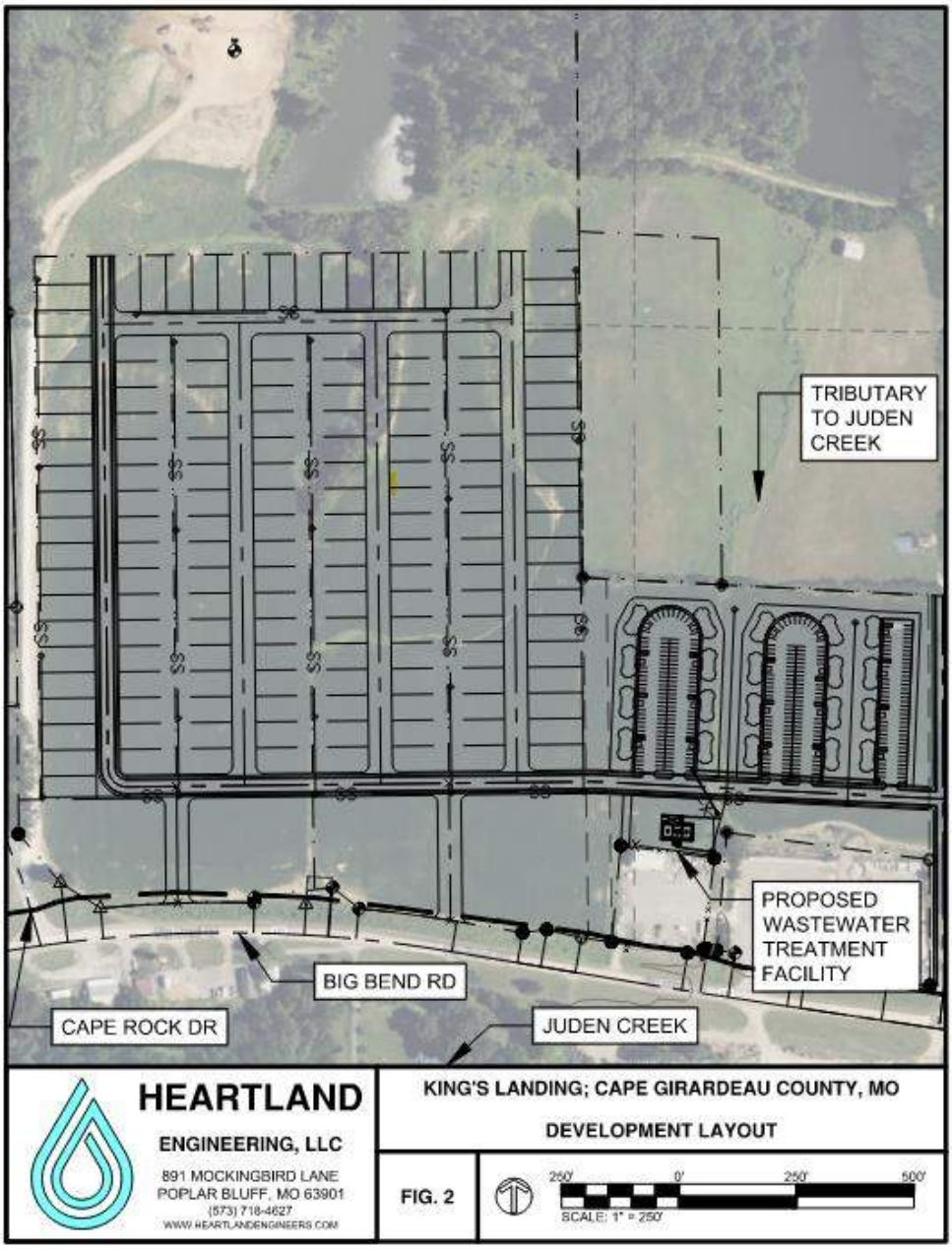
The following map provides a broad overview of the Cape Girardeau City limits as well as the King's Landing site:



III. Proposed Facility Description

A. Wastewater Treatment Facility (WWTF) Location

As previously discussed, the development is located northeast of Cape Girardeau and outside of City limits. A layout of the proposed development including the wastewater treatment facility is shown in the map below:



B. WWTF – Design & Peak Flows

The system is designed to provide treatment from a total of 14 small homes, 160 apartment units, and 6 commercial lots with restroom facilities only. The commercial lots include an estimated 2,000 square feet of office space with five employees per lot. The following chart outlines the expected flows to the facility:

King's Landing WWTF Influent Flow **User Type**	**Number of Units**	**DNR Flow Capita/Unit** (gpm)	**Hydraulic Capacity** (gpdpc)	**Total Flow** (gpd)
Single Family Dwellings (Homes)	140	3.7	100	51,800
2-Bed Apartment	160	3	75	36,000
Commercial Lots (Bathroom Only) - 2000sf Office	6	5	400	12,000
Total Estimated WWTF at Buildout =	306			99,800

Based on a population equivalent of 998, the peaking factor was determined to be 3.80 utilizing the following equation:

$$Peaking\ Factor\ = \frac{Q\ Peak\ Hourly}{Q\ Design\ Avg}$$

$$Peaking\ Factor\ = \frac{18 + \sqrt{P\ (in\ thousands)}}{4 + \sqrt{P\ (in\ thousands)}}$$

However, the equalization basin will be designed with sufficient volume to provide a buffer against the collection system's peaking factor of 3.80 and reduce the wastewater treatment facility's peaking factor to 2.0. Based on this information, the King's Landing WWTF design will include an average daily flow, after build-out, of 99,800 GPD. Using a peaking factor of 2.0 for the wastewater treatment facility, the design peak flow will be submitted for permitting of 199,600 GPD.

C. WWTF - Proposed NPDES permit & List of Pollutants of Concern

Based on normal residential flows to the plant, influent standard estimate pollutant concentrations are as follows:

King's Landing WWTF Influent Pollutant Concentrations			
Pollutant Type	**BOD** mg/l	**TSS** mg/l	**TKN** mg/l
Estimated Influent Concentration	250	250	40
Proposed WWTF Effluent Limits (Monthly)	10	20	See Below

Based on discussion with Missouri Department of Natural Resources staff, the following is the project's WWTF proposed Ammonia Limits:

C stream Ammonia Limits in Interior River Valleys and Hills Ecoregion			
Month	**Parameter**	**Average Monthly Limits**	**Maximum Daily Limits**
January	Ammonia	3.1	12.1
February	Ammonia	3.1	12.1
March	Ammonia	2.7	10.1
April	Ammonia	2.1	8.4
May	Ammonia	2.1	12.1
June	Ammonia	1.3	10.1
July	Ammonia	0.9	8.4
August	Ammonia	0.9	8.4
September	Ammonia	1.2	8.4
October	Ammonia	1.8	8.4
November	Ammonia	2.4	8.4
December	Ammonia	2.7	10.1

***The owner is aware that EPA-proposed ammonia limits for Mussel protection may be set as low at 0.4 during the summer months. Alternative #3 studied the cost of meeting these limits and was found to be economically non-feasible.

E.Coli is an additional pollutant of concern due to Whole Body Contact criteria.

There are no industrial or other high-strength sources of inflow that are expected to contribute to the WWTF loading.

D. WWTF Receiving Waterbody & Current Impairments

The King's Landing WWTF will discharge directly into Juden Creek at a point located approximately 7,000 feet upstream of its confluence with the Mississippi River. The discharge point can be found on site maps included in this report.

Juden Creek is a gaining stream that flows from the northwest of the site and serves discharges from the Cape Rock Village and Tanglewood Estate WWTF. Based on discussions with Missouri Department of Natural Resources staff, the Creek is not currently impaired and falls under a Tier 2 Analysis Review in the Antidegradation Study for the facility. A geohydrologic evaluation of the site was conducted by the Missouri Department of Natural Resources. The results of the survey found that the site has slight overall limitations and that the receiving stream is considered "gaining". A copy of the survey is attached to this report as

E. Regionalization & No-Discharge Options

1) Regionalization – The King's Landing treatment facility is located in a rural area of Cape Girardeau County which is outside of any City limit or Sewer District boundary. The closest facilities with the available capacity to treat the development's waste would be the City of Cape Girardeau, located approximately 2-3 miles to the south or the Cape Girardeau Reorganized Common Sewer District facility located approximately 10 miles to the northwest. The City of Cape Girardeau has a standing policy to refuse providing utility services, including sewer treatment, to any development outside of their city limits. In addition, both entities are so far

away that the cost of the infrastructure and significant challenges of securing construction right-of-way outweigh the cost of the construction of a new wastewater treatment facility. Based on these issues, regionalization is not considered a viable option.

2) No-Discharge Options - Per MoDNR requirements, a no-discharge treatment option is included in the WWTF alternatives. Please see the Alternatives Section within the report for additional information.

F. WWTF - Design BOD and TSS Loadings

The following limits will be proposed as a part of the WWTF design:

King's Landing WWTF Influent Pollutant Concentrations			
Pollutant Type	**BOD** mg/l	**TSS** mg/l	**TKN** mg/l
Estimated Influent Concentration	250	250	40
Proposed WWTF Effluent Limits (Monthly)	10	20	See Chart

The UV Disinfection system proposed for the project will be designed to ensure the protection of Whole Body Contact with a maximum limit of 206CFU/100mL.

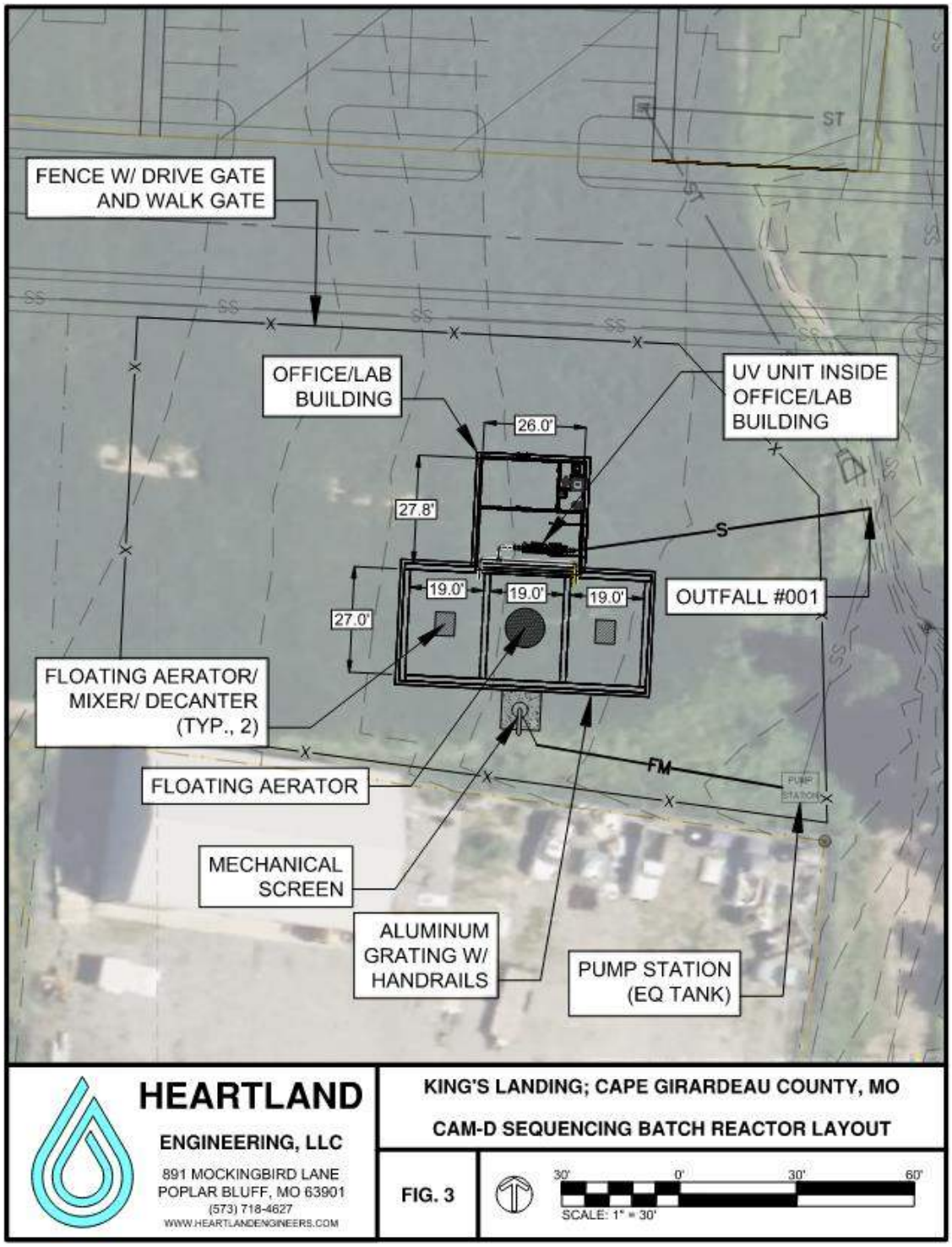
G. WWTF – Plant Process Description

The design will include the installation of a pump-fed Sequencing Batch Reactor (SBR) treatment facility. The facility is proposed to provide an influent flow equalization basin complete with influent duplex pumps. The pumps will supply flow into an automated fine screen that will feed to a three-chamber concrete structure below. The treatment structure will include two (SBR) batch reactors separated by a sludge storage tank. Each of the three tanks will be equally sized for constructability and cost reduction. The SBR tanks will include sludge wasting pumps discharging into the sludge holding tank between them. Supernatant will be removed by a variety of valves within the sludge basin to allow thickening prior to a haul-and-spread land application of solids. Land application of sludge will be provided by a subcontracted sludge hauler, licensed in the State.

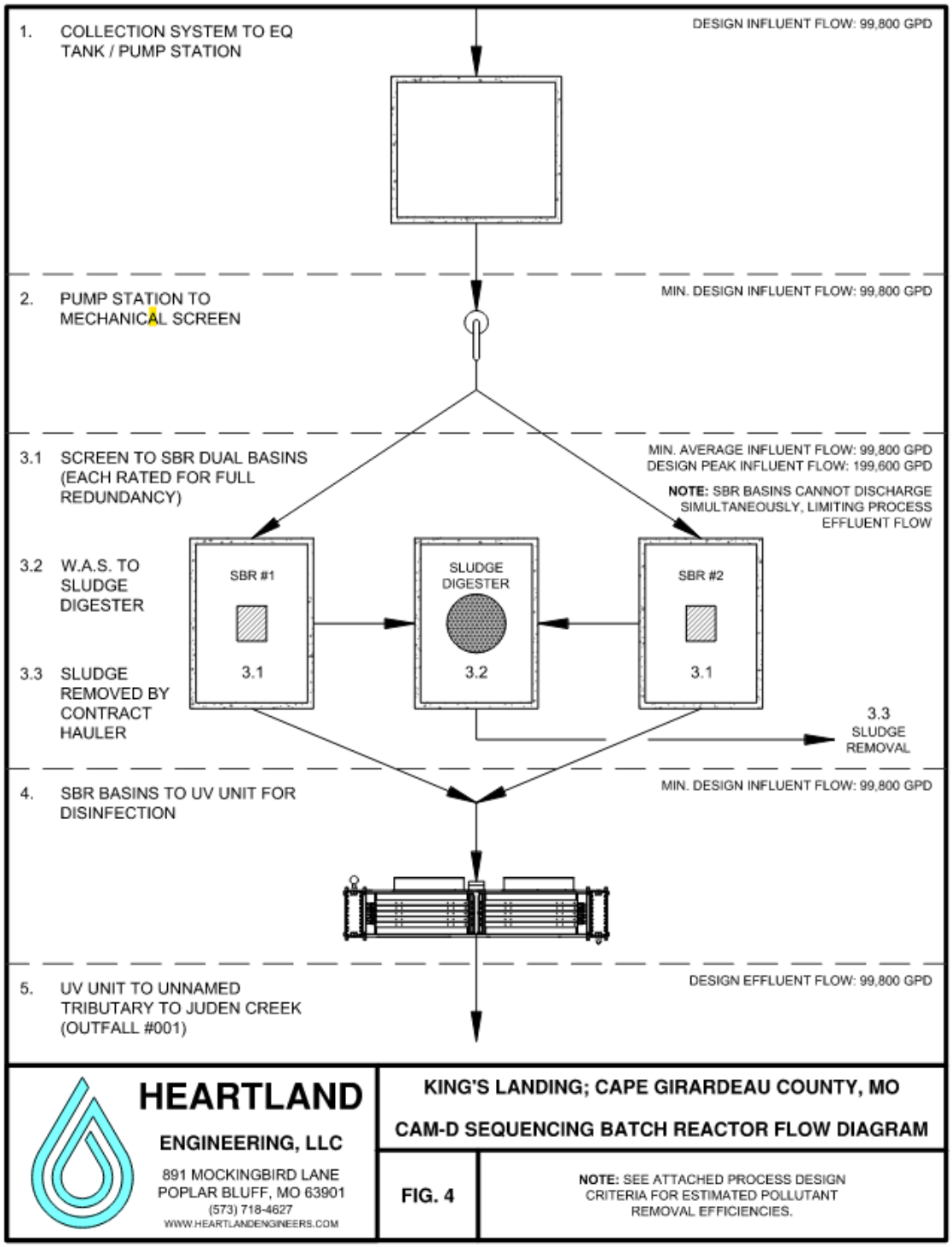
Effluent leaving the SBR basins will be controlled by electrically modulated valves and a magnetic flow meter, allowing a constant effluent discharge during the drain down of each respective basin. Both SBRs will flow into a common header feeding to a redundant UV bank prior to discharging to Juden Creek. Plant washdown water will be provided by the local Public Water Supply District, utilizing a RPZ valve for system safety. Plant controls will be contained within a local control building which will house a lab, control room, UV banks, and restroom.

H. WWTF – Individual Processes Description

The following represents the preliminary site layout for the WWTF:



The following diagram provides a flow chart of the proposes wastewater treatment facility:



The proposed plant process is further explained by the following (refer to the figures above for visual aids):

Headworks:

The wastewater treatment facility will be fed by a variety of 8" SDR-35 PVC gravity sewer mains which will terminate in the plant's new Equalization (EQ) Basin. The basin will be sized to provide enough storage for limited I&I into the collection during rainy weather conditions. The basin dimension will be 14'x14'x14'. The tank volume provides approximately 20,500 gallons of storage. The lift station will include two submersible pumps providing flow directly to the screens mounted on top of the SBR unit immediately adjacent to the basin. The pumps will be sized to provide a constant flow into the SBR units using variable frequency drives, electronic flow meters, and depth probe with emergency high-level alarm float. Each pump will be designed to provide 250 gallons of flow per minute to the screens at a total head of approximately 30 feet. It is expected that these pumps will be less than five horsepower, but final design will be required before that is certain. Variable frequency drives will be used to start/stop each motor and provide the operator with the ability to vary the output of each pump as well as start/stop timing.

A single perforated-plate screen will be located at the top of the SBR. Raw influent water will flow into the screen, which will include bypass piping contingencies should mechanical problems occur with the screen. Raw wastewater will then flow into the SBR tanks below through the use of electrically actuated valves into each of the two SBR tanks. The screen will be designed to receive up to 280 gallons per minute of peak flow.

Main Process:

A Sequencing Batch Reactor (SBR) will provide the primary treatment within the WWTF. Two concrete tanks dimensioned 27'L x 19' w x 19' d, will provide 17' of maximum operating depth and 2' of freeboard. The peak operating range within each tank will be set at 11.8' for a low (fill) level and a 17' max fill operating level. Each tank will provide 8,721 cubic feet (or 65,233 gallons) of total volume, but 2,667 cubic feet (or 19,953 gallons) operating volume between maximum high and low operating levels. Assuming five cycles per day per basin (2 basins x 5 cycles x 19,953 gallons), the plant will have the ability to have a peak flow of 199,536 gallons per day. However, the plant will be designed with a normal operating range between 14.4' and 11', providing a design average flow of 99,800 gpd.

The tanks will surround a central concrete sludge storage basin (see site layout figure above). All three basins will be of the same dimensions for constructability. The SBR will operate in "batches" by filling the first tank to an operator-set capacity level, at which time a series of treatment processes will begin within that basin. During the treatment, settling, and drain cycles within the first reactor, the second basin will be placed in filling cycle. Therefore, "batches" of wastewater treatment will be in constant motion. Similar to the influent, the effluent lines from each reactor will be controlled through the use of electrically actuated valves and electronic flow metering. These instruments will provide a steady operator-selected gravity flow leading directly to the ultraviolet (UV) disinfection system during the decant phase of each cycle.

Each reactor basin will have a floating device which provides aeration, mixing, and decanting. The operator will be able to set the level within each basin depending on the influent levels at that time. The operator will likely set the levels within each basin low during the early stages of the development due to a lack of customers at that time. As homes are built and flows increase, the operator will extend treatment times and depths as he/she works toward design load capacity.

Each reactor will also have a sludge wasting pump. The pumps will waste an operator-set amount of sludge immediately after the decant phase within each reactor. The sludge will empty into the sludge holding tank between the two reactors which will have multiple different decant valves, allowing the operator to decant supernatant back into the equalization basin. Once the sludge depth and thickness reach an operator approved level, the operator will utilize a quick connect located immediately outside of the sludge tank that will allow a sludge hauling truck to remove the sludge from the holding tank for permitted land application and/or haul to a receiving facility. The sludge basin will be provided with an aerator to fully mix and aerate the basin.

Aluminum stairs, railings and safety equipment will provide access to all equipment in and around the SBR.

Tertiary Equipment:

The disinfection system will consist of a "flow-through" style ultraviolet prefabricated stainless-steel unit. The system will be housed within the control building and be mounted at ground level. Gravity flow from the respective reactors will feed the unit prior to discharging to Juden Creek. The unit will be sized to accept a peak decant rate of 311 gallons per minute, making the unit capable of treating 450,000 gallons per day. As previously mentioned, the UV feed line will include an electronic flow meter which has the capability to provide flow pacing to the unit. This will allow bulb banks within the unit to turn on as needed for electric conservation.

Controls:

The plant will be controlled by a cellular monitoring and on-site control system located in the plant control building. Normal wastewater operations will occur from this location. The physical controls, switch gear, backup generator, and most other electrical components will be located in and around the control building. The building will include a control room, a restroom with shower, a laboratory, and the UV system mentioned above. Potable washdown water will be provided throughout the plant, supplied by the local water district and protected by an RPZ device.

I. Collection System – Existing Description

There is no collection system existing within the development currently.

J. Collection System – Line & Lift Station Quantities

The collection system will include approximately 8,450 of 8" SDR-35 PVC gravity mains in conjunction with 26, 4'-diameter manholes. All lines will gravity flow into the Equalization Lift Station mentioned above.

K. Collection System – Inflow and Infiltration Study (I/I)

The King's Landing collection system will be built from the ground up. No existing mains or facilities will be connected to the system. Therefore, there is no Inflow and Infiltration (I/I) to be studied.

L. System – Funding & Debt

The King's Land collection and treatment system will be built with private funds by the development. The system has no current debt.

M. History and Condition of System Components

There are no existing system components to be discussed.

N. Financial Status of the Sewer System

There is no current financial status of the sewer system to be discussed.

IV. Description of Need

A. Project Necessity

Housing is in desperate need in the local area. To address this need, the owners have devised a new development that will bring approximately 300 new housing units to the rapidly growing area. Unfortunately, there is no public sanitary sewer collection or treatment system within a reasonable distance that can be utilized. Therefore, the owners have decided address the issue by installing a state-of-the-art collection and treatment system capable of treating wastewater to very stringent limits.

B. Health and Safety Concerns

Health and Safety concerns are at the core of this report. Raw and under-treated wastewater discharged to local streams can impact wildlife and recreational users alike. As previously stated, the new WWTF that is proposed is highly capable of producing an effluent that will meet the stringent limits of the Missouri Department of Natural Resources anti-degradation process.

C. O&M Concerns

User rates will pay for the normal operations of the system. The system will be operated and maintained by Brian Strickland, PE (Strickland Engineering) who is a licensed wastewater operator under license #10147. Mr. Strickland currently operates the Cape Girardeau County Reorganized Common Sewer District sequencing batch reactor which was installed in 2020. The proposed system is very similar in operability, although smaller in effluent flow.

D. Status and Need of Other Utilities

This project has very little impact on other utilities. Potable water will be provided by the Cape Girardeau County Public Water Supply #5 and Ameren UE will provide power to the development. No other utility impact is known to exist.

V. Projected Population and Flows

A. Existing & Projected Population Trends

As previously shown, the following outlines the projected flow to the WWTF:

King's Landing WWTF Influent Flow User Type	Number of Units	DNR Flow Capita/Unit (gpm)	Hydraulic Capacity (gpdpc)	Total Flow (gpd)
Single Family Dwellings (Homes)	140	3.7	100	51,800
2-Bed Apartment	160	3	75	36,000
Commercial Lots (Bathroom Only) - 2000sf Office	6	5	400	12,000
Total Estimated WWTF at Buildout =	306			99,800

B. System Users – Individual and Equivalent

There are no current system users. In addition, there are not any large-scale users that are included in the development plan. Therefore, equivalent user calculations in this instance are not applicable. See above from projected build-out user calculations. However, assuming an average daily flow per capita of 100 gpd, the design population equivalent is 998.

C. WWTF – Existing and Projected Peak Flows

There are no current system users. Therefore, existing average and peak flow are not applicable. Based on a population equivalent of 998, the peaking factor was determined to be 3.80 utilizing the following equation:

$$Peaking\ Factor\ = \frac{Q\ Peak\ Hourly}{Q\ Design\ Avg}$$

$$Peaking\ Factor\ = \frac{18 + \sqrt{P\ (in\ thousands)}}{4 + \sqrt{P\ (in\ thousands)}}$$

However, the equalization basin will be designed with sufficient volume to provide a buffer against the collection system's peaking factor of 3.80 and reduce the wastewater treatment facility's peaking factor to 2.0. Based on this information, the King's Landing WWTF design will include an average daily flow, after build-out, of 99,800 GPD. Using a peaking factor of 2.0 for the wastewater treatment facility, the design peak flow will be submitted for permitting of 199,600 GPD.

D. WWTF - Existing and Anticipated BOD and TSS Loadings

There are no current system users. Therefore, existing BOD and TSS loadings are not applicable. A chart of expected nutrient loadings can be found in the BOD and TSS loading chart under the WWTF – Design BOD and TSS Loadings section above.

VI. Alternatives Considered

The alternatives considered for the Wastewater Treatment Facility include the following: 1) a Sequencing Batch Reactor (SBR); 2) a Sequencing Batch Reactor with Fixed Bubble Diffusion; or 3) a Sequencing Batch Reactor sized for a process guarantee to meet possible future EPA aquatic mussel ammonia limits; 4) a non-discharging lagoon coupled with a land application system; and a 5) Extended Aeration System with Clarification Units.

A. WWTF Alternative 1 – Sequencing Batch Reactor

1) **Description:** Prior to selecting an SBR option, three activated sludge technologies were preliminarily reviewed (Aqua CamD SBR, Argos SBR, and Schreiber extended aeration). All three of the options are capable of meeting the limits mentioned above. We chose to proceed with further design and cost estimating with the Aqua CamD system because it was the lowest equipment cost option, required less cast-in-place concrete, and the operator's familiarity with the system process control. The first wastewater treatment facility system alternative includes the construction of a Sequencing Batch Reactor treatment train. Raw influent would enter the WWTF through a flow equalization basin. The basin's pumps would send the influent water through a screen prior to entering the SBR (previously described in detail). Dual SBR units would surround an aerated sludge holding structure. Finished effluent would flow out of the SBR in batches to Ultraviolet disinfection system located in the laboratory next to the SBR. Settled sludge would be pumped into the sludge holding structure which would be thickened and land applied. Similar systems are generally able to produce very low effluent components and meet MoDNR regulations.
2) **Construction Cost and Average Annual O&M:** The following cost estimate outlines the construction costs associated with the WWTF Alternative #1:

King's Landing Wastewater Treatment System Improvements - Alternate 1

	Description	Quantity	Unit	Unit Price	Total
	TREATMENT PLANT				
1	Earthwork for SBR and Influent Structure	1	LS	$100,000.00	$100,000.00
2	Site Piping	1	LS	$75,000.00	$75,000.00
3	Concrete EQ Basin & Terminal Lift Station w/Duplex Pumps & Controls	1	LS	$200,000.00	$200,000.00
4	Influent Flow Metering Pit w/Meter	1	LS	$25,000.00	$25,000.00
5	Single Influent Automatic (No Manual) Screen Supply	1	LS	$75,000.00	$75,000.00
6	SBR, Sludge Basin, and Screen Structure Concrete w/Reinforcement	450	CY	$555.00	$249,750.00
7	SBR Equipment (Includes SBR Equipment, Sludge Basin Equipment & Pumps, Modulating Valves, Flow Meter, & Control Panel)	1	LS	$480,325.00	$480,325.00
8	UV Equipment Supply	1	LS	$60,000.00	$60,000.00
9	SBR, Sludge, UV, & Screen Equipment Installation	1	LS	$200,000.00	$200,000.00
10	SBR Stairs and Railings - Installed	1	LS	$75,000.00	$75,000.00
11	Miscellaneous Equipment - 2 Samplers	1	LS	$12,000.00	$12,000.00
12	Operations-Lab Building with Electrical and HVAC	1	LS	$225,000.00	$225,000.00
13	Site Electrical, Controls Installation, and Lighting	1	LS	$150,000.00	$150,000.00
14	Generator and ATS	1	LS	$125,000.00	$125,000.00
15	Site Gravel	1,000	Ton	$35.00	$35,000.00
16	Chain Link Fencing and Gates	800	LF	$95.00	$76,000.00
	Total Construction Costs				**$2,163,075.00**

The following outlines the facility expected Operations & Maintenance (O&M) costs:

Operations & Maintenance Cost	Monthly Cost	Yearly Cost
Utilities	$ 500.00	$ 6,000.00
Testing	$ 300.00	$ 3,600.00
Contract Operations	$ 1,000.00	$ 12,000.00
Billing company	$ 1,500.00	$ 18,000.00
Sludge hauling		$ 5,000.00
Repairs/maintenance		$ 5,000.00
Misc. Expenses		$ 5,000.00
Total O&M Cost		**$ 54,600.00**

The following outlines the facility present worth value. The evaluation assumes a 20-year; 6%-interest rate:

PRESENT WORTH BASED ON ANNUAL O & M =			**$626,257.70**
Annual Interest Rate……..…=	0.06		
# of Interest Periods (years)..=	20		
Annual Costs (O&M)…...….=	$54,600.00		
TOTAL CONSTRUCTION COSTS…….....…..…=			$2,163,075.00
O & M PRESENT WORTH……..…..……....=			$626,257.70
TOTAL PRESENT WORTH COSTS…...…..……..…=			**$2,789,332.70**

3) **Regionalization:** Regionalization is not relevant in this situation due to the distance to the nearest treatment plant. See page 5 for additional details. Therefore, no options are included for further regionalization.

B. WWTF Alternative 2 – SBR with Stationary Blowers and Course Bubble Diffusers

1) **Description:** The second WWTF alternative is very similar to Alternative #1, except that the option is more of a "traditional" SBR design. The SBR would include retrievable course bubble diffusers and two fully redundant blowers able to provide aeration to either of the SBR basins. Decanting would be provided by a standard floating decanting arm. The SBR basins would need to be slightly larger (25'x25'x17') to fit the proposed equipment. The decant time must be reduced to provide additional time for the aeration cycle. In doing so, the effluent discharge rate increases to approximately 500 GPM. The additional flow requires the UV disinfection system to be upsized to accommodate the additional flow.

The benefit of the system would be that it provides additional flexibility to meet very low effluent limits, including 2013 EPA suggested aquatic mussel limits. However, the capital expenditure for the additional equipment would substantially increase the project cost. This would include additional costs for concrete, equipment, controls, blower space within the control room, and piping. The expected result would be a further reduction of BOD and ammonia beyond the limits proposed by this report. Under this scenario, the O&M is slightly higher than Alternative #1. The alternative is not considered necessary or cost effective.

2) **Construction Cost and Average Annual O&M:** The following cost estimate outlines the construction costs associated with the WWTF Alternative #2:

King's Landing Wastewater Treatment System Improvements - Alternate 2

	Description	Quantity	Unit	Unit Price	Total
	TREATMENT PLANT				
1	Earthwork for SBR and Influent Structure	1	LS	$100,000.00	$100,000.00
2	Site Piping	1	LS	$125,000.00	$125,000.00
3	Concrete EQ Basin & Terminal Lift Station w/Duplex Pumps & Controls	1	LS	$200,000.00	$200,000.00
4	Influent Flow Metering Pit w/Meter	1	LS	$25,000.00	$25,000.00
5	Single Influent Automatic (No Manual) Screen Supply	1	LS	$75,000.00	$75,000.00
6	SBR, Sludge Basin, and Screen Structure Concrete w/Reinforcement	550	CY	$555.00	$305,250.00
7	SBR Equipment (Includes SBR Equipment, Blowers, Sludge Basin	1	LS	$816,640.00	$816,640.00
	Equipment & Pumps, Modulating Valves, Flow Meter, Control Panel, & Spare Parts)				
8	UV Equipment Supply	1	LS	$100,000.00	$100,000.00
9	SBR, Sludge, UV, & Screen Equipment Installation	1	LS	$200,000.00	$200,000.00
10	SBR Stairs and Railings - Installed	1	LS	$75,000.00	$75,000.00
11	Miscellaneous Equipment - 2 Samplers	1	LS	$12,000.00	$12,000.00
12	Operations-Lab Building with Electrical and HVAC	1	LS	$300,000.00	$300,000.00
13	Site Electrical, Controls Installation, and Lighting	1	LS	$250,000.00	$250,000.00
14	Generator and ATS	1	LS	$125,000.00	$125,000.00
15	Site Gravel	1,000	Ton	$35.00	$35,000.00
16	Chain Link Fencing and Gates	800	LF	$95.00	$76,000.00
	Total Construction Costs				**$2,819,890.00**

The operations and maintenance costs would be slightly higher than those for Alternative #1. This would include additional maintenance for the blowers and diffusers.

The following outlines the facility expected Operations & Maintenance (O&M) costs:

Operations & Maintenance Cost	Monthly Cost	Yearly Cost
Utilities	$ 500.00	$ 6,000.00
Testing	$ 300.00	$ 3,600.00
Contract Operations	$ 1,000.00	$ 12,000.00
Billing company	$ 1,500.00	$ 18,000.00
Sludge hauling		$ 5,000.00
Repairs/maintenance		$ 7,500.00
Misc. Expenses		$ 6,000.00
Total O&M Cost		**$ 58,100.00**

The following outlines the facility present worth value. The evaluation assumes a 20-year; 6%-interest rate:

PRESENT WORTH BASED ON ANNUAL O & M =			**$666,402.42**
Annual Interest Rate……..…=	0.06		
# of Interest Periods (years)..=	20		
Annual Costs (O&M)…...….=	$58,100.00		
TOTAL CONSTRUCTION COSTS…….....…..…=			$2,819,890.00
O & M PRESENT WORTH……..…..……....=			$666,402.42
TOTAL PRESENT WORTH COSTS…...…..……..…=			**$3,486,292.42**

3) **Regionalization:** Regionalization is not relevant in this situation due to the distance to the nearest treatment plant. See page 5 for additional details. Therefore, no options are included for further regionalization.

C. WWTF Alternative 3 – SBR Sized for Aquatic Mussell Process Guarantee

4) Description: The Missouri Department of Natural Resources requires this report to study the cost of a similar system which is able to meet the following 2013 EPA Ammonia Criteria:

2013 EPA Mussel Ammonia Criteria - C stream Ammonia Limits in Interior River Valleys and Hills Ecoregion			
Month	**Parameter**	**Average Monthly Limits**	**Maximum Daily Limits**
January	Ammonia	2.1	5.6
February	Ammonia	2.1	5.6
March	Ammonia	1.7	4.4
April	Ammonia	0.9	2.4
May	Ammonia	0.9	2.4
June	Ammonia	0.6	1.5
July	Ammonia	0.4	1.0
August	Ammonia	0.4	1.0
September	Ammonia	0.5	1.2
October	Ammonia	0.7	1.9
November	Ammonia	1.2	3.2
December	Ammonia	1.9	5.1

The third WWTF alternative would provide a process guarantee from the equipment manufacturer to meet these possible future limits. To do so, Alternative #3 includes all the same components from Alternative #1 but adds the following:

A. The SBR basin size must be slightly increased to 27'x20'x17' to provide additional aeration retention time.
B. The decant time must be reduced to provide additional time for the aeration cycle. In doing so, the effluent discharge rate increases to approximately 500 GPM. The additional flow requires the UV disinfection system to be upsized to accommodate the additional flow.
C. pH sensors and automated chemical feed system must be added for a caustic feed. The equipment is necessary to guarantee that the pH is kept between 6.8 and 7.2. Due to the

corrosive nature of the caustic feed, a separate chemical feed room must be added to the control room as well as a shower and eyewash station.

The capital expenditure for the additional equipment would substantially increase the project cost. Under this scenario, the O&M will be slightly higher than Alternative #1. Since the limits are only suggestions provided by the EPA and there is not proof that the limits will ever be imposed on a system the size of King's Landing, the alternative is considered economically non-feasible.

5) **Construction Cost and Average Annual O&M:** The following cost estimate outlines the construction costs associated with the WWTF Alternative #3:

King's Landing Wastewater Treatment System Improvements - Alternate 3

	Description	Quantity	Unit	Unit Price	Total
	TREATMENT PLANT				
1	Earthwork for SBR and Influent Structure	1	LS	$100,000.00	$100,000.00
2	Site Piping	1	LS	$75,000.00	$75,000.00
3	Concrete EQ Basin & Terminal Lift Station w/Duplex Pumps & Controls	1	LS	$200,000.00	$200,000.00
4	Influent Flow Metering Pit w/Meter	1	LS	$25,000.00	$25,000.00
5	Single Influent Automatic (No Manual) Screen Supply	1	LS	$75,000.00	$75,000.00
6	SBR, Sludge Basin, and Screen Structure Concrete w/Reinforcement	500	CY	$555.00	$277,500.00
7	SBR Equipment (Includes SBR Equipment, Sludge Basin Equipment & Pumps, Modulating Valves, Flow Meter, Control Panel, & Spare Parts)	1	LS	$720,580.00	$720,580.00
8	UV Equipment Supply	1	LS	$100,000.00	$100,000.00
9	SBR, Sludge, UV, & Screen Equipment Installation	1	LS	$200,000.00	$200,000.00
10	SBR Stairs and Railings - Installed	1	LS	$75,000.00	$75,000.00
11	Miscellaneous Equipment - 2 Samplers	1	LS	$12,000.00	$12,000.00
12	Operations-Lab Building with Electrical and HVAC	1	LS	$275,000.00	$275,000.00
13	Site Electrical, Controls Installation, and Lighting	1	LS	$225,000.00	$225,000.00
14	Caustic Feed Equipment	1	LS	$50,000.00	$50,000.00
15	Shower & Eye Wash Station	1	LS	$40,000.00	$40,000.00
16	Generator and ATS	1	LS	$125,000.00	$125,000.00
17	Site Gravel	1,000	Ton	$35.00	$35,000.00
18	Chain Link Fencing and Gates	800	LF	$95.00	$76,000.00
	Total Construction Costs				**$2,686,080.00**

The operations and maintenance costs would be slightly higher than those for Alternative #1. This would include a small amount of additional electrical consumption, as well as additional maintenance for the additional control and monitoring equipment.

The following outlines the facility expected Operations & Maintenance (O&M) costs:

Operations & Maintenance Cost	Monthly Cost	Yearly Cost
Utilities	$ 600.00	$ 7,200.00
Testing	$ 300.00	$ 3,600.00
Contract Operations	$ 1,000.00	$ 12,000.00
Billing company	$ 1,500.00	$ 18,000.00
Sludge hauling		$ 5,000.00
Repairs/maintenance		$ 6,000.00
Misc. Expenses		$ 5,000.00
Total O&M Cost		**$ 56,800.00**

The following outlines the facility present worth value. The evaluation assumes a 20-year; 6%-interest rate:

PRESENT WORTH BASED ON ANNUAL O & M =			**$651,491.53**
Annual Interest Rate……..…=	0.06		
# of Interest Periods (years)..=	20		
Annual Costs (O&M)…...….=	$56,800.00		
TOTAL CONSTRUCTION COSTS…….....…..…=			$2,686,080.00
O & M PRESENT WORTH.……..…..…….....=			$651,491.53
TOTAL PRESENT WORTH COSTS…...…..……..…=			**$3,337,571.53**

6) **Regionalization:** Regionalization is not relevant in this situation due to the distance to the nearest treatment plant. See page 5 for additional details. Therefore, no options are included for further regionalization.

D. WWTF Alternative 4 – Non-Discharging Land Application System

A non-discharge lagoon and land application system functions by collecting wastewater in a storage lagoon and periodically pumping the treated greywater through a land application system when environmental conditions are suitable. This approach typically eliminates the need for a single-point discharge permit. Greywater from the lagoon is decanted at optimal intervals and pumped into the land application system at a rate governed by the soil's morphology and hydraulic conductivity.

The design of a non-discharge lagoon and land application system generally consists of three key components:

1) The lagoon – Including sludge storage, normal storage, wet weather storage, and freeboard.
2) The land application lift station
3) The land application equipment – Typically permanently mounted or center-pivot.

Lagoon Design:

The lagoon must be sized to accommodate a minimum of 75-120 days of storage based on the average daily wastewater flow. The design also needs to include:

1) A dedicated 2-foot depth for sludge storage beneath the operating water level.
2) Sufficient volume to manage stormwater from a 1-in-10-year annual rainfall event and a 1-in-25-year, 24-hour rainfall event.
3) A dedicated 2-foot freeboard for emergency capacity.

After accounting for these factors, the required lagoon capacity is approximately 15 million gallons. Assuming a total lagoon depth of 13.5 feet, the lagoon would require an area of approximately 3.5 to 5 acres. Additionally, an impervious liner must be installed to prevent seepage into the surrounding environment and setbacks would be required for a host of DNR requirements.

Land Application Lift Station Design:
The lift station would be equipped to decant water from multiple levels within the lagoon, allowing operators to minimize the number of solids entering the application lines. A self-cleaning strainer would be included to further clarify the effluent before land application. The lift station design would only require a single pump, and an emergency generator is not necessary due to the lagoon's storage capacity, which provides sufficient time for system maintenance.

Land Application System Design:
The land application system is typically designed for a maximum annual application rate of 24 inches. It is assumed that the system can be operated for approximately 80 days each year. Based on an average daily flow of 98,800 gallons per day, the total annual greywater application would be 36.43 million gallons (4.87 million cubic feet). At the 24-inch per year application rate, the system would require a minimum of 56 acres of land for irrigation, plus additional acreage for stormwater management. Considering setback requirements from property boundaries and the inefficiency of spray system layout, it is estimated that the land application system will require at least 70 acres.

Feasibility Assessment:
Due to these substantial land requirements, particularly the need for approximately 70 acres of available land, this option is not feasible given the current limitations of the surrounding area. This analysis highlights the space and design constraints that make the implementation of a non-discharge lagoon and land application system impractical for this application.

1) **Construction Cost and Average Annual O&M:** Due to the option being unfeasible to construct, no construction cost, O&M, or present-worth values are provided by this report.

2) **Regionalization:** Regionalization is not relevant in this situation due to the distance to the nearest treatment plant. See page 5 for additional details. Therefore, no options are included for further regionalization.

E. WWTF Alternative 5 – Extended Aeration and Clarification System

2) **Description:** The fifth WWTF alternative would include the use of an extended aeration system followed by dual clarifier basins. Air would be provided by a retrievable grid system, utilizing fixed blowers. Return Activated Sludge (RAS) and Waste Activated Sludge (WAS) equipment would provide polishing recycling which would greatly enhance the effluent quality. Sludge storage would be necessary for the wasted sludge and Ultraviolet disinfection would be used for E.Coli control.

The effluent from the alternate would be very similar to that of the SBR in Alternate #1. However, the capital expenditure for the additional equipment would substantially increase the project cost. This would include additional costs for concrete, equipment, controls, blower space

within the control room, and piping. Under this scenario, the O&M is slightly higher than Alternative #1. The alternative is not considered necessary or cost effective.

7) **Construction Cost and Average Annual O&M:** The following cost estimate outlines the construction costs associated with the WWTF Alternative #5:

King's Landing Wastewater Treatment System Improvements - Alternate 5

	Description	Quantity	Unit	Unit Price	Total
	TREATMENT PLANT				
1	Earthwork for Extended Aeration, RAS/WAS, and Influent Structure	1	LS	$125,000.00	$125,000.00
2	Site Piping	1	LS	$125,000.00	$125,000.00
3	Concrete EQ Basin & Terminal Lift Station w/Duplex Pumps & Controls	1	LS	$200,000.00	$200,000.00
4	Influent Flow Metering Pit w/Meter	1	LS	$25,000.00	$25,000.00
5	Single Influent Automatic (No Manual) Screen Supply	1	LS	$75,000.00	$75,000.00
6	Extended Aeration, Dual Clarifiers, RAS/WAS, Sludge Basin, and Screen Structure Concrete w/Reinforcement	900	CY	$555.00	$499,500.00
7	Extended Aeration Equipment (Includes Primary Equipment, Sludge Basin Equipment & Pumps,	1	LS	$1,000,000.00	$1,000,000.00
	Clarifier Equipment, Flow Meter, Control Panel, & RAS/WAS Pumps(3))				
8	UV Equipment Supply	1	LS	$100,000.00	$100,000.00
9	Extended Aeration, RAS/WAS, Sludge, UV, & Screen Equipment Installation	1	LS	$250,000.00	$250,000.00
10	Basin Stairs and Railings - Installed	1	LS	$75,000.00	$75,000.00
11	Miscellaneous Equipment - 2 Samplers	1	LS	$12,000.00	$12,000.00
12	Operations-Lab Building with Electrical and HVAC	1	LS	$275,000.00	$275,000.00
13	Site Electrical, Controls Installation, and Lighting	1	LS	$250,000.00	$250,000.00
14	Shower & Eye Wash Station	1	LS	$40,000.00	$40,000.00
15	Generator and ATS	1	LS	$125,000.00	$125,000.00
16	Site Gravel	1,000	Ton	$35.00	$35,000.00
17	Chain Link Fencing and Gates	1,000	LF	$95.00	$95,000.00
	Total Construction Costs				**$3,306,500.00**

The operations and maintenance costs would be slightly higher than those for Alternative #1. This would include additional maintenance for the blowers and diffusers (similar to Alternate #2).

The following outlines the facility expected Operations & Maintenance (O&M) costs:

Operations & Maintenance Cost	Monthly Cost	Yearly Cost
Utilities	$ 500.00	$ 6,000.00
Testing	$ 300.00	$ 3,600.00
Contract Operations	$ 1,000.00	$ 12,000.00
Billing company	$ 1,500.00	$ 18,000.00
Sludge hauling		$ 5,000.00
Repairs/maintenance		$ 7,500.00
Misc. Expenses		$ 6,000.00
Total O&M Cost		**$ 58,100.00**

The following outlines the facility present worth value. The evaluation assumes a 20-year; 6%-interest rate:

PRESENT WORTH BASED ON ANNUAL O & M =			**$666,402.42**
Annual Interest Rate……..…=	0.06		
# of Interest Periods (years)..=	20		
Annual Costs (O&M)…...….=	$58,100.00		
TOTAL CONSTRUCTION COSTS…….....…..…=			$3,306,500.00
O & M PRESENT WORTH……..…..…….....=			$666,402.42
TOTAL PRESENT WORTH COSTS…...…..……..…=			**$3,972,902.42**

8) **Regionalization:** Regionalization is not relevant in this situation due to the distance to the nearest treatment plant. See page 5 for additional details. Therefore, no options are included for further regionalization.

VII. Recommended Alternative for Proposed Project

The engineer's recommended alternative for the treatment system is Alternative #1 from above, which includes the construction of a Sequencing Batch Reactor without tertiary treatment.

A. Location of Proposed Project

The project is to be constructed in the southeastern corner of the development, as reflected in Figure #2 near the beginning of the report.

B. WWTF Estimated Design Average and Peak Flows

See previous calculations shown above.

C. WWTF Estimated Design BOD and TSS Loadings

See previous calculations shown above.

D. WWTF Anticipated Effluent Requirements

See previous calculations shown above.

E. Collection System

As previously discussed, the collection system is proposed to be built through a series of 8" SDR-35 PVC collection lines utilizing 48" manholes. The collection system will terminate at the flow equalization basin feeding the SBR.

VIII. Reason For Selection of the Recommended Alternative

The justification for the selected alternative is relatively simple. The system's proposed operator has operated the Cape Girardeau Reorganized Common Sewer District SBR since its inception in 2022. He has witnessed the capability of the equipment and its ease of operation which consistently meets demanding effluent limits set on that facility by the Missouri Department of Natural Resources. The proposed alternative for King's Landing WWTF would utilize the similar equipment and essentially the same process. This level of dependability, mixed with an affordable system that can produce very low effluent constituents, make for a winning scenario.

IX. Total Project Cost and O&M Budgeting

Below is the treatment system alternative. These costs include estimated construction and non-construction costs:

King's Landing Wastewater Treatment System Improvements - Alternate 1					
	Description	Quantity	Unit	Unit Price	Total
	TREATMENT PLANT				
1	Earthwork for SBR and Influent Structure	1	LS	$100,000.00	$100,000.00
2	Site Piping	1	LS	$75,000.00	$75,000.00
3	Concrete EQ Basin & Terminal Lift Station w/Duplex Pumps & Controls	1	LS	$200,000.00	$200,000.00
4	Influent Flow Metering Pit w/Meter	1	LS	$25,000.00	$25,000.00
5	Single Influent Automatic (No Manual) Screen Supply	1	LS	$75,000.00	$75,000.00
6	SBR, Sludge Basin, and Screen Structure Concrete w/Reinforcement	450	CY	$555.00	$249,750.00
7	SBR Equipment (Includes SBR Equipment, Sludge Basin Equipment & Pumps,	1	LS	$504,180.00	$504,180.00
	Modulating Valves, Flow Meter, Control Panel, & Spare Parts)				
8	UV Equipment Supply	1	LS	$60,000.00	$60,000.00
9	SBR, Sludge, UV, & Screen Equipment Installation	1	LS	$200,000.00	$200,000.00
10	SBR Stairs and Railings - Installed	1	LS	$75,000.00	$75,000.00
11	Miscellaneous Equipment - 2 Samplers	1	LS	$12,000.00	$12,000.00
12	Operations-Lab Building with Electrical and HVAC	1	LS	$225,000.00	$225,000.00
13	Site Electrical, Controls Installation, and Lighting	1	LS	$150,000.00	$150,000.00
14	Generator and ATS	1	LS	$125,000.00	$125,000.00
15	Site Gravel	1,000	Ton	$35.00	$35,000.00
16	Chain Link Fencing and Gates	800	LF	$95.00	$76,000.00
	Total Construction Costs				**$2,186,930.00**

The following outlines the facility expected Operations & Maintenance (O&M) costs:

Operations & Maintenance Cost	Monthly Cost	Yearly Cost
Utilities	$ 500.00	$ 6,000.00
Testing	$ 300.00	$ 3,600.00
Contract Operations	$ 1,000.00	$ 12,000.00
Billing company	$ 1,500.00	$ 18,000.00
Sludge hauling		$ 5,000.00
Repairs/maintenance		$ 5,000.00
Misc. Expenses		$ 5,000.00
Total O&M Cost		**$ 54,600.00**

X. Project Financing

A. Project Administration

The project will utilize private financing through the owner. No government-subsidized loans and/or grants will be used to construct the facility.

B. Project Financial Impact

N/A

C. Current & Projected User Rates

There are no current user rates to be discussed. The Homeowners' Association will ultimately decide on user rates which will pay for ongoing O&M and plant debt repayment to the owner.

XI. Environmental Review

A. Environmental Impact

Since the project is being constructed with private funds, an environmental assessment is not necessary and will not be completed for the project. However, a Natural Heritage Review form was submitted through the Missouri Department of Conservation. The results of the request are attached to this reports as Appendix III.

B. Environmental Clearance Agencies

The following is a list of agencies that are anticipated to be contacted for environmental clearance related to the project:

1) Missouri Department of Conservation
2) Missouri Department of Natural Resources

C. Anticipated Water Quality

The proposed SBR treatment plant is expected to produce a very low and at some points non-detectable contaminant levels (BOD/TSS/Ammonia). See above information for proposed limits.

D. Environmental Impact Without the Proposed Project

This is non-applicable since no system is currently in-place.

E. Known Environmental Concern

There are no known environmental concerns arising from the construction of this project as of the time that this report was written.

XII. Conclusion

A. Funding Plan

The project will be self-funded through the owner-developer.

B. Project Need

As previously discussed, the area is currently in need of affordable housing for the quickly growing population. The project will provide new homes to approximately 300 new families that will contribute to the local economy and provide labor for farms and businesses in the area. The owner has taken the initiative to design and build a system that will have little effect on local stream while helping to fuel the local economy and work force.

APPENDIX I

MoDNR – SBR, Screen & UV Disinfection Equipment Information

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Process Design Report

KINGS LANDING MO

Design# 177147
Option: Revised Preliminary Design

AquaSBR®

Sequencing Batch Reactor

October 11, 2024
Designed By: Bryce Hatfield

6306 N. Alpine Rd Loves Park, IL 61111
(815) 654-2501 www.aqua-aerobic.com

Upstream Recommendations

- Neutralization is required ahead of the biological system if the pH is expected to fall outside of 6.5-8.5 for significant durations.

- Coarse screening and grit removal is recommended (by others) ahead of the biological system.

- Elevated concentration of hydrogen sulfide can be detrimental to both civil and mechanical structures. If anaerobic conditions exist in the collection system, steps should be taken to eliminate hydrogen sulfide prior to the treatment system.

- Fats, oils, and grease (FOG) removal may be necessary (by others) if the wastewater contains significant amounts of FOG. Historical data suggests levels less than 60 mg/l on a daily average basis (based on a 24 hour composite sample), along with a maximum of 90 mg/l is appropriate for biological treatment. If FOG levels above this are anticipated, please discuss with Aqua-Aerobic Systems to understand the impacts of elevated FOG on the system performance.

Flow Considerations

- The maximum flow, as shown on the design, has been assumed as a hydraulic maximum and does not represent an additional organic load.

Biological Process

- The decanter performance is based upon a free-air discharge following the valve and immediately adjacent to the basin. Actual decanter performance depends upon the complete installation including specific liquid and piping elevations and any associated field piping losses to the final point of discharge. Modification of the high water level, low water level, centerline of discharge, and / or cycle structure may be required to achieve discharge of full batch volume based on actual site installation specifics.

Aeration

- The aeration system has been designed to provide 1.25 lbs. O2/lb. BOD5 applied and 4.6 lbs. O2/lb. TKN applied at the design average loading conditions, while maintaining a residual DO concentration of 2 mg/l.

Process/Site

- The following parameters have been assumed, as displayed on the design (engineer to verify): Influent loadings, in basin temperatures, elevation, and ambient temperatures..

- The anticipated effluent nitrogen requirement is predicated upon an influent waste temperature of 10 °C or greater. While lower temperatures may be acceptable for a short-term duration, nitrification and (if required) denitrification below 10 °C can be unpredictable, requiring special operator attention.

- Sufficient alkalinity is required for nitrification, as approximately 7.1 mg alkalinity (as CaCO3) is required for every mg of NH3-N nitrified. If the raw water alkalinity cannot support this consumption, while maintaining a residual concentration of 50 mg/l, supplemental alkalinity shall be provided (by others).

- The maximum design flow and loading conditions, shown within the report, are based on maximum day conditions.

Equipment

- Changes in basin geometry may require alterations in the equipment recommendation.

- The basins are not included and shall be provided by others.

- Influent is assumed to enter the reactor above the water level, away from the decanter, and to avoid splashing or direct discharge in the immediate vicinity of other equipment. If the influent enters the basin below the water level, adequate hydraulic capacity shall be made in the headworks to prevent backflow from one reactor to the other during transition of influent.

- Based on the process requirements and selected equipment, the reactor wall height should be at least 19 ft in the bilogical reactors.

- Scope of supply includes freight, installation supervision and start-up services.

- Equipment selection is based upon the use of Aqua-Aerobic Systems' standard materials of construction and electrical components, suitable for non-classified electrical environments.

- The basin dimensions reported on the design have been assumed based upon the required volumes and assumed basin geometry. Actual basin geometry may be circular, square or rectangular with construction materials including concrete or steel.

- The control panel does not include motor starters or VFDs, which should be provided in a separate MCC (by others).

- Provisions should be made, by others, for overflows in each of the recommended basins.

AquaSBR® - Sequencing Batch Reactor - Design Summary

Design#: 177147

Project: KINGS LANDING MO

Option: Revised Preliminary Design

Designed by Bryce Hatfield on Friday, October 11, 2024

AQUA-AEROBIC SYSTEMS, INC. A Metawater Company

DESIGN INFLUENT CONDITIONS

Avg. Design Flow (ADF)	= 0.099 MGD	= 377 m³/day
Max Design Flow (MDF)	= 0.199 MGD	= 753 m³/day

DESIGN PARAMETERS

	Influent	mg/l	Effluent Required	<= mg/l	Anticipated	<= mg/l
Bio/Chem Oxygen Demand:	BOD5	250	BOD5	15	BOD5	15
Total Suspended Solids:	TSS	250	TSS	20	TSS	20
Total Kjeldahl Nitrogen:	TKN	40	--	--	--	--
Ammonia Nitrogen:	--	--	NH3-N	2	NH3-N	2
Total Phosphorus:	TP	8	--	--	--	--

SITE CONDITIONS

	Maximum		Minimum		Elevation (MSL)
Ambient Air Temperatures:	85 F	29.4 C	30 F	-1.1 C	604 ft
Influent Waste Temperatures:	68 F	20.0 C	50 F	10.0 C	184.1 m

SBR BASIN DESIGN VALUES

			Water Depth			Basin Vol./Basin		
No./Basin Geometry:	= 2 Rectangular Basin(s)		**Min (LWL)**	= 11.8 ft	= (3.6 m)	**Min (Vlwl)**	= 0.045 MG	= (171.6 m³)
Freeboard:	= 2.0 ft	= (0.6 m)	**Avg (AWL)**	= 14.4 ft	= (4.4 m)	**Avg (Vawl)**	= 0.055 MG	= (209.3 m³)
Length of Basin:	= 27.0 ft	= (8.2 m)	**Max (HWL)**	= 17.0 ft	= (5.2 m)	**Max (Vhwl)**	= 0.065 MG	= (247.0 m³)
Width of Basin:	= 19.0 ft	= (5.8 m)						

Number of Cycles:	= 5 per day/basin (advances cycles beyond MDF)	
Cycle Duration:	= 4.8 hr/cycle	
Food/Mass (F/M) ratio:	= 0.061 lbs. BOD5/lb. MLSS-Day	
MLSS Concentration:	= 4,500 mg/l @ LWL	
Hydraulic Retention Time:	= 1.111 days @ AWL	
Solids Retention Time:	= 18.8 days	
Est. Net Sludge Yield:	= 0.793 lbs. WAS/lb. BOD5	
Est. Dry Solids Produced:	= 164.5 lbs. WAS/day	= (74.6 kg/day)
Est. Solids Flow Rate:	= 40 gpm (1,973 gal/day)	= (7.5 m³/day)
Decant Flow Rate @ MDF:	= 311 gpm (as avg. from HWL to LWL)	= (19.6 l/sec)
LWL to CenterLine Discharge:	= 2.0 ft	= (0.6 m)
Lbs. O2/lb. BOD5	= 1.25	
Lbs. O2/lb. TKN	= 4.6	
Actual Oxygen Required:	= 412 lbs./day	= (186.9 kg/day)
Daily Max. Month Avg. Estimated Power*:	= 527.9 kWh/day	

* Power consumption calculations in this document are based on maximum month conditions. Detailed power vs. loading calculations can be provided if requested.

DESIGN INFLUENT CONDITIONS

Avg. Design Flow (ADF) = 0.099 MGD = 377 m³/day

Max Design Flow (MDF) = 0.199 MGD = 753 m³/day

		Conc. mg/l	Mass lb/day	kg/day
Bio/Chemical Oxygen Demand:	BOD5	250	207.5	94.1
Total Suspended Solids:	TSS	250	207.5	94.1
Total Kjeldahl Nitrogen:	TKN	40	33.2	15.1
Total Phosphorus:	TP	8	6.6	3

SITE CONDITIONS

	Maximum		Minimum	
Ambient Air Temperatures:	85 F	29.4 C	30 F	-1.1 C
Influent Waste Temperatures:	68 F	20.0 C	50 F	10.0 C
Elevation (Mean Sea Level):	604 ft	184 m		

EFFLUENT OBJECTIVES

		Conc. mg/l	Mass lb/day	kg/day
Bio/Chemical Oxygen Demand:	BOD5	15	12.4	5.6
Total Suspended Solids:	TSS	20	16.6	7.5
Ammonia Nitrogen:	NH3-N	2	1.7	0.8

BASIN SIZING CALCULATIONS

1. **Mass of Bio-Solids necessary for treatment (lbs MLSS)**

   Based upon an F/M ratio of 0.061/day, the mass of mixed liquor suspended solids (MLSS) is:

   lb MLSS = (lb BOD5/day) / (F/M) = 3,402.7 lb MLSS = (1,543.4 kg)

2. **Total Reactor Volume at Low Level (Vlwl-T)**

   Based upon an MLSS concentration of 4,500 mg/l measured at the lowest water level, the total React Volume at low water level (Vlwl) is:

   Vlwl-T = lb MLSS/(MLSS mg/l x 8.34 lb/gal) = 0.091 MG-Total = 12,121.1 ft³-Total = (343.2 m³-Total)

3. **Reactor Volume for each Basin at Low Level (Vlwl/basin)**

   The AquaSBR shall utilize a 2 reactor system. The resultant unit volume for each reactor at the minimum water depth is:

   Vlwl/basin = (Vlwl-T)/(Number of Reactors) = 0.045 MG/basin = 6,060.6 ft³/basin = (171.6 m³/basin)

4. Average Decantable Volume for each basin (ADV)

Each AquaSBR basin shall perform treatment via 5 Cycle(s)/Day with each cycle comprising 288 Minutes (4.8 Hours). At the average daily flow (ADF) of 0.1 MGD, the batch volume at average conditions is:

ADV = ADF/(No. of Basins x No. Cycles/Day/Basin) = 9,950 gal = (37.7 m³)

5. Reactor Volume per basin at Average Flow Conditions (Vawl/Basin)

Vawl/Basin = Vlwl/Basin + ADV = 0.055 MG/basin = 7,390.8 ft³/basin = (209.3 m³/basin)

6. Maximum Decantable Volume for each basin (MDV)

The AquaSBR has been specifically designed to maintain 5 Cycle(s)/Day/Basin up to the Maximum Daily Flow stated above. Based upon the Maximum Daily Flow (MDF) of 0.199 MGD, the batch volume at maximum conditions is:

MDV = MDF/(No. of Basins x No. Cycles/Day/Basin) = 19,900 gal = (75.3 m³)

7. Reactor Volume per basin at Maximum Flow Conditions (Vhwl/Basin)

The maximum volume of each basin in the AquaSBR system is:

Vhwl/Basin = Vlwl/Basin + MDV = 0.065 MG/basin = 8,721 ft³/Basin = (247.0 m³/basin)

8. Low Water Level (LWL)

The low water level (LWL) must allow proper storage of sludge during the settle phase while providing a reasonable maximum water level. Based upon the design MLSS, the lowest operating water level is:

LWL = 11.8 ft = (3.6 m)

9. Selection of reactor geometry and dimensional requirements

The AquaSBR can be configured for a variety of reactor geometries, quantities, and materials of construction. Typical construction may employ circular, square, or rectangular tanks in concrete, steel, or earthen-sloped basins. The following has been either assumed by Aqua or designated based upon supplied information:

Number of Basins (Nb):	= 2	
Selected Reactor Geometry:	= Rectangular	
Length of Reactor:	= 27.0 ft	= (8.2 m)
Width of Reactor:	= 19.0 ft	= (5.8 m)
Low Water Level (LWL):	= 11.8 ft	= (3.6 m)
Average Water Level (AWL):	= 14.4 ft	= (4.4 m)
High Water Level (HWL):	= 17.0 ft	= (5.2 m)
Minimum Reactor Volume/Basin:	= 0.045 MG	= (171.6 m³)
Average Reactor Volume/Basin:	= 0.055 MG	= (209.3 m³)
Maximum Reactor Volume/Basin:	= 0.065 MG	= (247.0 m³)

PROCESS CALCULATIONS

Cycle Structure

1. Cycle Configuration

In order to perform the necessary physical and biological treatment for the specified conditions, the following treatment phases shall be used:

A.) Mix Fill	- True anoxic mixing, independent of aeration, with influent.
B.) React Fill	- Aeration/Anoxic mixing with presence of influent.
C.) React	- Aeration/Anoxic mixing under true Batch conditions.
D.) Settle	- Quiescent solids/liquid separation.
E.) Decant/Idle	- Effluent withdrawal via solids excluding, dual control decanter.
F.) Sludge Waste	- Removal of excess biological sludge.

2. Cycle Times

The following process segments have been determined specifically for this application based upon a combination of empirical data and established kinetic models adapted for the AquaSBR. The following summarizes the process conditions:

A.) No. Of Cycles (Ncdb)	= 5	E.) Mixing (Tmix)	= 2.98 Hours/cycle
B.) Total Cycle Time (Tc)	= 4.8 Hours	F.) Settling (Tset)	= 0.75 Hours/cycle
C.) Filling Time/Cycle (Tf)	= 2.4 Hours	G.) Decanting (Tdec)	= 1.07 Hours/cycle
D.) Aeration (Tair)	= 2.4 Hours/cycle	H.) Sludge Waste (Tsig)	= 4.93 Minutes/cycle

Hydraulic Rentention Time (HRT)

1. Hydraulic Retention @Average Design Conditions (HRT-avg)

Based upon an average volume of 0.055 MG/reactor and 2 reactor(s), the HRT at an average flow of 0.1 MGD is:

HRT-avg = (Vawl/Reactor x # Reactors)/ADF = 1.11 days (26.7 hours)

2. Hydraulic Retention @ Maximum Design Conditions (HRT-mdf)

Based upon a maximum volume of 0.065 MG/reactor and 2 reactors, the HRT at a maximum flow of 0.199 MGD is:

HRT-mdf = (Vhwl/Reactor x # Reactors)/MDF = 0.66 days (15.7 hours)

Sludge Production

1. Net Sludge Yield (Yn)

Based upon the design MLSS concentration, influent loading, and volume requirements stated above, the AquaSBR shall produce a certain quantity of sludge, as is typical of activated sludge processes. The sludge yield factor, Yn is:

Yn = 0.793 lb Waste activated sludge (WAS)/lb BOD5/day

Please note that the calculated sludge yield, Yn, was estimated via a kinetic model which accounts for the influent organic and inorganic TSS as well as the developed active, endogenous, inert-organic, and inert-inorganic fractions of the MLSS.

2. Net Sludge Production (lb WAS/Day)

The net sludge production (dry solids basis) is:

lb WAS/day = lb BOD5/day x Yn = 164.5 lb WAS/day = (74.6 kg/day)

3. Sludge Volume (Vs)

The volume of sludge produced, assuming a settled sludge concentration of 1.00% is:

Vs = lb WAS/day/(sludge conc. x 8.34) = 1,973 gpd = (7.5 m^3/day)

4. Mean Cell Retention Time (Ts)

The mean cell retention time (Sludge age, Ts, SRT, MCRT) of the proposed system necessary to attain the specified effluent objectives is:

Ts = lb MLSS/(lb WAS/day + lb TSSe/day) = 18.8 days

5. Oxygen Utilization Rates for Synthesis, Oxidation & Nitrification

Based upon a kinetic evaluation of the influent data with respect to the proposed design considerations, the estimated oxygen uptake rate (OUR) at average conditions is 28.0 mg/l/hr. The process oxygen required is:

OUR lb/hr = OUR mg/l/hr x Vawl/basin x 8.34 = 12.9 lb O2/hr/basin = (5.9 kg/hr/basin)

AERATION SYSTEM EQUIPMENT REQUIREMENTS

Actual Oxygen Requirement (AOR)

1. Oxygen Required For Organic Reduction (Rb)

The aeration system shall be designed to provide 1.25 lb O2 for each lb BOD5, as influent to the SBR system. This oxygen provision shall account for the oxygen utilization for synthesis, as well as endogenous respiration.

Rb = 1.25 lb O2/lb BOD5 x lb BOD5 applied/day = 259.4 lb O2/day = (117.7 kg/day)

2. Oxygen Required For Nitrification (Rn)

Additional oxygen may be necessary for nitrification of TKN to NO3-N. While an effluent requirement may or may not exist, it may be difficult to prevent nitrification from exerting an oxygen demand (when nitrogen is present in the influent). Nitrification requires 4.6 lb O2 to oxidize each lb of TKN to NO3-N.

Rn = lb O2/lb TKN x lb TKN applied/day = 152.7 lb O2/day = (69.3 kg/day)

3. Carbon Stabilized via Denitrification (Rd)

No credits for oxygen recovery via denitrification have been taken (Rd = 0).

4. Total Actual Oxygen Requirement (AORt)

The total oxygen demand under process (field) conditions is:

AORt = Rb + Rn – Rd = 412.0 lb O2/day (total) = (186.9 kg/day)

5. Hourly Actual Oxygen Requirement (AORh)

Based on 2.4 hours of aeration per cycle, 5 cycles/day/basin, and 2 Basin(s), the hourly AORh is:

AORh = 17.2 lb O2/hr/basin = (7.8 kg/hr/basin)

6. Actual Aeration Time Required To Meet Average Demand (At)

The aeration system has been designed to meet the design maximum oxygen requirement in 2.4 hours/cycle/basin. Since average conditions will not require as much oxygen, the actual aeration time shall be adjusted to generate a power draw reflective of average conditions. The aeration time required at average conditions is:

At = (OUR/AOR) x Design aeration/cycle/basin = 1.8 hr/cycle/basin

Standard Conditions

1. Standard Oxygen Requirement (SORh)

Standard (Clean Water) Oxygen Transfer Rate (CWTR)

CWTR = 1.30 lb O2/BHP-Hour = (0.79 kg/kWh/basin)

Process Wastewater Conditions

1. Field Oxygen Transfer Factor (FTF)

While the AOR quantifies the necessary oxygen to satisfy the biochemical reactions, the process water possesses inherent characteristics that typically inhibit oxygen transfer, as it compares to tap (clean) water. The FTF coefficient adjusts standard conditions to those expected in the field

FTF = Alpha x Theta^(T-20) x [(Beta x Csm) – Cr]/Cstm = 0.602

Where:

Alpha = Ratio of mass transfer rate of O2 in process water to clean water = 0.850

Beta = Ratio of saturation of O2 in process water to clean water = 0.950

Theta = Temperature correction factor for O2 transfer = 1.024

T = Design reactor temperature = 20.00 C

Cst = Saturation DO at standard conditions = 9.092

Cs = Cst corrected for site elevation and temperature = 8.88 mg/l

Cr = Residual dissolved oxygen concentration = 2.0 mg/l

2. Field Oxygen Transfer Rate (FTR)

Based on the actual anticipated field conditions, the CWTR of the AquaCam-D must be derated to establish a rate of oxygen transfer into the process water:

Surface Aeration Power Requirements (NPHPr)

1. The Total Nameplate Horsepower required for aeration via the AquaCam-D is:

NPHPr = (AORh/FTR)/Lm = 23.1 NPHP = (17.2 kW)

Where:

Lm is the motor loading, typically 88-95% of full nameplate horsepower

Aeration Selection

1. Aeration Recommendation

Number of AquaCAM-D's operating/basin:	= 1	
Number of total aerators operating:	= 2	
Motor size of each aerator:	= 25 HP	= (19 kW)
Total number of installed units:	= 2	
Total installed NPHP:	= 50 HP	= (37 kW)

Average Aerator Power Estimation

1. Estimated Daily Power Required for aeration with AquaCam-D's (Pwa)

The AquaCam-D performs aeration/mixing: Refer to the following page for power requirements.

MIXING SYSTEM EQUIPMENT REQUIREMENTS

1. Energy Requirements (HP-mix)

To provide uniform mixing of biological solids to a level typically encountered in activated sludge, approximately 150.0 HP/MG is necessary with the AquaCam-D's. The mixing level required is:

HP-mix = 150.0 HP/MG x Vhwl/basin = 9.8 HP = (7.3 kW)

2. Aeration Demand versus Mixing Demand

Since AquaCam-D's have been selected to perform both aeration and mixing, the requirement that demands more energy shall be used in the determination of the power requirement (No. 3 below).

Based upon the above approximate energy requirements, Aqua recommends: (1) - 25.0 NPHP AquaCam-D(s) (Aerator/Mixer/Decanters)

3. Average Power Estimation (Pwm)

Pwm = NPHP x Lm x 0.7457 x Mixing hrs/cycle x Nb x Ncdb = 527.8 kWh/day

Where

Lm is the motor loading, typically 88-95% of full nameplate horsepower.

EFFLUENT DECANTING EQUIPMENT REQUIREMENTS

1. Decant Flow Rate Required at Maximum Design Flow (Qdec)

The decanter shall remove effluent via gravity flow, reducing the water level from the maximum depth to the minimum depth in the design decant phase time (Tdec). The decant flow required is:

Qdec = MDV/(Ncdb x Nb x Tdec) = 311.0 gpm = (1.2 m³M)

The flow rate calculated above is the average rate (from high water level to low water level) at maximum design conditions. The actual decant flow rate will vary depending on the prevailing driving head, assuming the effluent valves are not throttled, flow is not pumped, or an orifice plate has not been employed. Refer to design notes for further decanter notes.

SLUDGE REMOVAL SYSTEM REQUIREMENTS

1. Sludge Flow Rate required at Average Design Flow (ADF)

Sludge flow rate (Qs):

Sludge will be removed at the end of each cycle at the following rate:

Qs = Vs/(Ncdb x Nb x Tslg) = 40.0 gpm = (2.5 l/sec)

2. Sludge Energy Required (HP-sludge)

Based upon an estimated average driving head of 15.0 ft and an assumed pump efficiency of 60%, the sludge removal energy required is:

HP-sludge = (Flowrate x head)/(3,960 x efficiency) = 0.3 BHP = (0.19 kW)

3. Average Power Estimation (Pws)

Pws = BHP x Tslg x Ncdb x Nb x 0.7457 = 0.2 kWh/day

Note: Power estimation assumes sludge is pumped. Refer to design notes for discussion if gravity sludge wasting is employed.

Power consumption calculations in this document are based on maximum month conditions. Detailed power vs. loading calculations can be provided if requested.

AEROBIC DIGESTER DESIGN PARAMETERS

Sludge Flowrate to the Digester	= 1,973.0 gal/day	= (7.5 m³/day)
Inlet Sludge Concentration	= 1.00%	
Solids Loading to the Digester	= 164.5 lb/day	= (74.6 kg/day)
Inlet Volatile Solids Fraction	= 73.4%	

AEROBIC DIGESTER BASIN DESIGN VALUES

No./Basin Geometry:	= 1 Rectangular Basin(s)				
Length of Basin:	= 27 ft	= (8.2 m)			
Width of Basin:	= 19 ft	= (5.8 m)			
Min. Water Depth:	= 11.9 ft	= (3.6 m)	**Min. Basin Vol. Basin:**	= 45,663.2 gal	= (172.9 m³)
Max. Water Depth:	= 17 ft	= (5.2 m)	**Max. Basin Vol. Basin:**	= 65,233.1 gal	= (247.0 m³)

AEROBIC DIGESTER PROCESS DESIGN PARAMETERS

Solids Retention Time:	= 66.1 days	
Digester Design Temperature:	= 20 C	
Volatile Solids Destruction:	= 49%	
Digester Solids Concentration:	= 2%	
Oxygen Supplied for Digestion:	= 2 lbs O2 per lb VSS Destroyed	
Oxygen Distribution Per Basin:	= 100.0%	
Actual Oxygen Required:	= 118.4 lb/day	= (53.7 kg/day)
Volatile Percentage After Digestion:	= 58.5%	
Estimated Dry Solids to be Removed:	= 105.4 lb/day	= (47.8 kg/day)
Volume of Solids to be Removed:	= 631.7 gal/day	= (2.39 m³/day)
Estimated Supernatant Volume:	= 19,569.9 gal/basin	= (74.08 m³/basin)
Assumed Supernatant Duration:	= 180 minutes	
Calculated Supernatant Flow:	= 108.7 gpm	= (6.9 l/sec)

1. The Volatile Solids Destruction listed above shall be used for determination of the oxygen demand during summer conditions. It should be noted that the actual VSS destruction will be dependant upon digester inlet condition, temperature, and operating conditions.
2. The Digester Solids Concentration is reflected as an average concentration, assuming the operations include frequent settling and supernating practices.

AEROBIC DIGESTER EQUIPMENT CRITERIA

Mixing Energy with Aerators:	= 140 HP/MG	= (27.58 W/m³)
NPHP Provided:	= 10.0	= (7.5 kW)
Avg. Power Required:	= 164.65 kW-hr/day	

AquaSBR

Influent Valves

2 Influent Valve(s) will be provided as follows:

- 4 inch electrically operated plug valve(s).

Transfer Pumps/Valves

2 Submersible pump assembly(ies) consisting of the following items:

- 2.4 HP Submersible Pump(s) with painted cast iron pump housing, discharge elbow, and multi-conductor electrical cable.
- 3 inch diameter plug valve(s).
- 3 inch diameter swing check valve.
- Guide bar(s).
- Upper guide bar bracket(s).

AquaCam-D

2 AQUACAM-D Assembly(ies) consisting of:

- 25 HP Aerator/Mixer/Decanter(s) with fiberglass floats, painted steel power section, and 304 stainless steel restrained mooring frame and weir.
- Aluminum band clamp heater integral to the decanter power section(s).
- 6 inch diameter decant hose assembly.
- 4" schedule 40 304 stainless steel restrained mooring post(s) with base plate.
- #8 AWG four-conductor electrical service cable(s).
- #14 AWG ten-conductor electrical service cable(s).
- 6 inch electrically operated butterfly valve(s) with actuator.

1 The following part consists of:

- 6" Magnetic flow meter(s).

Level Sensor Assemblies

2 Pressure Transducer Assembly(ies) each consisting of:

- Pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting pipe weldment(s).

2 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

Instrumentation

2 Dissolved Oxygen Assembly(ies) consisting of:

- DO probe(s).
- Mounting bracket weldment(s).

2 TSS Sensor(s) will be provided as follows:

- TSS probe(s).
- 45 degree elbow(s).

2 Process Controller(s) consisting of:

- Controller and display module(s).

AquaSBR: Aerobic Digester

Aerators

1 AquaJet Aerator(s) will be provided as follows:

- 10 HP Model FSS Aqua-Jet Aerator(s) including electrical cable.

1 AquaJet II Dome Assembly(ies) will be provided as follows:

- Polyester fiberglass discharge spray cover(s) with 304 stainless steel diffuser head attachment ring.

1 Draft Tube Assembly(ies) will be provided as follows:

- 6 ft. 304 stainless steel draft tube assembly with 304 stainless steel fasteners.

Aerator Mooring

1 Aerator restrained mooring system(s) consisting of:

- 304 stainless steel restrained mooring frame(s).
- #12 AWG-four conductor electrical service cable(s).
- Vinyl electrical cable float(s).
- Electrical cable strain relief grip(s), 2 eye, wire mesh.
- 4" Schedule 40 304 stainless steel restrained mooring post(s) with base plate.
- Stainless steel anchors.

Level Sensor Assemblies

1 Sensor installation(s) consisting of:

- Pressure transducer(s).
- Stainless steel sensor guide rail weldment(s).
- PVC sensor mounting pipe(s).
- Top support(s).

1 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

Controls

Controls wo/Starters

1 Controls Package(s) will be provided as follows:

- NEMA 12 panel enclosure suitable for indoor installation and constructed of painted steel.
- Fuse(s) and fuse block(s).
- Compactlogix Processor.
- Operator interface(s).
- Remote access Ethernet modem(s).

IntelliPro

Instrumentation

1 IntelliPro® Process Control System will be provided as follows:

- Aqua-Aerobic Systems' IntelliPro® Process Management System software for enhanced biological process monitoring, control and automated optimization.

- Desktop PC with flat panel monitor, keyboard, mouse, and modem. Windows Operating System.
- Color inkjet printer.
- Uninterrupted power supply.
- Microsoft Office Software.
- FactoryTalk View Studio for Machine Edition software.
- RS Logix software.
- High speed internet connection with recommended minimum download and upload speeds of 1 MB/s shall be available (by others). A fixed IP address is required from the internet service provider. Influent flow meter signal shall be available directly hardwired to the control panel. If direct hardwire signal is not available, the current flow rate and daily total flow shall be available over the communication network.

Aqua CAM-D®

Combination Aerator/Mixer/Decanter

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Aqua CAM-D®

Combination Aerator/Mixer/Decanter

The AquaCAM-D® is a combination aerator/mixer/decanter designed for use in sequencing batch reactor systems (SBRs), treating flows as low as a few thousand gallons per day up to 100,000 gallons per day. The unit independently aerates and mixes the reactor to achieve anaerobic, anoxic and aerobic environments, while offering subsurface decanting of the final effluent. These capabilities make the AquaCAM-D ideal for low level phosphorus and total nitrogen applications. The unit has proven performance in a variety of municipal and industrial applications for both pretreatment and secondary wastewater treatment.

Features and Advantages

- Economical Enhanced Biological Nutrient Removal for Lower Flows
- Simple, Low Cost Installation
- Surface Accessible Components
- Proven Aqua-Aerobic Decanter
- Modular Design Promotes Easy Expansion
- Flexible Tank Options
- No Aeration Yard Piping or Blower Buildings
- Ideal for Cold Climates

Typical Applications

- Schools
- Residential Subdivisions
- Shopping Malls
- Parks, Camps, and Resorts
- Mobile Home Parks
- Nursing Homes
- Landfill Leachate
- Industrial Wastewater

Close-up view of the AquaCAM-D® system.

Overview of the AquaCAM-D® unit in operation.

Operation Description

High velocity movement of water through the air induction volute creates a pressure differential. Atmospheric air is drawn into the volute through the air intake port and forcefully discharged into the basin, enhancing oxygen transfer. By opening the unit's electrically operated air valve, the Aqua CAM-D is operated as an aerator. Closing the air valve enables the unit to operate as a mixer, allowing for anoxic mixing during selected phases of the SBR cycle. Following the Settle phase of the SBR cycle, the submerged weir of the decanter opens and draws clear effluent from below the water surface. The AquaCAM-D is then ready to begin its next cycle of treatment.

Operation of the unit is controlled by a microprocessor with automatic level overrides to control the system during conditions of greater than peak flow.

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

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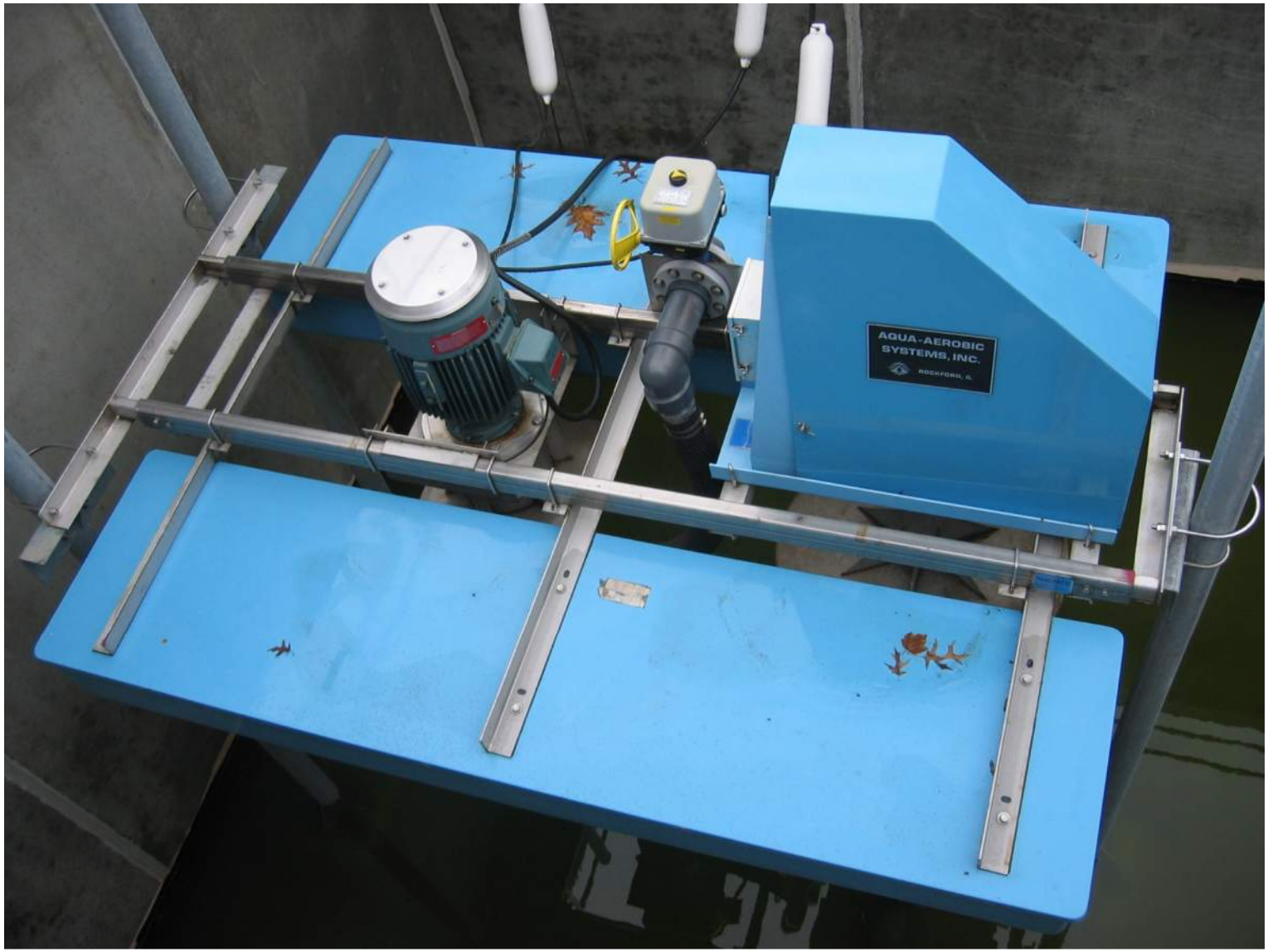
Bulletin #951D 1/24


Garage
Lab
Controls
Post-EQ
SBR #2
Digester
SBR #1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ROCKFORD, IL


AquaSBR


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SYSTEMS, INC


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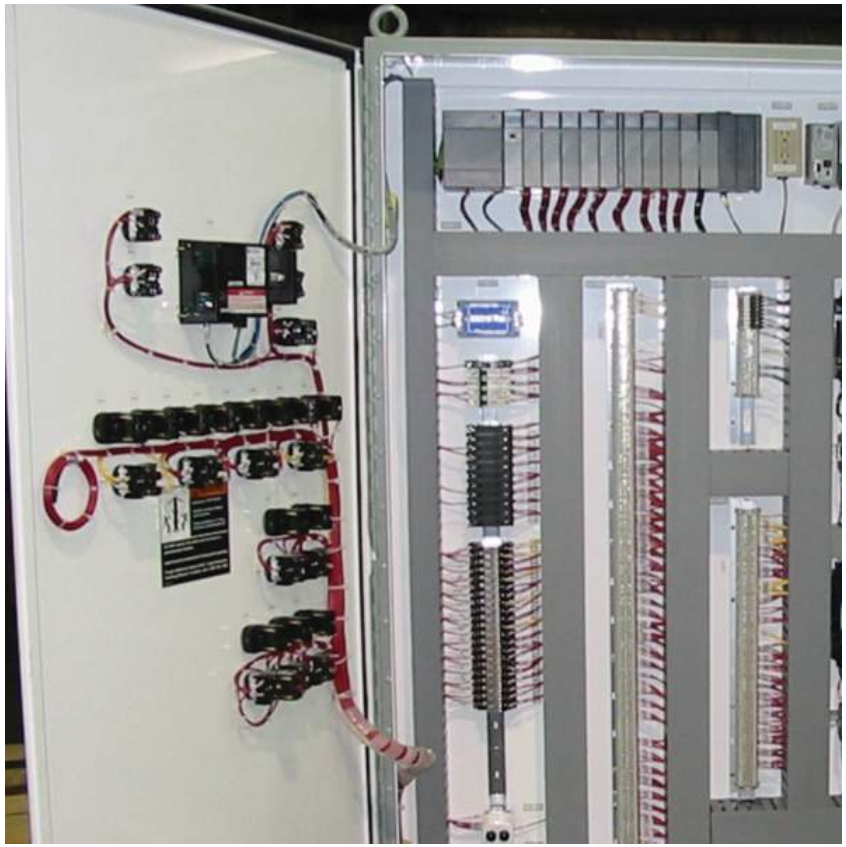
SYSTEMS, INC.

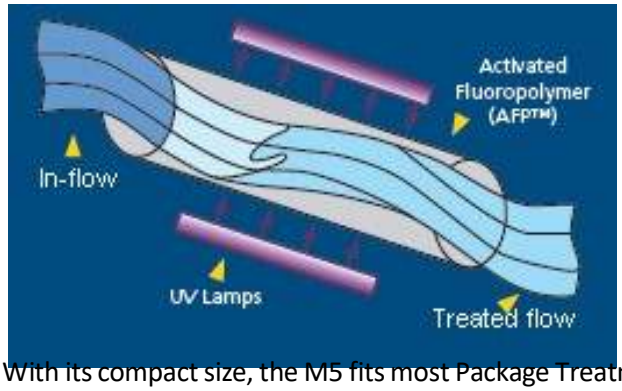


M-5 UV Disinfection system for Wastewater

M - 5 Series

The M-5 Series UV Reactors from Enaqua are the most practical and efficient UV disinfection systems for low and moderate flow wastewater treatment plants, small package plants, and Sequencing Batch Reactors (SBR's).

Each M-5 utilizes Enaqua's Non-Contact UV process which promotes superior, efficient disinfection. Using AFP 840 tubes and a unique plug flow design, you receive the maximum disinfection capability from the lamps, while the turbulent action of the water scours the inside of the tubes, keeping them free from scale build up.



With its compact size, the M5 fits most Package Treatment plants designs and budgets. The M-5 is designed for flows up to 364 GPM and multiple units can be configured in Parallel or Series for higher flows.

Features & Highlights

- ☑ Flow up to 364 GPM per Unit at 65% UVT
- ☑ All wetted components constructed of 304 SS
- ☑ No Quartz Sleeves to foul
- ☑ Turbulent flow-self cleaning
- ☑ Air cooled lamps
- ☑ More consistent UV output
- ☑ Reduced maintenance
- ☑ Up to 24 On/Off cycles per day without damaging lamps & ballasts
- ☑ Dry lamp changes
- ☑ No special cleaning requirements or fixtures
- ☑ Lamp racks weigh less than 40 lbs.
- ☑ Quick Disconnect lamp racks
- ☑ Remote start via dry contacts

ENAQUA™
A GRUNDFOS COMPANY

TYPICAL SPECIFICATIONS:

Disinfection capacity	Up to 364 GPM @ 65% UVT
Connection	6.0" Θ Flange (150 mm)
Housing	Corrosion Resistant Alloy
Dimensions	107.0" x 28.7" x 32.3"
Lamp Type	145 W LPHO Non-Amalgam
Number of lamps	15
Ballast design	Electronic
Removable lamp rack	Yes
UV Sensor	Yes
Lamp life detection	Yes
Controls#	Menu driven LCD Display
Remote Start Capability	Yes
Alarm Outputs^	1/1
Operating Pressure*	< 40.0 psig (2.76 bar)
Operating Voltage+	120/240 Volts+
Operating Current	21 Amps (max)@ 120 V 1PH

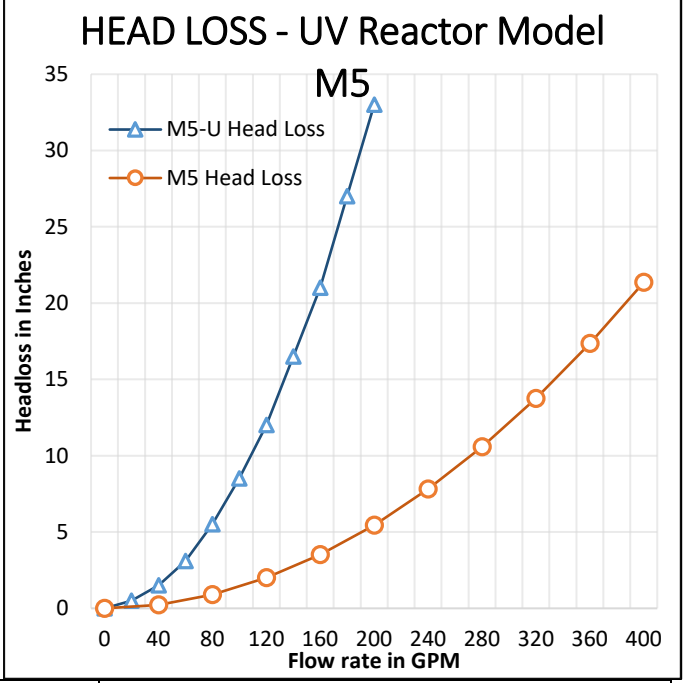
^ One UV Status (On/Off), one master alarm output

MODBUS TCP/IP compatible controller available upon request

+ NON GFCI Circuit Required

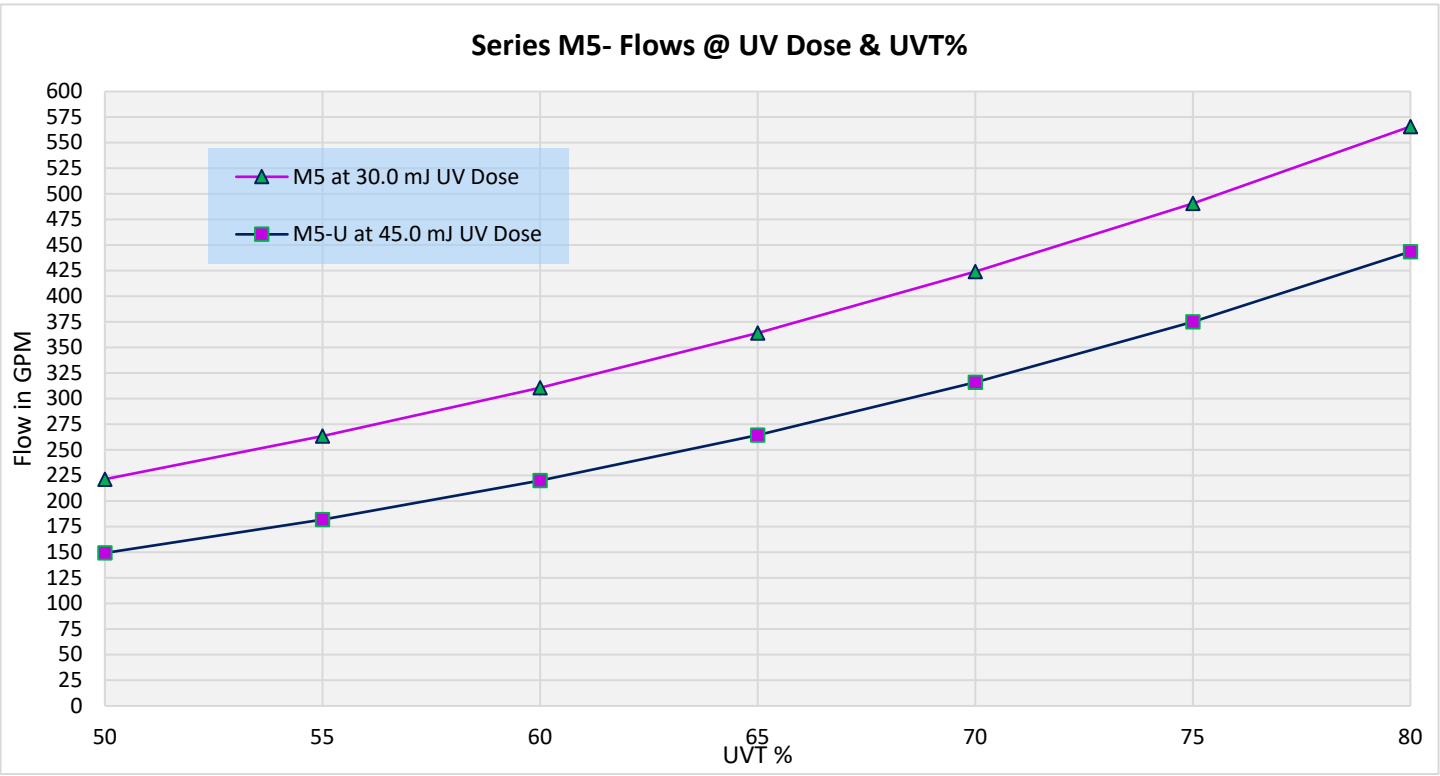
Standard "Flange to Flange Head loss @ Flows is provided in Graph Below:

* Up to 80 psig systems available upon request



For a typical Waste Water Treatment process effluent:

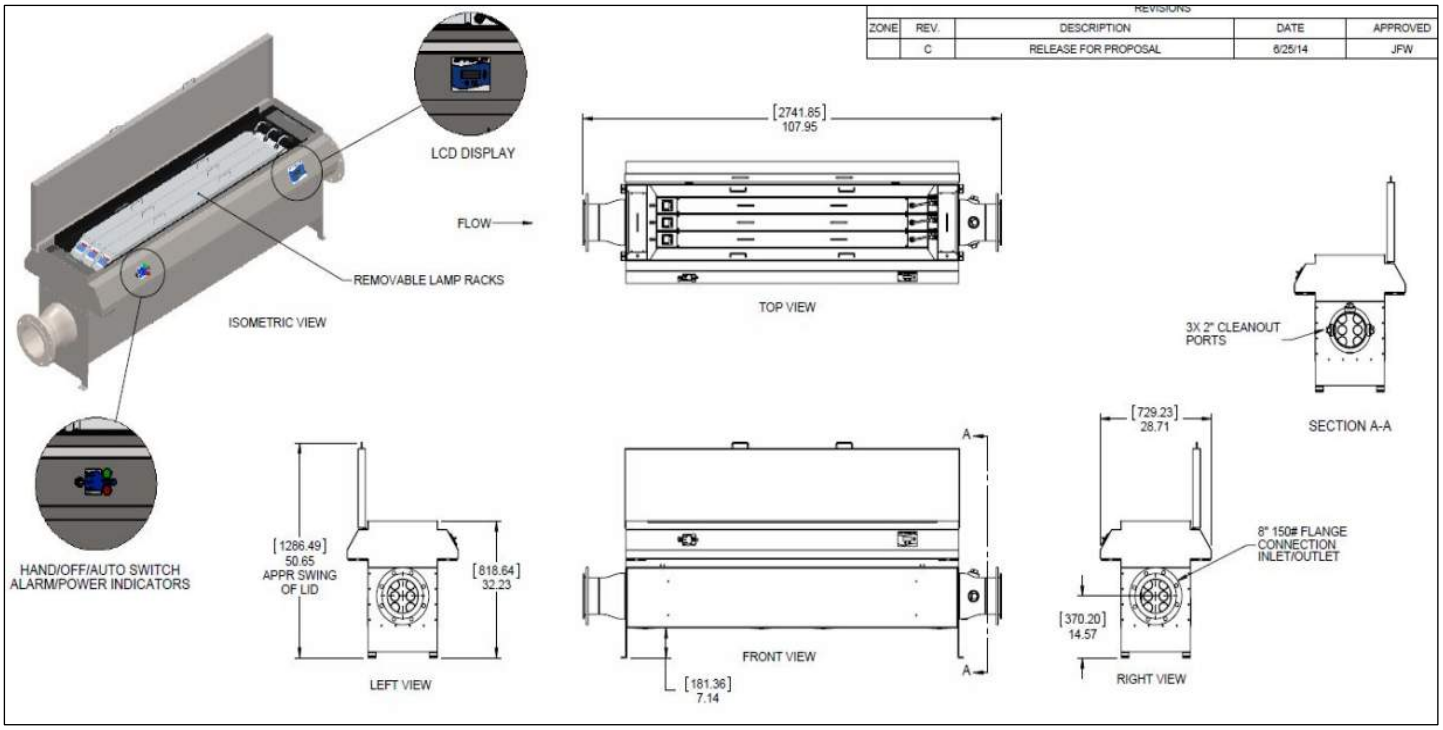
Minimum UV Transmittance (%)	>65.0(%)
Total Suspended Solids (Maximum)	<30.0 (mg/L)
Manufacturer Calculated UV Dose	30.0 (mJ/cm2)
Target Indicator Organism Influent Maximum	≤200,000/126,000 (CFU/100 mL)
Target Indicator Organism Effluent Permit Limit	≤200/ 126(CFU/100 mL)+



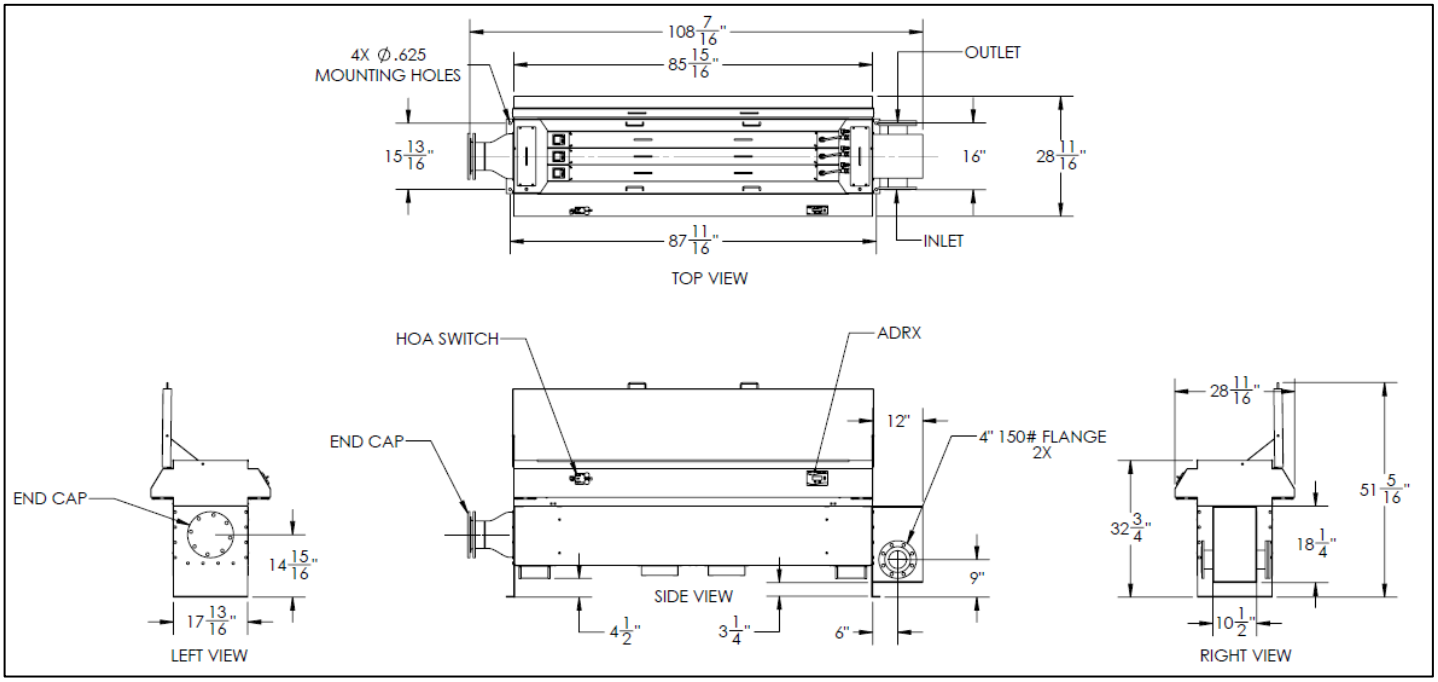
+: Standard 126 CFU for E. Coli, and 200 CFU for Fecal Coliform

SAMPLE DRAWINGS:

M5



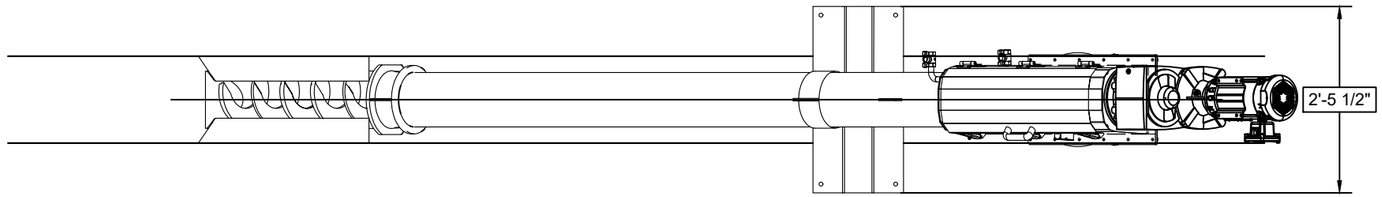
M5-U



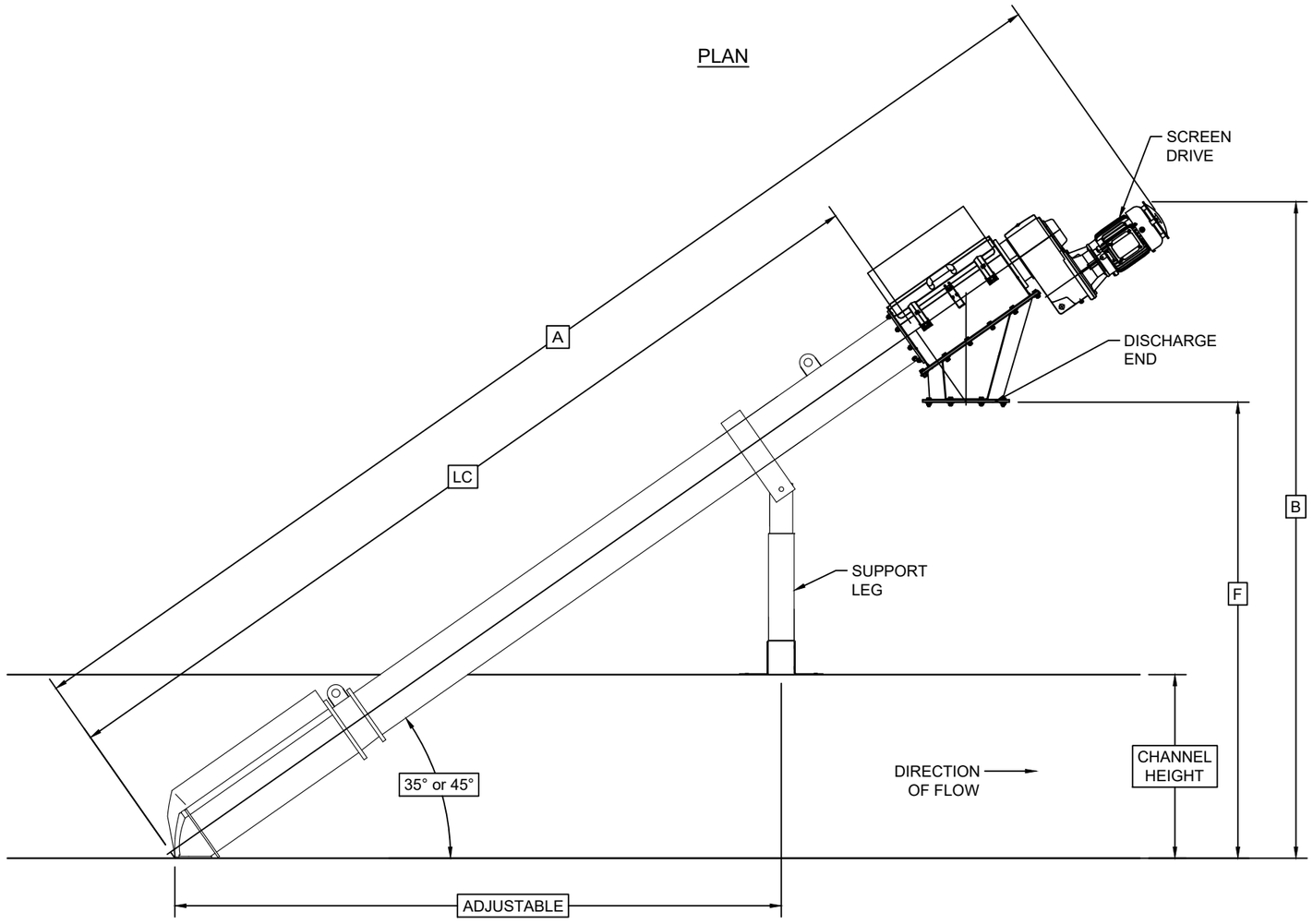
For more information, visit our website at www.enaqua.com
All values are nominal; specifications subject to change without notice.

Enaqua, a Grundfos Company
1350 Specialty Drive, Suite F
Vista, CA 92081 (USA)
Phone: (760) 599-2644
Info@enaqua.com

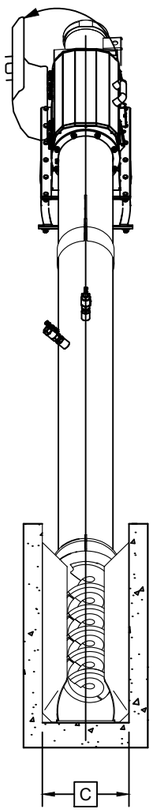
ENAQUA™ A GRUNDFOS COMPANY



PLAN



SIDE ELEVATION



FRONT ELEVATION

NOMINAL (LC)	NOMINAL (LC)	OVERALL LENGTH	OVERALL HEIGHT	CHANNEL WIDTH (MINIMUM)	DISCHARGE FROM INVERT OF CHANNEL
LC Metric	LC Imperial	A	B	C	F
2500	8'-2 3/7" (98.42")	10'-8" (128.00")	6'-3 1/2" (75.50")	0'-11 4/5" (11.81")	3'-9 2/5" (45.4")
3000	9'-10 1/9" (118.11")	12'-3 5/8" (147.83")	7'-2 4/5" (86.8")	0'-11 4/5" (11.81")	4'-8 2/3" (56.7")
3500	11'-5 4/5" (137.80")	13'-11 1/2" (167.50")	8'-2 1/9" (98.1")	0'-11 4/5" (11.81")	5'-8" (68.0")
4000	13'-11 1/2" (157.50")	15'-7 1/5" (187.20")	9'-1 2/5" (109.4")	0'-11 4/5" (11.81")	6'-7 1/4" (79.25")
4500	14'-9 1/6" (177.16")	17'-2 8/9" (206.89")	10'-0 2/3" (120.9")	0'-11 4/5" (11.81")	7'-6 1/4" (90.5")
5000	16'-4 6/7" (196.85)	18'-10 4/7" (226.57")	10'-11 4/5" (131.96")	0'-11 4/5" (11.81")	8'-5 6/7" (101.8")
5500	18'-0 1/2" (216.50")	20'-6 1/4" (246.26")	11'-11 1/4" (143.26")	0'-11 4/5" (11.81")	9'-5 1/7" (113.1")
6000	19'-8 2/9" (236.22")	22'-2" (265.0")	12'-10 4/7" (154.56")	0'-11 4/5" (11.81")	10'-4 4/9" (124.4")
6500	21'-4" (255.00")	23'-9 5/8" (285.95")	13'-9 5/6" (165.82")	0'-11 4/5" (11.81")	11'-3 5/7" (135.7")
7000	22'-11 3/5" (275.60")	25'-5 1/3" (305.32")	14'-9 1/8" (177.12")	0'-11 4/5" (11.81")	12'-3" (147")
7500	24'-7 2/7" (295.27")	27'-1" (325.00")	15'-8 1/8" (187.2")	0'-11 4/5" (11.81")	13'-2 1/3" (158.3")
8000	26'-3" (314.96")	28'-8 3/8" (344.68)	16'-6 7/16" (198.4")	0'-11 4/5" (11.81")	14'-1 3/5" (169.6")

NOTES:
1. CONCRETE, GROUT, INTERCONNECTING PIPING NOT BY SAVECO
2. ALL INTERCONNECTING PIPING TO BE SELF SUPPORTING
3. DRAWING NOT FOR CONSTRUCTION

SAVECO® Member of WAMGROUP® Formerly Enviro-Care®

Project Information
PROJECT NAME:

Third Angle Projection

Status: SALES DRAWING

Title: GCP300 SPECO WASTEMASTER SHAFTLESS SPIRAL SCREEN

Designer	Checker	Date	Sheet
MB29	--	12-27-2022	1 OF 1
Scale	Drawing Number		Revision
1/8"=1'-0"	WEC		-

APPENDIX II

MoDNR – Geohydrologic Evaluation Results

MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

Michael L. Parson
Governor

Dru Buntin
Director

LWE25030
Cape Girardeau County

October 25, 2024

Brian Strickland
113 West Main Street, Suite 1
Jackson, MO 63755

RE: King's Landing WWTF

Dear Brian Strickland:

On September 11, 2024, the Missouri Geological Survey received a request to perform a geohydrologic evaluation for the above referenced project located in Cape Girardeau County. Included with this letter is a report that details the geologic and hydrologic conditions at the site and the potential for groundwater contamination in the event of wastewater treatment failure.

Thank you for the evaluation request. If you are in need of further assistance or have questions regarding the report, please contact our office at P.O Box 250, Rolla, Mo 65402-0250, by telephone at 573-368-2100 or gspeg@dnr.mo.gov.

Sincerely,

MISSOURI GEOLOGICAL SURVEY

Andrew Herrera
Geologist
Environmental Geology Section

c: Brandon Williams
WPP
Southeast Regional Office

Missouri Department Of Natural Resources
Missouri Geological Survey
Geological Survey Program
Environmental Geology Section

Project ID Number
LWE25030
County
Cape Girardeau County

Request Details

Project: King's Landing WWTF

Legal Description: 21 T31N R14E
Quadrangle: CAPE GIRARDEAU
Latitude: 37 20 33.09
Longitude: -83 30 17.62

Organization Official

Name: Brandon Williams
Address: 2985 Boutin Drive
City: Cape Girardeau
State: MO Zip: 63701
Phone: 573-335-3382
Email: bowconstruction@aol.com

Preparer

Name: Brian Strickland
Address: 113 West Main Street, Suite 1
City: Jackson
State: MO Zip: 63755
Phone: 573-243-4080
Email: bstrick@stricklandengineering.com

Project Details

Report Date:
Date of Field Visit: 10/22/2024

Previous Reports: Not Applicable

Facility Type
- [X] Mechanical treatment plant
- [ ] Recirculating filter bed
- [ ] Land application
- [ ] Lagoon or storage basin
- [ ] Subsurface soil absorption system
- [ ] Lagoon or storage basin W/Land App
- [ ] Lagoon or storage basin W/SSAS
- [ ] Other type of facility

Type of Waste
- [ ] Animal
- [X] Human
- [ ] Process or industrial
- [ ] Leachate
- [ ] Other waste type

Funding Source
- [X] IWT
- [ ] WWL-SRF

Additional Information
- [ ] Plans were submitted
- [ ] Site was investigated by NRCS
- [ ] Soil or geotechnical data were submitted

Geologic Stream Classification: [X] Gaining [ ] Losing [ ] No discharge

Overall Geologic Limitations
- [X] Slight
- [ ] Moderate
- [ ] Severe

Collapse Potential
- [X] Not applicable
- [ ] Slight
- [ ] Moderate
- [ ] Severe

Topography
- [X] <4%
- [ ] 4% to 8%
- [ ] 8% to 15%
- [ ] >15%

Landscape Position
- [ ] Broad uplands
- [ ] Floodplain
- [ ] Ridgetop
- [ ] Alluvial plain
- [ ] Hillslope
- [X] Terrace
- [ ] Narrow ravine
- [ ] Sinkhole

Bedrock: The uppermost bedrock is the Devonian-age Bailey Formation.

Surficial Materials: The surficial materials are clay loam and silt loam.

Missouri Department Of Natural Resources
Missouri Geological Survey
Geological Survey Program
Environmental Geology Section

Project ID Number
LWE25030
County
Cape Girardeau County

Recommended Construction Procedures for Earthen Facility	Determine Overburden Properties	Determine Hydrologic Conditions
☐ Installation of clay pad and Compaction	☐ Particle size analysis	☐ Groundwater elevation
☐ Diversion of subsurface flow	☐ Atterberg limits	☐ Direction of groundwater flow
☐ Artificial sealing	☐ 95% Max. dry density test method	☐ 25-Year flood level
☐ Rock excavation	☐ Overburden thickness	☐ 100-Year flood level
☐ Limit excavation depth	☐ Permeability coefficient-undisturbed	
	☐ Permeability coefficient-remolded	

Remarks:

On October 22, 2024, a geologist with the Missouri Geological Survey conducted a geohydrologic evaluation for a proposed mechanical treatment plant located at approximately, 89°30'18"W 37°20'33"N, in Cape Girardeau, Missouri. The proposed facility is approximately 1 acre in size and will discharge wastewater into a tributary of Juden Creek. The purpose of the site visit is to observe the geologic and hydrologic characteristics and to determine the potential for groundwater contamination in the event of wastewater treatment failure.

Surface water runoff from the site generally drains east to a tributary of Juden Creek. A portion of Juden Creek was evaluated and classified as gaining for approximately 2 miles downstream from the proposed discharge point.

The surficial materials onsite were measured using a handheld soil probe. Surficial materials were measured to a depth of approximately 3.8 feet. The surficial materials consist of silt loam and clay loam and exhibit low to moderate permeability. According to nearby geologic well log data, surficial materials may be up to 30 feet thick.

Bedrock was not observed onsite, however; according to nearby geologic well data and areal geologic mapping, the uppermost bedrock is the Devonian-age Bailey Formation comprised of thinly bedded limestone intercalated with shale. This bedrock exhibits low to moderate primary permeability and moderate to high permeability due to faulting in the area.

There are no known sinkholes or springs located within 1 mile of the facility. However, the site is located within the Jackson Fault Zone. There are various faults within 1 mile of the site. These faults may provide preferential pathways for water to flow into the subsurface.

Based on the characteristics observed, the site receives a slight overall geologic limitations rating. In the event of storage basin collapse or wastewater treatment failure, local, shallow groundwater resources, and surface waters of the tributary of Juden Creek and Juden Creek, may be adversely impacted.

APPENDIX III

MoDNR – Natural Heritage Review Results

Missouri Department of Conservation

Missouri Department of Conservation's Mission is to
protect and manage the forest, fish, and
wildlife resources of the state and to
facilitate and provide opportunities for all citizens to
use, enjoy and learn about these resources.

Natural Heritage Review Level Three Report: Species Listed Under the Federal Endangered Species Act

There are records of species listed under the Federal Endangered Species Act, and possibly also records for species listed Endangered by the state, or Missouri Species and/or Natural Communities of Conservation Concern within or near the the defined Project Area. Please contact the U.S. Fish and Wildlife Service and the Missouri Department of Conservation for further coordination.

Foreword: Thank you for accessing the Missouri Natural Heritage Review Website developed by the Missouri Department of Conservation with assistance from the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, Missouri Department of Transportation and NatureServe. The purpose of this report is to provide information to federal, state and local agencies, organizations, municipalities, corporations, and consultants regarding sensitive fish, wildlife, plants, natural communities, and habitats to assist in planning, designing, and permitting stages of projects.

PROJECT INFORMATION

Project Name and ID Number: King's Landing WWTF #15209
User Project Number: 24-183
Project Description: Construction of a new wastewater treatment facility for a residential development in Cape Girardeau County. Discharge from the WWTF will be to the highway ditch tributary to Juden Creek.
Project Type: Waste Transfer, Treatment, and Disposal, Liquid waste/Effluent, Wastewater treatment plant, Construction or expansion
Contact Person: Brian Strickland
Contact Information: bstrick@stricklandengineering.com or 5732434080

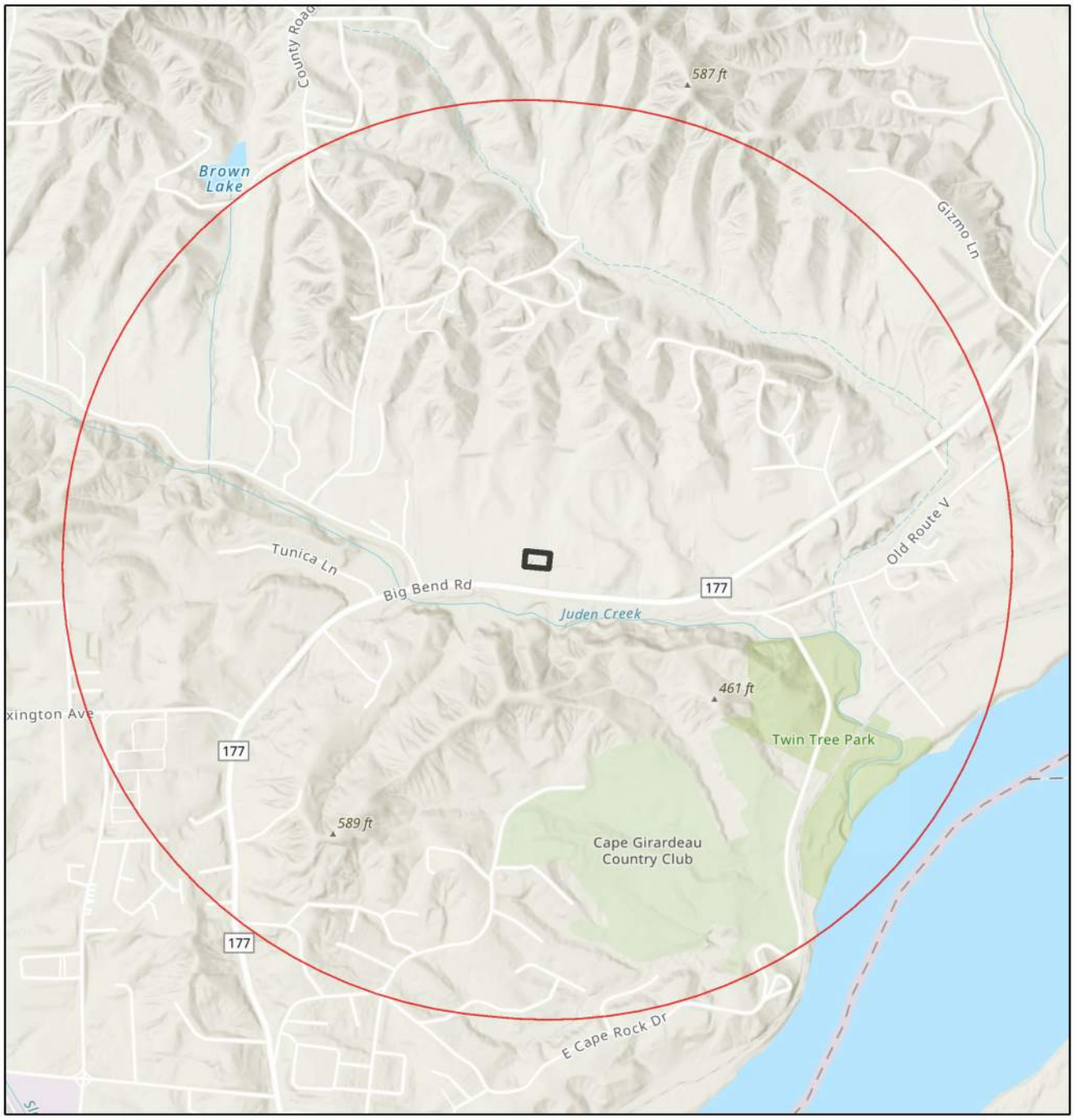
Disclaimer: This NATURAL HERITAGE REVIEW REPORT identifies if a species or natural community tracked by the Natural Heritage Program is known to occur within or near the project area submitted, and shares recommendations to avoid or minimize project impacts to sensitive species or natural habitats. Incorporating information from the Natural Heritage Program into project plans is an important step in reducing impacts to Missouri's sensitive natural resources. If an occurrence record is present, or the proposed project might affect federally listed species, the user must contact the Department of Conservation or U.S. Fish and Wildlife Service for more information.

This Natural Heritage Review Report is not a site clearance letter for the project. Rather, it identifies public lands and records of sensitive resources located close to and/or potentially affected by the proposed project. If project plans or location change, this report may no longer be valid. Because land use conditions change and animals move, the existence of an occurrence record does not mean the species/habitat is still present. Therefore, reports include information about records near but not necessarily on the project site. Lack of an occurrence record does not mean that a sensitive species or natural community is not present on or near the project area. On-site verification is the responsibility of the project. However, the Natural Heritage Program is only one reference that should be used to evaluate potential adverse project impacts and additional information (e.g. wetland or soils maps, on-site inspections or surveys) should be considered. Reviewing current landscape and habitat information, and species' biological characteristics would additionally ensure that Missouri Species of Conservation Concern are appropriately identified and addressed in planning efforts.

U.S. Fish and Wildlife Service – Endangered Species Act (ESA) Coordination: Lack of a Natural Heritage Program occurrence record for federally listed species in your project area does not mean the species is not present, as the area may never have been surveyed. Presence of a Natural Heritage Program occurrence record does not mean the project will result in negative impacts. This report does not fulfill Endangered Species Act consultation with the U.S. Fish and Wildlife Service (USFWS) for listed species. Direct contact with the USFWS may be necessary to complete consultation and it is required for actions with a federal connection, such as federal funding or a federal permit; direct contact is also required if ESA concurrence is necessary. Visit IPaC: Home (fws.gov) to initiate USFWS Information for Planning and Conservation (IPaC) consultation. Contact the Columbia Missouri Ecological Field Services Office (573-234-2132, or by mail at 101 Park Deville Drive, Suite A, Columbia, MO 65203) for more information.

Transportation Projects: If the project involves the use of Federal Highway Administration transportation funds, these recommendations may not fulfill all contract requirements. Please contact the Missouri Department of Transportation at 573-526-4778 or visit Home Page | Missouri Department of Transportation (modot.org) for additional information on recommendations.

King's Landing WWTF



September 11, 2024

1:19,471

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Buffered Project Boundary

Project Boundary

Species or Communities of Conservation Concern within the Area:

There are records of species listed under the Federal Endangered Species Act, and possibly also records for species listed Endangered by the state, or Missouri Species and/or Natural Communities of Conservation Concern within or near the defined Project Area. Please contact the U.S. Fish and Wildlife Service and the Missouri Department of Conservation for further coordination.

Email (preferred): NaturalHeritageReview@mdc.mo.gov
MDC Natural Heritage Review
Science Branch
P.O. Box 180
Jefferson City, MO
65102-0180
Phone: 573-522-4115 ext. 3182

U.S. Fish and Wildlife Service
Ecological Service
101 Park Deville Drive
Suite A
Columbia, MO
65203-0007
Phone: 573-234-2132

Other Special Search Results:

The project occurs on or near public land, Juden Creek CA, please contact MDC.

Your project is near a designated Natural Area . Please contact Missouri Department of Conservation (NaturalHeritageReview@mdc.mo.gov) for further coordination.

Project Type Recommendations:
Waste Transfer, Treatment and Disposal -Wastewater treatment plant: New or Maintenance; Clean Water Act permits issued by other agencies regulate both construction and operation of wastewater systems, and provide many important protections for fish and wildlife resources throughout the project area and at some distance downstream. Fish and wildlife almost always benefit when unnatural pollutants are removed from water, and concerns are minimal if construction is managed to minimize erosion and sedimentation/runoff to nearby streams and lakes, including adherence to any Clean Water Act permit conditions.
Revegetate disturbed areas to minimize erosion using native plant species compatible with the local landscape and wildlife needs. Annual ryegrass may be combined with native perennials for quicker green-up. Avoid aggressive exotic perennials such as crownvetch and sericea lespedeza. Please see Best Management Practices for Construction and Development Projects Affecting Missouri Rivers and Streams (mo.gov).

Project Location and/or Species Recommendations:

Endangered Species Act Coordination - If this project has the potential to alter habitat (e.g. tree removal, projects in karst habitat) or cause direct mortality of bats, please coordinate directly with U.S. Fish and Wildlife Service (Ecological Services, 101 Park Deville Drive, Suite A, Columbia, Missouri 65203-0007; Phone 573-234-2132 Ext. 100 for Ecological Services) for further coordination under the Endangered Species Act. Indiana bats *(Myotis sodalis*, federal- and state-listed endangered) and **Northern long-eared bats** (*Myotis septentrionalis,* federal-listed threatened) may occur near the project area. Both of these species of bats hibernate during winter months in caves and mines. During the summer months, they roost and raise young under the bark of trees in wooded areas, often riparian forests and upland forests near perennial streams. During project activities, avoid degrading stream quality and where possible leave snags standing and preserve mature forest canopy. Do not enter caves known to harbor Indiana bats or Northern long-eared bats, especially from September to April.

Bald Eagle: The project location submitted and evaluated is within the geographic range of nesting Bald Eagles in Missouri. Bald Eagles (*Haliaeetus leucocephalus*) may nest near streams or water bodies in the project area. Nests are large and fairly easy to identify. Adults begin nesting activity in late December and January and young birds leave the nest in late spring to early summer. While no longer listed as endangered, eagles continue to be protected by the federal government under the Bald and Golden Eagle Protection Act. Work managers should be alert for nesting areas within 1500 meters of project activities, and follow federal guidelines at: Do I need an eagle take permit? | U.S. Fish & Wildlife Service (fws.gov) if eagle nests are seen.

Interior Least Tern: The project location submitted and evaluated occurs within the known range of the Interior Least Tern in Missouri. Interior Least Terns (*Sterna antillarum athalassos,* federally and state listed endangered) nest and forage along the Mississippi River, and sometimes along the adjacent floodplain, from St. Louis to the southern boundary of the state. Habitat loss and diminishing water quality can impact least tern populations. See Interior Least Tern Best Management Practices (mo.gov) for best management recommendations.

Karst: This county has known karst geologic features (e.g., caves, springs, and sinkholes, all characterized by subterranean water movement). Few karst features are recorded in Natural Heritage records, and ones not noted here may be encountered at the project site or affected by the project. Cave fauna (many of which are Species of Conservation Concern) are influenced by changes to water quality; please check your project site for any karst features and make every effort to protect groundwater in the project area. Additional information and specific recommendations are available at Management Recommendations for Construction and Development Projects Affecting Missouri Karst Habitat (mo.gov).

Pallid Sturgeon: The project location submitted and evaluated is located within or adjacent to the Mississippi or Missouri rivers. Pallid Sturgeons (*Scaphirhynchus albus*, federal- and state-listed endangered) are big river fish that range widely in the Mississippi and Missouri River system (including parts of some major tributaries). Any project that modifies big river habitat or impacts water quality should consider the possible impact to pallid sturgeon populations. See Pallid Sturgeon Best Management Practices (mo.gov) for Best Management Practices. Additional coordination with the U.S. Fish and Wildlife Service under the Endangered Species Act may be necessary (U.S. Fish and Wildlife Service, Ecological Services, 101 Park DeVille Drive, Suite A, Columbia, Missouri 65203-0007; phone 573-234-2132.)

Invasive exotic species are a significant issue for fish, wildlife and agriculture in Missouri. Seeds, eggs, and larvae may be moved to new sites on boats or construction equipment. Please inspect and clean equipment thoroughly before moving between project sites. See Managing Invasive Species in Your Community | Missouri Department of Conservation (mo.gov) for more information.

- Remove any mud, soil, trash, plants or animals from equipment before leaving any water body or work area.
- Drain water from boats and machinery that have operated in water, checking motor cavities, live-well, bilge and transom wells, tracks, buckets, and any other water reservoirs.
- When possible, wash and rinse equipment thoroughly with hard spray or HOT water (>140° F, typically available at do-it-yourself car wash sites), and dry in the hot sun before using again.

Streams and Wetlands – Clean Water Act Permits: Streams and wetlands in the project area should be protected from activities that degrade habitat conditions. For example, soil erosion, water pollution, placement of fill, dredging, in-stream activities, and riparian corridor removal, can modify or diminish aquatic habitats. Streams and wetlands may be protected under the Clean Water Act and require a permit for any activities that result in fill or other modifications to the site. Conditions provided within the U.S. Army Corps of Engineers (USACE) Clean Water Act Section 404 permit (Kansas City District Regulatory Branch (army.mil)) and the Missouri Department of Natural Resources (DNR) issued Clean Water Act Section 401 Water Quality Certification (Section 401 Water Quality Certification | Missouri Department of Natural Resources (mo.gov)), if required, should help minimize impacts to the aquatic organisms and aquatic habitat within the area. Depending on your project type, additional permits may be required by the Missouri Department of Natural Resources, such as permits for stormwater, wastewater treatment facilities, and confined animal feeding operations. Visit Wastewater Permits | Missouri Department of Natural Resources (mo.gov) for more information on DNR permits. Visit both the USACE and DNR for more information on Clean Water Act permitting.

For further coordination with the Missouri Department of Conservation and the U.S. Fish and Wildlife Services, please see the contact information below:

Email (preferred): NaturalHeritageReview@mdc.mo.gov
MDC Natural Heritage Review
Science Branch
P.O. Box 180
Jefferson City, MO
65102-0180
Phone: 573-522-4115 ext. 3182

U.S. Fish and Wildlife Service
Ecological Service
101 Park Deville Drive
Suite A
Columbia, MO
65203-0007
Phone: 573-234-2132

Miscellaneous Information

FEDERAL Concerns are species/habitats protected under the Federal Endangered Species Act and that have been known near enough to the project site to warrant consideration. For these, project managers must contact the U.S. Fish and Wildlife Service Ecological Services (101 Park Deville Drive Suite A, Columbia, Missouri 65203-0007; Phone 573-234-2132; Fax 573-234-2181) for consultation.

STATE Concerns are species/habitats known to exist near enough to the project site to warrant concern and that are protected under the Wildlife Code of Missouri (RSMo 3 CSR 1 0). "State Endangered Status" is determined by the Missouri Conservation Commission under constitutional authority, with requirements expressed in the Missouri Wildlife Code, rule 3CSR 1 0-4.111. Species tracked by the Natural Heritage Program have a "State Rank" which is a numeric rank of relative rarity. Species tracked by this program and all native Missouri wildlife are protected under rule 3CSR 10-4.110 General Provisions of the Wildlife Code.

See Missouri Species and Communities of Conservation Concern Checklist (mo.gov) for a complete list of species and communities of conservation concern. Detailed information about the animals and some plants mentioned may be accessed at Mofwis Search Results. Please contact the Missouri Department of Conservation to request printed copies of any materials linked in this document.

South Cape County Sewer Company, LLC

King's Landing Wastewater Collection and Treatment System — Construction Timeline

DNR Construction Permit No. CP0002556 (issued Aug. 19, 2025; valid 24 months, expires Aug. 19, 2027)

TIMELINE

Phase / Milestone	Start	Finish	Status
DNR Facility Plan Approval	—	Jan 2025	**Complete**
DNR Construction Permit CP0002556	—	Aug 2025	**Complete**
WWTF construction	Sep-25	Aug 2026	**In progress**
Collection system & first homes	2026	Build-out	**In progress**
WWTF substantial completion	—	Aug 2026	**Planned**
Facility startup & commissioning	Sept 2026	Sept 2026	**Planned**
Statement of Work Completed → request operating permit	—	Sept 2026	**Planned**
DNR Operating Permit issued	—	by Dec 31, 2026	**Planned**

South Cape County Sewer Company, LLC

King's Landing Wastewater Collection and Treatment System — Construction Timeline

DNR Construction Permit No. CP0002556 (issued Aug. 19, 2025; valid 24 months, expires Aug. 19, 2027)

MILESTONE SCHEDULE

#	Milestone / Activity	Responsible Party	Start	Target / Actual Completion	Status	DNR / Regulatory Reference
1	Geohydrologic site evaluation	Missouri Geological Survey	—	Oct 19, 2024	Complete	10 CSR 20-6.010(7)(B)2 — basis for facility plan
2	Facility plan submitted to DNR	Heartland Engineering, LLC	—	Dec 1, 2024	Complete	10 CSR 20-6.010(3) facility planning
3	DNR Facility Plan Approval (Appendix 7)	Missouri DNR	—	Jan 31, 2025	Complete	Facility Plan Approval letter
4	DNR Construction Permit No. CP0002556 issued (Appendices 3 & 8)	Missouri DNR	—	Aug 19, 2025	Complete	Construction permit; valid 24 months
5	WWTF construction	Cape Land & Development, LLC / contractor	Sept 2025 (est.)	Aug 2026 (target)	In progress	Authorized under CP0002556
6	Collection system & first residential construction	Cape Land & Development, LLC	2026 (ongoing)	Phased to build-out	In progress	Authorized under CP0002556
7	WWTF substantial completion	Contractor / Engineer	—	Aug 2026 (target)	Planned	Prerequisite to Statement of Work Completed
8	Facility startup & commissioning	Strickland Engineering, L.C. (Operator)	Sept 2026	Sept 2026	Planned	Operator contract (Appendix 4)
9	Statement of Work Completed filed with DNR; request operating permit	SCC Sewer / Engineer	—	Sept 2026 (target)	Planned	10 CSR 20-6.010(5)(N)
10	DNR Operating Permit issued	Missouri DNR	—	By Dec 31, 2026 (expected)	Planned	State Operating Permit (facility MO-0140945)