STATE OF MISSOURI

DEPARTMENT OF NATURAL RESOURCES

MISSOURI CLEAN WATER COMMISSION

CONSTRUCTION PERMIT

The Missouri Department of Natural Resources hereby issues a permit to:

Village of Freeburg
P.O. Box 237
Freeburg, MO 65035

for the construction of (described facilities):

See attached.

Permit Conditions:

See attached.

Construction of such proposed facilities shall be in accordance with the provisions of the Missouri Clean Water Law, Chapter 644, RSMo., and regulation promulgated thereunder, or this permit may be revoked by the Department of Natural Resources.

As the department does not examine structural features of design or the efficiency of mechanical equipment, the issuance of this permit does not include approval of these features.

A representative of the department may inspect the work covered by this permit during construction. Issuance of a permit to operate by the department will be contingent on the work substantially adhering to the approved plans and specifications.

This permit applies only to the construction of water pollution control components; it does not apply to other environmentally regulated areas.

August 18, 2026
Effective Date

August 17, 2028
Expiration Date

Heather S. Peters, Director, Water Protection Program

CONSTRUCTION PERMIT

I. CONSTRUCTION DESCRIPTION

The project will include the construction of Triplepoint NitrOx® equipment for ammonia removal and ultraviolet (UV) lights and contact chamber for disinfection of *E. coli*. In addition, improvements to the headworks will include the construction of a manual bar screen and flow control structure. An airlift, blowers and controls, air piping, and other associated equipment required to operate the Triplepoint NitrOx® equipment and UV system will be constructed.

This project will also include general site work appropriate to the scope and purpose of the project and all necessary appurtenances to make a complete and usable wastewater treatment facility.

II. COST ANALYSIS FOR COMPLIANCE

Pursuant to Section 644.145, RSMo., when issuing permits under this chapter that incorporate a new requirement for discharges from publicly owned combined or separate sanitary or storm sewer systems or publicly owned treatment works, or when enforcing provisions of this chapter or the Federal Water Pollution Control Act, 33 U.S.C. 1251 et seq., pertaining to any portion of a publicly owned combined or separate sanitary or storm sewer system or [publicly owned] treatment works, the Department of Natural Resources shall make a "finding of affordability" on the costs to be incurred and the impact of any rate changes on ratepayers upon which to base such permits and decisions, to the extent allowable under this chapter and the Federal Water Pollution Control Act. This process is completed through a cost analysis for compliance. Permits that do not include new requirements may be deemed affordable.

Cost Analysis for Compliance - The department has made a reasonable search for empirical data indicating the permit is affordable. The search consisted of a review of department records that might contain economic data on the community, a review of information provided by the applicant as part of the application, and public comments received in response to public notices of this draft permit. If the empirical cost data was used by the permit writer, this data may consist of median household income, any other ongoing projects that the department has knowledge, and other demographic financial information that the community provided as contemplated by Section 644. 145.3. See **APPENDIX – COST ANALYSIS FOR COMPLIANCE**.

III. CONSTRUCTION PERMIT CONDITIONS

The permittee is authorized to construct subject to the following conditions:

1. This construction permit does not authorize discharge.

2. All construction shall be in accordance with the plans and specifications submitted by Bartlett & West on June 25, 2026, and signed and sealed by the engineers listed below, and approved by the department on August 18, 2026.

   Plans
   - Signed and sealed by Kyle J. Landwehr, P.E. on June 25, 2026.
   - Signed and sealed by Max A. Kurinsky, P.E. on June 26, 2026.
   - Signed and sealed by Matthew Vander Tuig, P.E. on June 26, 2026.
   - Signed and sealed by Hope M. Drennan, P.E. on June 26, 2026.
   - Signed and sealed by Michael P. Becker, P.E. on June 26, 2026.
   - Signed and sealed by Richard A. Stones, P.E. on June 26, 2026.
   - Signed and sealed by Chad D. Yost, P.E. on June 26, 2026.

   Specifications
   - Signed and sealed by Kyle J. Landwehr, P.E. on June 23, 2026.
   - Signed and sealed by Hope M. Drennan, P.E. on June 23, 2026.
   - Signed and sealed by Michael P. Becker, P.E. on June 26, 2026.
   - Signed and sealed by Richard A. Stones, P.E. on June 26, 2026.
   - Signed and sealed by Chad D. Yost, P.E. on June 29, 2026.

3. Regulation 10 CSR 20-4.040(18)(B)1 requires that projects be publicly advertised, allowing sufficient time for bids to be prepared and submitted. Projects should be advertised at least 30 days prior to bid opening.

4. The department must be contacted in writing prior to making any changes to the approved plans and specifications that would directly or indirectly have an impact on the capacity, flow, system layout, or reliability of the proposed wastewater treatment facilities or any design parameter that is addressed by 10 CSR 20-8, in accordance with 10 CSR 20-8.110(11).

5. All changes in contract price or time within the approved scope of work must be by change order in accordance with 10 CSR 20-4.040(19).

6. State and federal law does not permit bypassing of raw wastewater; therefore, steps must be taken to ensure that raw wastewater does not discharge during construction. If a sanitary sewer overflow or bypass occurs, report the appropriate information to the department's electronic Sanitary Sewer Overflow/Bypass Reporting system at https://dnr.mo.gov/mogem/ or Central Field Office per 10 CSR 20-7.015(9)(G).

7. In addition to the requirements for a construction permit, 10 CSR 20-6.200 requires land disturbance activities of 1 acre or more to obtain a Missouri State Operating Permit to discharge stormwater. The permit requires best management practices sufficient to control runoff and sedimentation to protect waters of the state. Land disturbance permits

will only be obtained by means of the department's ePermitting system available online at https://dnr.mo.gov/data-e-services/missouri-gateway-environmental-management-mogem. See https://dnr.mo.gov/data-e-services/water/electronic-permitting-epermitting for more information.

8. A United States Army Corps of Engineers (USACE) Section 404 Department of Army permit (§404) along with the department's Section 401 Water Quality Certification or waiver (§401) may be required for the activities described in this permit. This permit is not valid until these requirements are satisfied. If construction activity will disturb any land below the ordinary high water mark of jurisdictional waters of the U.S., then a §404/§401 will likely be required. Since the USACE makes determinations on what is jurisdictional, you must contact the USACE to determine permitting requirements. See https://dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees/section-401-water-quality for more information or you may contact the department's Water Protection Program at 573-522-4502 or wpsc401cert@dnr.mo.gov.

9. All construction must adhere to applicable 10 CSR 20-8 (Chapter 8) requirements. Some of the requirements include:
   - All screening devices and screening storage areas shall be protected from freezing. 10 CSR 20-8.150(4)(A)1.
   - Provisions shall be made for isolating or removing screening devices from their location for servicing. 10 CSR 20-8.150(4)(A)2.
   - Manually cleaned screen channels shall be protected by guard railings and deck gratings with adequate provisions for removal or opening to facilitate raking. 10 CSR 20 8.150(4)(A)3.A.(I)
   - Flood protection shall apply to new construction and to existing facilities undergoing major modification. The wastewater facility structures, electrical equipment, and mechanical equipment shall be protected from physical damage by not less than the one hundred (100) year flood elevation. 10 CSR 20 8.140(2)(B), 10 CSR 20 8.130(2)(A)
   - Electrical equipment. Electrical equipment shall be provided with the following requirements:
     - 10 CSR 20-8.130(4)(B)2.A. Electrical equipment must comply with 10 CSR 20-8.140(7)(B);
     - Utilize corrosive resistant equipment located in the wet well; 10 CSR 20-8.130(4)(B)2.B.
     - Provide a watertight seal and separate strain relief for all flexible cable; 10 CSR 20-8.130(4)(B)2.C.

- Install a fused disconnect switch located above ground for the main power feed for all pumping stations. 10 CSR 20-8.130(4)(B)2.D.

- When such equipment is exposed to weather, it shall comply with the requirements of weatherproof equipment; enclosure NEMA 4; NEMA 4X where necessary; and *NEMA Standard 250-2014*, published December 15, 2014. 10 CSR 20-8.130(4)(B)2.E.

- Install lightning and surge protection systems; 10 CSR 20-8.130(4)(B)2.F.

- Install a one hundred ten volt (110 V) power receptacle inside the control panel located outdoors to facilitate maintenance; 10 CSR 20-8.130(4)(B)2.G.

- Provide Ground Fault Circuit Interruption (GFCI) protection for all outdoor receptacles. 10 CSR 20-8.130(4)(B)2.H.

- Moving Bed Bioreactor (MBBR). A MBBR secondary treatment system shall provide upstream preliminary treatment units capable of—

  - Screening to reduce pass-through and suspended solids; 10 CSR 20-8.180(8)(A)

  - Grit removal; 10 CSR 20-8.180(8)(B) and;

  - Oil and grease removal. 10 CSR 20-8.180(8)(C)

- Effective flow splitting devices and control appurtenances (*e.g.* gates and splitter boxes) shall be provided to permit proper proportioning of flow and solids loading to each settling unit, throughout the expected range of flows. 10 CSR 20-8.160(2)(B)

- Overflow weirs shall be readily adjustable over the life of the structure to correct for differential settlement of the tank. 10 CSR 20-8.160(3)(C)1.

- Walls of settling tanks shall extend at least 6 inches above the surrounding ground surface and shall provide not less than 12 inches of freeboard. 10 CSR 20-8.160(3)(E)

- Safety features shall appropriately include machinery covers, lifelines, handrails on all stairways and walkways, and slip resistant surfaces. For additional safety follow the provisions listed in 10 CSR 20-8.140(8). 10 CSR 20-8.160(5)(A)

- The design shall provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal mechanism, baffles, weirs, inlet stilling baffle areas, and effluent channels. 10 CSR 20-8.160(5)(B)

- For electrical equipment, fixtures, and controls in enclosed settling basins and scum tanks, where hazardous concentrations of flammable gases or vapors may accumulate, follow the provisions in 10 CSR 20-8.140(7)(B). The fixtures and controls shall be

conveniently located and safely accessible for operation and maintenance. 10 CSR 20-8.160(5)(C)

- Emergency Power. Disinfection and dechlorination processes, when used, shall be provided during all power outages. 10 CSR 20-8.190(2)(A)
- The UV dosage shall be based on the design peak hourly flow, maximum rate of pumpage, or peak batch flow. 10 CSR 20-8.190(5)(A)1.
- The UV system shall deliver the target dosage based on equipment derating factors and, if needed, have the UV equipment manufacturer verify that the scale up or scale down factor utilized in the design is appropriate for the specific application under consideration. 10 CSR 20-8.190(5)(A)3.
- The UV system shall deliver a minimum UV dosage of thirty thousand microwatt seconds per centimeters squared (30,000 $\mu W \cdot s/cm^2$). 10 CSR 20-8.190(5)(A)4.
- The UV system must continuously monitor and display at the UV system control panel the following minimum conditions:
    - The relative intensity of each bank or closed vessel system; 10 CSR 20-8.190(5)(C)1.A.;
    - The operational status and condition of each bank or closed vessel system; 10 CSR 20-8.190(5)(C)1.B.;
    - The ON/OFF status of each lamp in the system; 10 CSR 20-8.190(5)(C)1.C.; and,
    - The total number of operating hours of each bank or each closed vessel system. 10 CSR 20-8.190(5)(C)1.D.
- The UV system shall include an alarm system. Alarm systems shall comply with 10 CSR 20-8.140(7)(C). 10 CSR 20-8.190(5)(C)2.

10. Upon completion of construction:

    A. The Village of Freeburg will become the continuing authority for operation and maintenance of these facilities;

    B. Submit an electronic copy of the as-builts if the project was not constructed in accordance with previously submitted plans and specifications; and

    C. Submit the Statement of Work Completed form (https://dnr.mo.gov/document-search/wastewater-construction-statement-work-completed-mo-780-2155) to the department in accordance with 10 CSR 20-6.010(5)(N) and request the operating permit modification be issued.

IV. REVIEW SUMMARY

1. CONSTRUCTION PURPOSE

The project includes modifications to the existing wastewater treatment system to better meet effluent limitations. The new NitrOx® system will allow for ammonia reduction while the UV disinfection system will help meet *E. coli* limits consistently. Sludge removal will allow for better treatment and help meet new 5-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) limits as well as percent removal.

2. FACILITY DESCRIPTION

The existing facility has a two-cell lagoon where the sludge is retained in the cells. Additions to the wastewater treatment process include a bar screen, air lift structure, Triplepoint NitrOx® system, polishing clarifier, and UV disinfection system. Sludge will be removed from the lagoons. The upgrades will help meet *E. coli*, ammonia, BOD_5, and TSS limits as well as percent removal.

The Freeburg WWTF is located 0.45 miles east of the intersection of Gilbert Avenue and Hwy 63, Freeburg, Missouri, in Osage County. The facility has a design average flow of 100,000 gallons per day (gpd) and serves a hydraulic population equivalent of approximately 1,000 people. The actual average daily flow is closer to 50,000 gpd and the maximum month average daily is estimated to be 65,000 gpd. The treatment system is sized to treat design average flow of 100,000 gpd.

3. COMPLIANCE PARAMETERS

The existing facility can meet BOD_5, TSS, and ammonia weekly and monthly averages. The proposed project is required to meet final effluent limits established in Missouri State Operating Permit No. MO-0058220.

The following limits will be applicable to the facility after construction is completed:

Parameter	Units	Weekly Average Limit/Daily Maximum	Monthly Average Limit
Biochemical Oxygen Demand$_5$	mg/L	45	30
Total Suspended Solids	mg/L	45	30
Ammonia as N (Jan 1 – Mar 31)	mg/L	12.1	3.0
Ammonia as N (Apr 1 – Jun 30)	mg/L	12.1	2.0
Ammonia as N (Jul 1 – Sep 30)	mg/L	12.1	1.5
Ammonia as N (Oct 1 – Dec 31)	mg/L	12.1	2.9
BOD_5 Percent Removal	%	85	85
TSS Percent Removal	%	85	85

4. REVIEW OF MAJOR TREATMENT DESIGN CRITERIA

Existing Components:
Lagoon Cell Nos. 1 and 2 are both aerated. Cell No. 1 has a wastewater volume of 1,238,000 gallons, 7.6 feet (ft) side water depth, and a sludge depth of 1.49 ft. Cell No. 2 has a wastewater volume of 1,410,000 gallons, 7.8 ft side water depth, and a sludge depth of 0.78 ft. This provides approximately 52.97 days of total retention at the proposed design flow.

New Components:

- Bar Screen – The bar screen has a width of 2 ft, depth of 4.61 ft, and a bar spacing of one and a half inch. The screen will be positioned at an angle of 45 degrees from the horizontal to allow for manual raking of the screen.

- Lagoon aerators and blowers – The two lagoons cell will have 12 Ares 750T aerators. Cell No. 1 will be supplied two aerators and Cell No. 2 will have the remaining one. The aerators will supply 164.3 pounds per day of oxygen. Blowers shall be designed to supply a standard air flow of 79.29 standard cubic feet per minute (scfm) per blower. The discharge pressure shall be at least 6.61 pounds per square gauge (psig), and the minimum horsepower (HP) will be 7.5 HP for each blower. There shall be a minimum of two blower units, one for duty and one standby/backup.

- Airlift – Airflow for the primary airlift will be 16.92 cubic feet per minute (cfm) and the secondary airlift will provide 16.92 cfm. The air lifts will push the recycled flow from the clarifier and Cell No. 2 to the NitrOx® unit. The secondary air lift will be accompanied with an 8-inch pipe.

- Triplepoint Water Technologies, LLC NitrOx® – The lagoon-treated effluent will be pumped to the NitrOx® system. The NitrOx® system can treat a design average flow of 50,700 gpd. The system is composed of two tanks with each approximately 8 ft x 8 ft x 15 ft with a sidewater depth of 12 ft. Total volume of the two tanks is 11,489 gallons. The average flow hydraulic retention time is 4.4 hours, and the peak flow hydraulic retention time is 1.1 hours. A floating insulating cover shall be installed in each tank. An immersion tank heater will be installed to maintain a minimum wastewater temperature of 5°C. Each tank shall be filled with high surface area media. Aeration by means of tri-lobe or bi-lobe positive displacement blowers each capable of supplying 85 scfm with 7.5 HP motors. The effluent from the NitrOx® basins will flow by gravity to the clarifier for polishing prior to disinfection and discharge.

- Polishing Clarifier – There will be one polishing clarifier following the NitrOx® treatment. The basin will be 10 ft by 10 ft with approximately 12 ft of sidewater depth. The surface overflow rate at the average daily flow of 50,000 gpd equals 500 gpd per square foot.

- Ultraviolet Disinfection – Disinfection is the process of removal, deactivation, or killing of pathogenic microorganisms. A two bank UV disinfection system with low pressure mercury slimline lamps shall be provided and capable of treating a peak flow of 260,000 gpd while delivering a minimum UV intensity of 30.0 mJ/cm^2 with an expected ultraviolet transmissivity of 47 percent minimum.

- Flowmeters – Installation of an electromagnetic flow measurement device will aid in wastewater service, and will measure the flow from UV disinfection to the outfall.

5. OPERATING PERMIT

Missouri State Operating Permit No. MO-0058220 will require a modification to reflect the construction activities. The modified Freeburg WWTF, MO-0058220, was successfully public noticed from July 2, 2026, to August 3, 2026, with no comments received. When construction has reached substantial completion, submit the Statement of Work Completed to the department in accordance with 10 CSR 20-6.010(5)(N) and request the operating permit modification be issued.

V. NOTICE OF RIGHT TO APPEAL

If you were adversely affected by this decision, you may be entitled to an appeal before the Administrative Hearing Commission (AHC) pursuant to Section 621.250 RSMo. To appeal, you must file a petition with the AHC within 30 days after the date this decision was mailed or the date it was delivered, whichever date was earlier. If any such petition is sent by registered mail or certified mail, it will be deemed filed on the date it is mailed; if it is sent by any method other than registered mail or certified mail, it will be deemed filed on the date it is received by the AHC. Any appeal should be directed to:

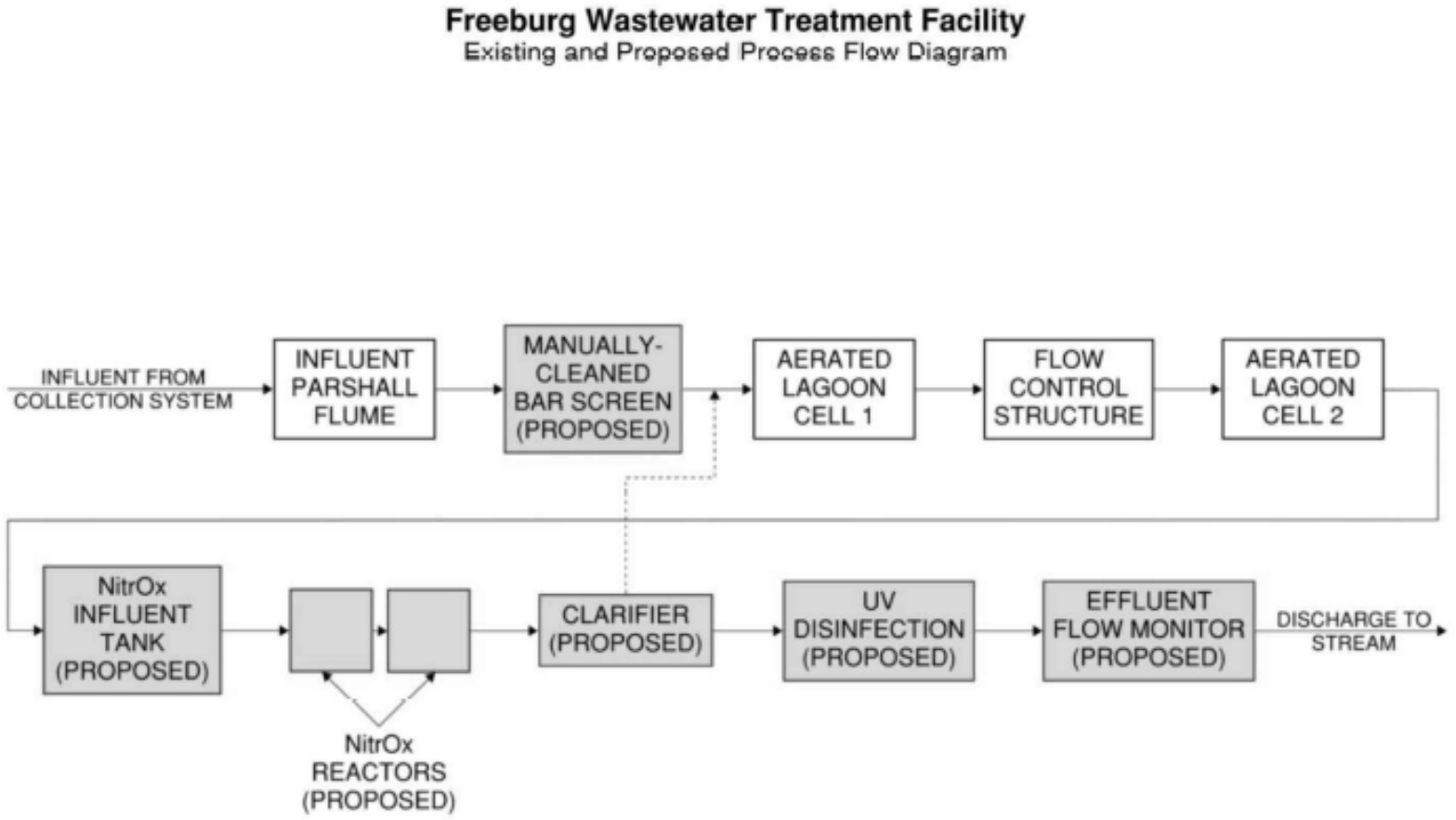
Administrative Hearing Commission
U.S. Post Office Building, Third Floor
131 West High Street, P.O. Box 1557
Jefferson City, MO 65102-1557
Phone: 573-751-2422
Fax: 573-751-5018
Website: https://ahc.mo.gov

Angie Garcia, P.E.
Financial Assistance Center
angie.garcia@dnr.mo.gov

APPENDICES

APPENDIX 1 – PROCESS FLOW DIAGRAM
APPENDIX 2 – SUMMARY OF DESIGN

APPENDIX 1 – PROCESS FLOW DIAGRAM



APPENDIX 2 – SUMMARY OF DESIGN

SUMMARY OF DESIGN

FOR

FREEBURG WASTEWATER IMPROVEMENTS
OSAGE COUNTY, MISSOURI

VILLAGE OF FREEBURG, MISSOURI

KYLE J. LANDWEHR – PROFESSIONAL ENGINEER
LICENSE NO. PE-2023000495

BARTLETT & WEST, INC.
MISSOURI CERTIFICATE OF AUTHORITY NO. 000167-ENGINEERING
601 Monroe Street, Suite 201
Jefferson City, MO 65101
(573) 634-3181

PROJECT NO. 21134.003

DATE PREPARED: OCTOBER 2025

Bartlett&West
Driving Community and Industry Forward, Together.

FREEBURG, MO WWTF DESIGN PARAMETERS			
Plant Flow (Influent to Lagoons)	**VALUE**	**UNITS**	
Dry Weather Average Daily Flow (Based on Flow Monitoring)	42,000	gpd	
Projected 20-Year Dry Weather Average Daily Flow	42,000	gpd	
Maximum Monthly Average Daily Flow (BASIS FOR TREATMENT CALCS) - Permitted Design Flow	50,000	gpd	
Peak Hourly Influent Flow	969,475	gpd	1.5 CFS Peak Discharge into Cell 1 (From HECHMS)
Treatment Throughput Flow	**VALUE**	**UNITS**	
Annual Average Daily Flow	50,000	gpd	
Permitted Design Flow	100,000	gpd	
Maximum Monthly Average Daily Flow		gpd	**Triplepoint to Determine**
Peak Daily Flow		gpd	**Triplepoint to Determine**
Peak Hourly Flow (maximum peak daily hydraulic throughput) - based on attenuation calcs	258,527	gpd	.4 CFS Peak into Triplepoint (From HECHMS)
Influent Loading @ 50,000 gpd	**VALUE**	**UNITS**	
BOD	250	mg/L	
	104.3	lbs/day	
TSS	420	mg/L	
	175.1	lbs/day	
NH3-N	35	mg/L	
	14.6	lbs/day	
TKN	45	mg/L	
	18.8	lbs/day	
Total P	55	mg/L	
	22.9	lbs/day	
Oil & Grease	16	mg/L	
	6.7	lbs/day	
Alkalinity	500	mg/L	
	208.5	lbs/day	
EXISTING LAGOONS			
Cell 1	**VALUE**	**UNITS**	
Lagoon Bottom Elevation	757.80	ft	
Lagoon Bottom Surface Area	2,872	ft^2	
	0.1	acres	
Lagoon Top of Berm Elevation	771.31	ft	
Lagoon Top of Berm Surface Area	38,053.00	ft^2	
Lagoon 2ft Freeboard Elevation	769.00	ft	
Lagoon 2ft Freeboard Surface Area	31,929.00	ft^2	
	0.7	acres	
Max Depth	13.5	ft	Top of burm - bottom elevation
Cell 2	**VALUE**	**UNITS**	
Lagoon Bottom Elevation	758.20	ft	
Lagoon Bottom Surface Area	6,023	ft^2	
	0.1	acres	
Lagoon Top of Berm Elevation	771.10	ft	
Lagoon Top of Berm Surface Area	35,869.00	ft^2	
Lagoon 2ft Freeboard Elevation	769.00	ft	
Lagoon 2ft Freeboard Surface Area	30,299.00	ft^2	
	0.7	acres	
Max Depth	12.9	ft	Top of burm - bottom elevation
PERMITTED/ANTICIPATED PLANT EFFLUENT LIMITS	**VALUE**	**UNITS**	

Permitted Average Daily Flow	100,000	gpd	
BOD Monthly Average	45	mg/L	
BOD Weekly Average	30	mg/L	
TSS Monthly Average	45	mg/L	
TSS Weekly Average	30	mg/L	
NH3-N Maximum Daily Limit (January)	12.1	mg/L	ammonia limits should be calculated in PER report.
NH3-N Monthly Average Limit (January)	3.1	mg/L	
NH3-N Maximum Daily Limit (February)	10.1	mg/L	
NH3-N Monthly Average Limit (February)	2.7	mg/L	
NH3-N Maximum Daily Limit (March)	12.1	mg/L	
NH3-N Monthly Average Limit (March)	3.1	mg/L	
NH3-N Maximum Daily Limit (April)	12.1	mg/L	
NH3-N Monthly Average Limit (April)	2.7	mg/L	
NH3-N Maximum Daily Limit (May)	12.1	mg/L	
NH3-N Monthly Average Limit (May)	2.2	mg/L	
NH3-N Maximum Daily Limit (June)	12.1	mg/L	
NH3-N Monthly Average Limit (June)	1.7	mg/L	
NH3-N Maximum Daily Limit (July)	12.1	mg/L	
NH3-N Monthly Average Limit (July)	1.5	mg/L	
NH3-N Maximum Daily Limit (August)	12.1	mg/L	
NH3-N Monthly Average Limit (August)	1.3	mg/L	
NH3-N Maximum Daily Limit (September)	12.1	mg/L	
NH3-N Monthly Average Limit (September)	1.8	mg/L	
NH3-N Maximum Daily Limit (October)	12.1	mg/L	
NH3-N Monthly Average Limit (October)	2.5	mg/L	
NH3-N Maximum Daily Limit (November)	12.1	mg/L	
NH3-N Monthly Average Limit (November)	3.1	mg/L	
NH3-N Maximum Daily Limit (December)	12.1	mg/L	
NH3-N Monthly Average Limit (December)	3.1	mg/L	
E-Coli Weekly Average (#/100 mL)	1030	#	these should be in current permit, won't change
E-Coli Monthly Average (#/100 mL)	206	#	
Oil & Grease Daily Maximum	15	mg/l	these should be in current permit, won't change
Oil & Grease Monthly Average	10	mg/L	
pH (min)	6.5	SU	these should be in current permit, won't change
pH (max)	9	SU	

ACTUAL LAGOON EFFLUENT (8/3/2022 AND 8/5/2022 GRAB SAMPLES)	VALUE	UNITS
BOD 8/5/2022	31	mg/L
BOD 8/3/2022	46	mg/L
TSS 8/5/2022	31	mg/L
TSS 8/3/2022	44	mg/L
NH3-N 8/5/2022	0.6	mg/L
NH3-N 8/3/2022	4.04	mg/L
TKN 8/5/2022	5.0	mg/L
TKN 8/3/2022	8.02	mg/L
TOTAL PHOSPHORUS 8/5/2022	19.20	mg/L
TOTAL PHOSPHORUS 8/3/2022	19.4	mg/L
ALKALINITY 8/5/2022	246.0	mg/L
ALKALINITY 8/3/2022	267	mg/L
E. COLI 8/5/2022	2420	#/100 mL
E. COLI 8/3/2022	2420	#/100 mL
HEXANE 8/5/2022	7	mg/L
HEXANE 8/3/2022	7	mg/L

ACTUAL LAGOON EFFLUENT (EDMRs 2017-2022)				
Dates	PH	BOD (mg/L)	TSS (mg/L)	NH3 (mg/L)
3/31/2017	8.20	13	16	24.90
6/30/2017	7.80	17	29	2.00
10/31/2017	7.40	39	17	0.800
1/31/2018	7.30	19	50	7.000
5/31/2018	7.50	35	15	0.800
8/31/2018	7.50	16	35	2.000
12/31/2019	6.70	14	13	23.80
6/30/2020	6.80	41	43	12.90
12/31/2020	6.80	13	41	4.60
3/31/2021	6.80	19	46	3.60
6/30/2021	6.70	88	76	3.90
3/31/2022	6.70	20	48	23.50
6/30/2022	6.70	18	10	1.60

Ares Aeration® & NitrOx® Basis of Design

Date: 03-18-2025
Project Name: Freeburg, MO
Project Number: cd27748

The Aeration Process

Biological Oxygen (BOD) Calculations

Removal of BOD (and CBOD) takes place naturally in an aerated lagoon. The Characteristic Equation for treatment efficiency of 5-Day Biological Oxygen Demand is given in Equations 1 through 3, at the bottom of this report. These calculations are used to size the lagoons. They are independent of the aeration calculations and assume that sufficient dissolved oxygen levels are maintained in the water. The equation is dependent on time and temperature. For lagoons operated in series, the equation is applied separately to each cell and the results are combined.

Aeration Requirement Calculations

Aeration calculations are more complicated than biological calculations as they depend on several factors. These include:

- Site conditions, such as treatment depth, elevation, and temperature.
- Design parameters, such as minimum dissolved oxygen (DO) level and oxygen supply rate.
- Actual Oxygen Requirement (AOR), which is based on the nutrient loading rates (these can include BOD/CBOD and TKN/NH_3-N and are based on the product of nutrient concentrations and the wastewater flowrate).
- Type of aerator.
- Oxygen transfer efficiency (OTE) of the aerator, which should be measured by an independent lab.
- Field condition adjustments (see Equation 2, below).
- Mixing requirements, such as complete or partial mix. The former is generally only required for activated sludge basins (ASB) or other high strength processes with short detention times.

Aerated Lagoons—Long Treatment Times

Aerated lagoons are typified by their comparatively large size and long treatment times (usually greater than 10 days). Influent concentrations are low to moderate (usually less than 300 mg/L of BOD). The bulk of the treatment takes place aerobically with additional anaerobic respiration taking place on the lagoon floor. Aerated lagoons do not generally have a mixed liquor suspended solids (MLSS) or return activated sludge (RAS) component. Partial mixing is required to prevent stratification and eliminate dead zones; however, complete mix is not necessary.

Aerated lagoons are typically designed to operate at a minimum DO level of 2 mg/L. Oxygen is usually supplied at a rate of 1.5 times the BOD demand. If nitrification/denitrification takes place, the oxygen supply rate is designed for 4.6 times the nitrogenous oxygen demand (NBOD).

Activated Sludge Basins (ASB)

Activated sludge basins (ASB) and other related wastewater tanks and lagoons are characterized by short treatment times (usually from 1 to 5 days), high wastewater strengths, and an active biomass that must be maintained in suspension to prevent rapid sludge accumulation. A high strength (greater than 2,000 mg/L) return activated sludge (RAS) component is usually fed back into the basin from a downstream clarifier. Biological nutrient removal is much faster in these basins.

ASBs are typically designed to operate at a minimum DO level of 1 to 2 mg/L. Oxygen is supplied at a rate of 1.0 to 1.5 times the BOD demand. If nitrification/denitrification takes place, the oxygen supply rate is designed for 4.0 to 4.6 times the nitrogenous oxygen demand (NBOD). An aeration system is based on both oxygenation requirements and complete mix requirements, whichever is greater.

TRIPLEPOINT ENVIRONMENTAL

Detailed Design Calculations: Aerated Lagoons

SUMMARY - General Design Parameters

v4.6.1	C	Design Scenario Name		Design
	1	Influent Flowrate	MGD	0.05
	3	Influent Concentration	mg/L	250.0
	4	Effluent Conc. (Summer)	mg/L	3.5
	5	Effluent Conc. (Winter)	mg/L	11.2
	6	Actual Oxygen Supplied	lb/day	164.3
	7	Air included for nitrification?		No
	8	Number of Aerators		3
	9	Estimated Tubing Length	ft	300
	10	Standard Airflow	SCFM	79.29
	11	Inlet Airflow	ICFM	93.00
	12	Design Pressure (w/cushion)	psig	6.62
	13	Projected Brake Hp	bhp	3.34
	14	Estimated Design Hp	hp	7.5

1. $FTE = \alpha\ (SOTE)\ \theta^{[T-20]}\ (\beta\ C^*_{-T} - DO) \div C^*_{-20}$ *field transfer efficiency*

   Where,

α	contaminant factor {contaminants, depth, bubble size} (range: 0.40–0.70)
β	TDS factor {total dissolved solids} (range: 0.90–1.00)
$\theta = 1.024$	temperature factor
DO	target dissolved oxygen level (mg/L)
C^*_{-T}	saturation oxygen concentration at site—adjusted for water depth
C^*_{-20}	sat. oxygen concentration at STP conditions—adjusted for water depth
T	water temperature (Celsius)

2. $Airflow = AOR / (25.056 * FTE)$
3. $E = 2.3 * k * t / (1 + 2.3 * k * t)$ *biological treatment efficiency*

   Where,

k = varies	kinetic coefficient {related to temperature} (range: 0.06 to 0.12)
t = time	treatment time in days

SUMMARY - Biological Treatment Calculations				
	Item	Description	Units	Design
	1	Number of Treatment Cells		2
	2	Flow Regime		Series
	3	Site Elevation - HWL	ft	769
Cell 1				
	4	Wastewater Flowrate	MGD	0.05
	5	Treatment Volume	M-Gal	1.238
	6	Treatment Time	days	24.76
	7	Treatment Type	-	Partial Mix
	8	Std Reaction Rate, k_{20}	$days^{-1}$	0.28
Summer	9	Design Water Temp	°C	20
	10	Design Reaction Rate, k_T	$days^{-1}$	0.122
	11	Biological Treatment Eff.	%	87.4%
	12	Influent BOD Loading	lb/day	104
	13	Influent BOD Concentration	mg/L	250.0
	14	BOD Removed	lb/day	91
	15	Effluent BOD Loading	lb/day	13
	16	Effluent BOD Concentration	mg/L	31.5
Winter	17	Design Water Temp	°C	0.5
	18	Design Reaction Rate, k_T	$days^{-1}$	0.061
	19	Biological Treatment Eff.	%	77.7%
	20	Influent BOD Loading	lb/day	104
	21	Influent BOD Concentration	mg/L	250.0
	22	BOD Removed	lb/day	80.9
	23	Effluent BOD Loading	lb/day	23
	24	Effluent BOD Concentration	mg/L	55.8
	N1	Influent NBOD Loading	lb/day	19
	N2	Influent NBOD Conc.	mg/L	44.9
	N3	Assumed NBOD Removed	lb/day	-
	N4	Effluent NBOD Loading*	lb/day	19
	N5	Assumed Eff. NBOD Conc.	mg/L	45
Cell 2				
	25	Wastewater Flowrate	MGD	0.05
	26	Treatment Volume	M-Gal	1.41
	27	Treatment Time	days	28.21
	28	Treatment Type	-	Partial Mix
	29	Std Reaction Rate, k_{20}	$days^{-1}$	0.28
Summer	30	Design Water Temp	°C	20
	31	Design Reaction Rate, k_T	$days^{-1}$	0.122
	32	Biological Treatment Eff.	%	88.8%
	33	Influent BOD Loading	lb/day	13
	34	Influent BOD Concentration	mg/L	31.5
	35	BOD Removed	lb/day	12
	36	Effluent BOD Loading	lb/day	1
	37	Effluent BOD Concentration	mg/L	3.5
Winter	38	Design Water Temp	°C	0.5
	39	Design Reaction Rate, k_T	$days^{-1}$	0.061
	40	Biological Treatment Eff.	%	79.9%
	41	Influent BOD Loading	lb/day	23
	42	Influent BOD Concentration	mg/L	55.8
	43	BOD Removed	lb/day	18.6
	44	Effluent BOD Loading	lb/day	5
	45	Effluent BOD Concentration	mg/L	11.2
	N6	Influent NBOD Loading	lb/day	19
	N7	Influent NBOD Conc.	mg/L	44.9
	N8	Assumed NBOD Removed	lb/day	-
	N9	Effluent NBOD Loading*	lb/day	19
	N10	Assumed Eff. NBOD Conc.	mg/L	45

SUMMARY - Aeration Calculations				
	Item	Description	Units	Design
	1	Site Elevation	ft	769
	2	O_2 Loading Factor (BOD_5)	O2/BOD	1.5
	3	Alpha-value, α		0.60
	4	Beta-value, β		0.95
	5	Theta-value, θ		1.02
Cell 1				
	6	Lagoon Side Water Depth	ft	11.20
	7	Air Release Depth	ft	10.45
	8	AOR - Total	lb/day	136
	9	SOTE/ft	%/ft	2.01%
	10	SOTE	%	21.04%
	11	Design DO Concentration	mg/L	2.0
	12	FTE		8.32%
	13	Air requirement	scfm	65
	14	Airflow per aeration unit	scfm	32.7
	15	Aerator Type		750T
	16	Number of aeration units	units	2
	17	Water Pressure	psig	4.52
	18	Aerator Pressure Loss	psig	0.55
	19	Header/Feeder P Loss	psig	0.55
	20	Total Operating Pressure	psig	5.62
	21	Design Motor Pressure	psig	6.62
Cell 2				
	22	Lagoon Side Water Depth	ft	10.80
	23	Air Release Depth	ft	10.05
	24	AOR - Total	lb/day	28
	25	SOTE/ft	%/ft	2.02%
	26	SOTE	%	20.33%
	27	Design DO Concentration	mg/L	2.0
	28	FTE		8.03%
	29	Air requirement	scfm	14
	30	Airflow per aeration unit	scfm	13.8
	31	Aerator Type		750T
	32	Number of aeration units	units	1
	33	Water Pressure	psig	4.35
	34	Aerator Pressure Loss	psig	0.55
	35	Header/Feeder P Loss	psig	0.71
	36	Total Operating Pressure	psig	5.61
	37	Design Motor Pressure	psig	6.61

The NitrOx® Process

The patented NitrOx Process was developed based on the principle that nitrification will reliably occur when the proper conditions are created. For wastewater lagoon systems that receive primarily domestic waste, the critical conditions required for nitrification include:

- CBOD of 20–30 mg/L
- Dissolved Oxygen of 4.6 lb/O2 per pound of NH3-N (Metcalf & Eddy)
- Sufficient population of Nitrifying bacteria
- Given sufficient Nitrifying bacteria, a water temperature of 4–5° C

The NitrOx Process utilizes the existing lagoon infrastructure for 90% BOD removal, after which nitrifying bacteria begin to nitrify. The effluent from the lagoons then flows hydraulically or is pumped into a two-stage nitrification reactor. In colder climates where the winter water temperature drops below 4° C, a thermal regulation heat exchanger is added in order to increase the water temperature; typically, only a few degrees during the coldest months of the year. In the two NitrOx Reactor cells, there are millions of individual biofilm carriers that provide a habitat for nitrifying bacteria, ensuring that there are sufficient nitrifying bacteria even in the coldest water conditions. Each NitrOx Reactor cell has aeration to provide the necessary oxygen, as well as to create a complete mix environment to keep the biofilm carriers in constant motion. The two cells are covered with floating insulated covers to mitigate heat loss and the media is kept in the tanks with stainless steel sieves. Finally, the effluent from the second NitrOx Reactor is discharged into a final polishing/clarification lagoon prior to the ultimate discharge from the lagoon system.

NitrOx® LAGOON AMMONIA REMOVAL

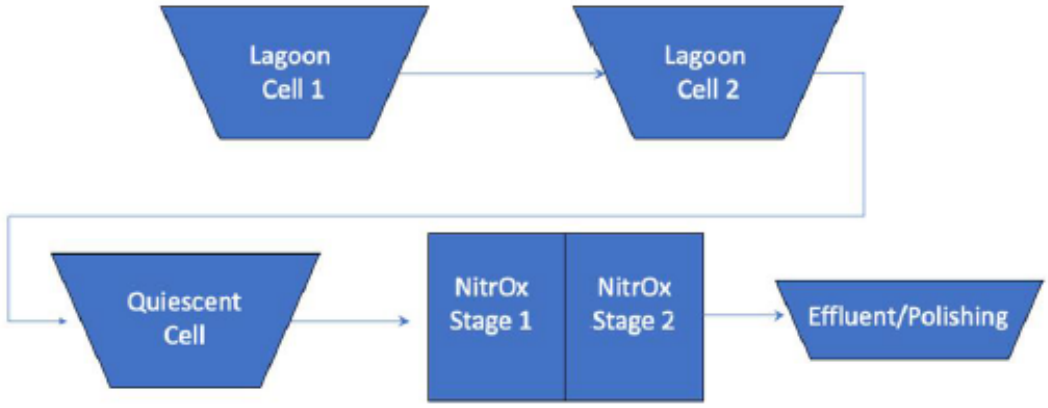


Figure 1: Typical flow process of the NitrOx Lagoon Ammonia Removal Process.
*Note that other configurations are possible.

TRIPLEPOINT ENVIRONMENTAL
Detailed Design Calculations: NitrOx

	SUMMARY - Design Input Values		
	Plant Influent Characteristics	**Units**	**Values**
1	Annual Average Daily Flow	gpd	50,000
2	Maximum Monthly Average Daily Flow	gpd	62,500
3	Peak Daily Flow	gpd	150,000
4	Peak Hourly Flow	gpd	969,475
5	Influent BOD	mg/L	250
6	Influent BOD	lbs/day	130.3
7	Influent TSS	mg/L	420
8	Influent TSS	lbs/day	218.9
9	Influent NH3-N	mg/L	35.0
10	Influent NH3-N	lbs/day	18.2
11	Influent TKN	mg/L	45.0
12	Influent TKN	lbs/day	23.5
A1	Influent NOx-N	mg/L	0.0
A2	Influent NOx-N	lbs/day	0.0
13	Influent pH		7
14	Water Temperature	deg-C	12
	NitrOx Influent Characteristics	**Units**	**Values**
15	Annual Average Daily Flow	gpd	50,000
16	Maximum Monthly Average Daily Flow	gpd	62,500
17	Peak Daily Flow	gpd	106,250
18	Peak Hourly Flow	gpd	258,527
19	Influent BOD	mg/L	15
20	Influent TSS	mg/L	30
21	Influent NH3-N	mg/L	25.6
22	Influent TKN	mg/L	35.6
23	Design Influent NH3-N	mg/L	35.6
A3	Design Influent NOx-N	mg/L	0
A4	Alkalinity Required as CaCO3 (Minumum)	mg/L	285
24	Influent pH		7
25	NitrOx Water Temperature	deg-C	5

	SUMMARY - General Design Parameters		
	NitrOx Tank Sizing Summary	**Units**	**Values**
26	Number of Treatment Trains Proposed		1
27	Number of Tanks Per Train		2
28	Total Number of Tanks		2
29	Length of Each	ft	8.0
30	Width of Each	ft	8.0
31	Side Water Depth of Each	ft	12
32	Tank Height of Each	ft	15
33	Volume of Each	gallons	5,745
34	Volume Total	gallons	11,489
35	Hydraulic Retention Time at Max Month Flow	hours	4.4
36	Hydraulic Retention Time at Peak Hourly Flow	hours	1.1
41	Number of Ares Units per Tank		1
42	Total Number of Ares Units		2

	NitrOx Air Requirement (Per Treatment Train)	Stage 1	Stage 2
43	AOR (lbs/day)	48	48
44	Assumed Diffuser Subm. at AWL (ft.)	11.25	11.25
45	Elevation (ft.)	769	769
46	Alpha	0.70	0.70
47	Beta	0.95	0.95
48	Target DO Residual (MBBR Process) (mg/L)	5.0	5.0
49	SOR (lbs/day)	150	150
50	Target Diffuser Efficiency/ft. Submergence	2.2	2.2
51	**Airflow (scfm)**	**24**	**24**

	NitrOx Blower Requirement Summary	Units	Values
52	No. of Blowers (Includes one redundant)		2
53	Airflow Requirement per Blower (Inc. Airlift)	scfm	85
54	Airflow per 1,000 scfm	scfm/1,000 cf	32
55	Water Pressure at Air Release Depth	psig	4.87
56	Piping and Diffuser Losses	psig	1.50
58	**Maximum Design Discharge Pressure**	**psig**	**6.37**
59	Assumed Overall Efficiency		0.62
60	Approximate BHP Requirement/Blower	bhp	3.7
61	Approximate BHP Requirement Total	bhp	3.7
62	Estimated Nameplate HP / Blower	hp	7.5
63	Blower Type		Tri-Lobe PD

SUMMARY - Calculated Output Values

	NitrOx Effluent Parameters	Units	Values
64	Effluent SCBOD	mg/L	7.5
65	Effluent SCBOD	lbs/day	3.9
66	Effluent NH3-N in Winter (Monthly Average)	mg/L	2.7
67	Effluent NH3-N in Winter (Monthly Average)	lbs/day	1.4
68	Effluent NH3-N in Summer (Monthly Average)	mg/L	1.3
69	Effluent NH3-N in Summer (Monthly Average)	lbs/day	0.7

Freeburg Primary Air Lift Calculations (258,527 GPD)

Enter data in green cells only

Pumping rate	258,527	gallon/day
Pipe diameter	4.03	inch
submergence	7.93	ft
lift	2.12	ft
% submergence	79%	

Input data

cross-sectional area of pipe	0.088	ft2
Pipe volume	0.70	ft3
Pipe volume/cu.ft.	7.48	gallon
Vl (Flow rate)	179.53	GPM
A (Pipe area)	0.088	ft2
L (Lift)	2.1	ft
D (Pipe diameter)	4.026	inch
Lf (density of fluid)	62.4	lb/ft3
S (submergence)	7.93	ft
Lg (Gas density)	0.0765	lb/ft3
Value of Ordinate	112,074	1.12E+05
Value of Abscissa	100<Y<10,225	14.29
	10,225<Y<73,637	13.23
	73,637<Y<117,690	15.91
	117,690<Y<123,645	12.37
	123,645<Y<128,308	2.49
	128,308<Y<99,018	24.58
Graph reading	15.91	

Don't change anything

Vg (Gas flow)	16.92	ft3/min
Pressure	3.43	psi

Answer

Calculations for an air lift assembly

Results from left	
gal/day	258,527
gal/hr	10771.96
gal/min	179.53

Calculate needed gals/day	
4166.667	gal/hr
100,000	gal/day

Calculation of maximum air lift pump capacity

total length	10.83	feet	330.0984	cm	feet of water	7.2561
submergence	67	%	0.67		feet of rise	3.5739
pipe diameter	4.03	inches	10.2362	cm		
water flow	472.148	liter/min	124.742	gal/min	179,627.85	gal/day

optimal air flow range for these parameters

8%	437.17	liter/min	15.43	cfm
9%	433.16	liter/min	15.29	cfm
pressure	3.14	PSI		

Freeburg Secondary Air Lift Calculations (258,527 GPD)

Enter data in green cells only

Pumping rate	258,527	gallon/day
Pipe diameter	4.03	inch
submergence	9.38	ft
lift	2.62	ft
% submergence	78%	

Input data

cross-sectional area of pipe	0.088	ft2
Pipe volume	0.83	ft3
Pipe volume/cu.ft.	7.48	gallon
Vl (Flow rate)	179.53	GPM
A (Pipe area)	0.088	ft2
L (Lift)	2.6	ft
D (Pipe diameter)	4.026	inch
Lf (density of fluid)	62.4	lb/ft3
S (submergence)	9.38	ft
Lg (Gas density)	0.0765	lb/ft3
Value of Ordinate	107,212	1.07E+05
Value of Abscissa	100<Y<10,225	13.49
	10,225<Y<73,637	12.52
	73,637<Y<117,690	14.31
	117,690<Y<123.645	8.58
	123,645<Y<128,308	0.84
	128,308<Y<99,018	21.75
Graph reading	14.31	

Don't change anything

Vg (Gas flow)	16.92	ft3/min
Pressure	4.06	psi

Answer

Calculations for an air lift assembly

Results from left	
gal/day	258,527
gal/hr	10771.96
gal/min	179.53

Calculate needed gals/day	
4166.667	gal/hr
100,000	gal/day

Calculation of maximum air lift pump capacity

total length	10.83	feet	330.0984	cm	feet of water	7.2561
submergence	67	%	0.67		feet of rise	3.5739
pipe diameter	4.03	inches	10.2362	cm		
water flow	472.148	liter/min	124.742	gal/min	179,627.85	gal/day

optimal air flow range for these parameters

8%	437.17	liter/min	15.43	cfm
9%	433.16	liter/min	15.29	cfm
pressure	3.14	PSI		

CHECK OF FREEBURG PROJECT

Evaporation in Inches per Month												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total from MO Atlas
0.00	0.00	0.00	3.99	4.94	5.99	6.52	5.98	4.54	3.42	0.84	0.28	36.5 (FIGURE 152 of ATLAS)
Average Rainfall in Inches per Month												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1.80	2.10	3.10	3.80	4.80	4.10	3.80	3.60	3.80	3.40	3.80	2.80	40.90 (MONTHLY DATA IS IN FIGURES 3 THROUGH 1
Net Rainfall in Inches per Month												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1.80	2.10	3.10	-0.19	-0.14	-1.89	-2.72	-2.38	-0.74	-0.02	2.96	2.52	4.40

Freeburg Lagoon Cell 1 Surface Area: 37,694.00 ft^2

FreeburgLagoon Cell 2 Surface Area: ft^2 Not considering cell 2 because it is downstream of the tripepoint system

Average Daily Dry Weather Flow (ADF): 34876.80 gallons per day

Net Gallons into Lagoon (without consideration of collection system I&I) (AVERAGE YEAR)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
days/month:	31	28	31	30	31	30	31	31	30	31	30	31
Gallons per Month:	1,123,473	1,025,892	1,154,018	1,041,822	1,077,928	1,002,001	1,017,247	1,025,333	1,028,903	1,080,640	1,115,768	1,140,389
Gallons per Day:	36,241	36,639	37,226	34,727	34,772	33,400	32,814	33,075	34,297	34,859	37,192	36,787

Average Rainfall in Inches per Month (1 in 10 driest year)*												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total from MO Atlas
1.36	1.59	2.35	2.88	3.64	3.11	2.88	2.73	2.88	2.58	2.88	2.12	31
Net Rainfall in Inches per Month												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1.36	1.59	2.35	-1.11	-1.30	-2.88	-3.64	-3.25	-1.66	-0.85	2.04	1.84	-5.50

*per month values figure from per month per applied to total inches for 1 in 10 driest year

Net Gallons into Lagoon (without consideration of collection system I&I) (1 in 10 Driest Year)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
days/month:	31	28	31	30	31	30	31	31	30	31	30	31
Gallons per Month:	1,113,236	1,013,949	1,136,388	1,020,211	1,050,629	978,683	995,635	1,004,859	1,007,291	1,061,303	1,094,156	1,124,465
Gallons per Day:	35,911	36,212	36,658	34,007	33,891	32,623	32,117	32,415	33,576	34,236	36,472	36,273

Design Flow: 43,750 GPD

Percentage of Design Flow: 73.41% Tripepoint reccomends

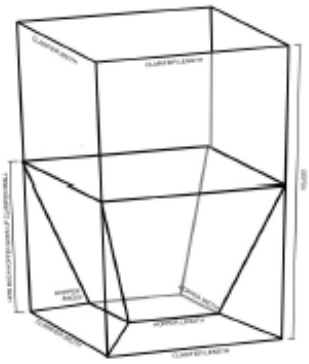
Average Rainfall in Inches per Month (Drought)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Net Rainfall in Inches per Month												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
0.00	0.00	0.00	-3.99	-4.94	-5.99	-6.52	-5.98	-4.54	-3.42	-0.84	-0.28	

Net Gallons into Lagoon (without consideration of collection system I&I) (in drought conditions)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
days/month:	31	28	31	30	31	30	31	31	30	31	30	31
Gallons per Month:	1,081,181	976,550	1,081,181	952,538	965,148	905,668	927,962	940,748	939,618	1,000,753	1,026,483	1,074,600
Gallons per Day:	34,877	34,877	34,877	31,751	31,134	30,189	29,934	30,347	31,321	32,282	34,216	34,665

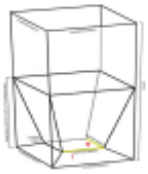
If these flows were negative, we may consider the impact of extreme

Indicates user entry
Indicates Calculated Value (do not edit formula)

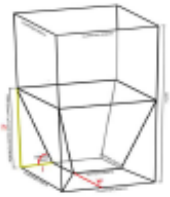
Clarifier Sizing Length and width dimension must match for volume calculations to be correct in this tab. The equations for the hopper corners are based on right triangular pyramids, and additional calculations are necessary if perfect right angles do not exist (length/width dimensions differ)		
length (l)	10.00	ft
width (w)	10.00	ft
depth (d)	11.00	ft



Hopper Bottom Dimensions Length and Width Dimensions must match for volume calculations to be correct in this tab.		
length (l)	4.50	ft
width (w)	4.50	ft



Height of Hopper on Side Walls			check on width
Length between Hopper and Side Wall (l)	2.75	ft	2.75
Angle of Hopper	60.00	deg	60.00
Height hopper goes up the the Wall (h)	4.76	ft	4.76
			OK



Volume of Hopper Rectangle		
length (l)	4.50	ft
width (w)	4.50	ft
height (h)	4.76	ft
Volume	96.43	ft^3

Volume of Hopper Right Triangular Prism		
base length (b)	2.75	ft
prism length (l)	4.50	ft
height (h)	4.76	ft
Volume Per Prism	29.47	ft^3
Total Volume (4 Prisms)	117.89	ft^3

Volume of Hopper Right Triangular Pyramids		
Triangle base length (b)	2.75	ft
Triangle height (h)	2.75	ft
Pyramid Length (l)	4.76	ft
Volume Per Pyramid	6.00	ft^3
Total Volume (4 Pyramids)	48.08	ft^3

Volume of Clarifier Above Hopper		
length (l)	10.00	ft
width (w)	10.00	ft
height (h)	7.24	ft
Volume	723.86	ft^3

Usable Volume Summary		
Volume of Hopper	262.37	ft^3
Volume above Hopper	723.86	ft^3
Total Usable Volume	986.24	ft^3

DOUBLE CHECK USING ONLINE CALCULATOR HERE: https://www.omnicalculator.com/physics/rectangular-pyramid-volume#volume-equation

	Design Average Daily Flow	Design Average Daily Flow (with 1 Q return)	Peak Flow	Peak Flow (with 1Q return)
Q(gal/day)	50,000	100,000	258,527	308,527
SOR (gpd/ft2)	500.00	1,000.00	2,585.27	3,085.27
DT (hours)	3.54	1.77	0.68	0.57
WOR (gpd/ft)	2,500.00	5,000.00	12,926.35	15,426.35
SLR (lb/day/ft2)	0.13	0.25	0.65	0.77

USER INPUT

Conversions	
1 ft3	7.48052 gal

CLARIFIER	
length (ft)	10.00
width (ft)	10.00
depth (ft)	12.00
area(ft^2)	100.00
volume(ft^3)	1,200.00
volume(gal)	8,976.62
TSS(mg/L)	30.00

Nitrox Tank	
Nitrox Tank length	8
Nitrox Tank width	8
Nitrox Tank sidewater depth	12

USABLE CLARIFIER	
volume(ft^3)	986.06
volume(gal)	7,376.21

SOR	Surface Overflow Rate	Design Flow = 1,200 gpd/ft2 Minimum = 800 gpd/ft2 Maximum = 3,000 gpd/ft2	10 CSR 20-8.160 (3) (B) 2
DT	Dentention Time	Minimum = 1.5 hours Maximum = 2.5 hours	Civil Engineering Reference Manual
WOR	Weir Overflow Rate	Maximum = 20,000 gpd/ft	10 CSR 20-8.160 (3) (C)
SLR	Solids Loading Rate	Typical Min = 0.8 lb/day/ft2 Typical Max = 1.2 lb/day/ft2	Metcalf & Eddy Table 8-34 (pg 890 - 5th Edition (Blake's Book))
**this is not a requirement we are super concerned with - generally applies to clarifiers following activated sludge			
SWD	Side Water depth	Minimum = 12 ft Maximum = 20 ft	Metcalf and Eddy (pg 837 - 4th Edition (Kyle's Book))

Bartlett & West

Project No. 21134.003
Project: Freeburg Wastewater System Improvements
Subject: Weir Trough Design
Location: Freeburg

Weir Trough Orifice Discharge Calculations

Orifice calcs:

Equations Used:

$$Q_o = C_o A_o \sqrt{2g(H - E_o)}$$

Q_o = orifice outflow
C_o = orifice discharge coefficient
g = acceleration due to gravity 32.2 ft/s²
A_o = net opening area = $\pi d^2/4$
H = water Elevation

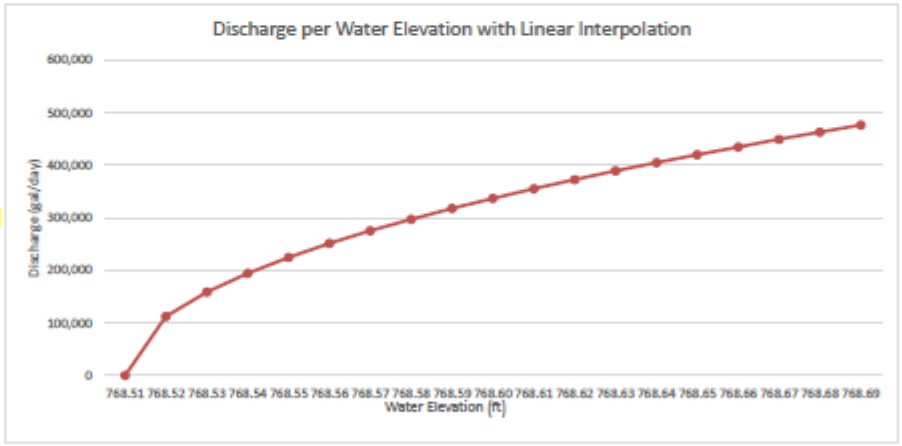
C_o = 0.62

Weir Saw Tooth Elevation: 769.01 peak flow plus 1Q:
dimension to bottom of trough (in): 6 verify with jetincorp cut sheet

#1:

FL orifice = 768.51 ft (assuming hole in bottom of weir trough)
Number of orifices = 1
Diameter of Orifice = 8 in

Water Elevation (ft)	H (ft)	Q (cfs)	Q (gpd)	H (in)	
768.51	0.00	0.00	0	0.00	
768.52	0.01	0.17	112,242	0.12	ADF
768.53	0.02	0.25	158,735	0.24	
768.54	0.03	0.30	194,410	0.36	
768.55	0.04	0.35	224,485	0.48	
768.56	0.05	0.39	250,982	0.60	peak
768.57	0.06	0.43	274,937	0.72	peak
768.58	0.07	0.46	296,966	0.84	
768.59	0.08	0.49	317,470	0.96	peak + 1Q
768.60	0.09	0.52	336,727	1.08	
768.61	0.10	0.55	354,942	1.20	
768.62	0.11	0.58	372,266	1.32	
768.63	0.12	0.60	388,819	1.44	
768.64	0.13	0.63	404,696	1.56	
768.65	0.14	0.65	419,973	1.68	
768.66	0.15	0.67	434,713	1.80	
768.67	0.16	0.69	448,970	1.92	
768.68	0.17	0.72	462,788	2.04	
768.69	0.18	0.74	476,205	2.16	



Bartlett & West

Project No. 21134.003
Project: Freeburg Wastewater System Improvements
Subject: Weir Trough Design
Location: Freeburg

Clarifier Weir using the Kindsvater-Shen equation

CLARIFIER WEIR:

Inputs:

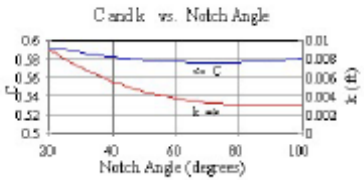
Q_{min} (MGD):	0		
Q_{max} (MGD):	0.258527		
Θ (degrees)	90		
spacing between v notch weirs (in):	6		
length of weir (ft):	20		
Elevation of v-notch weir opening (ft):	769.01	DS Weir HGL +6"	767.8116
Total opening height of each v-notch weir (in):	3.00		

Outputs:

C:	0.5779049
k (ft):	0.0029025
Number of v notch weirs:	40

$$Q = 4.28\, C \tan\left(\frac{\theta}{2}\right)(h+k)^{5/2}$$

where Q = Discharge (cfs)
C = Discharge Coefficient
θ = Notch Angle
h = Head (ft)
k = Head Correction Factor (ft)



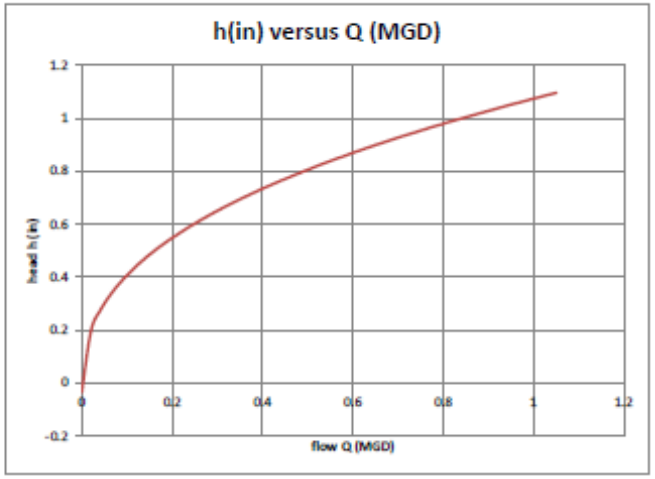
$$C = 0.607165052 - 0.000874466963\,\emptyset + 6.10393334\times10^{-6}\,\emptyset^2$$

$$k\,(ft.) = 0.0144902648 - 0.00033955535\,\emptyset + 3.29819003\times10^{-6}\,\emptyset^2 - 1.06215442\times10^{-8}\,\emptyset^3$$

where Ø is the notch angle in degrees

Q vs h table:

Q (MGD)	Q (gpm)	h (ft)	h(in)	WSE (ft)	
0.000	0.00	-0.0029	-0.03	769.01	
0.005	3.59	0.0202	0.24	769.03	
0.010	7.18	0.0275	0.33	769.04	
0.016	10.77	0.0329	0.39	769.04	
0.021	14.36	0.0373	0.45	769.05	
0.026	17.95	0.0410	0.49	769.05	
0.031	21.54	0.0443	0.53	769.05	
0.036	25.13	0.0473	0.57	769.06	(low diurnal pattern of dry weather flow)
0.041	28.73	0.0501	0.60	769.06	(low diurnal pattern of dry weather flow)
0.047	32.32	0.0527	0.63	769.06	(ADF)
0.052	35.91	0.0551	0.66	769.07	
0.057	39.50	0.0573	0.69	769.07	
0.062	43.09	0.0594	0.71	769.07	
0.067	46.68	0.0615	0.74	769.07	
0.072	50.27	0.0634	0.76	769.07	
0.078	53.86	0.0653	0.78	769.08	
0.083	57.45	0.0670	0.80	769.08	
0.088	61.04	0.0688	0.83	769.08	
0.093	64.63	0.0704	0.84	769.08	
0.098	68.22	0.0720	0.86	769.08	
0.103	71.81	0.0736	0.88	769.08	
0.109	75.40	0.0751	0.90	769.09	
0.114	78.99	0.0765	0.92	769.09	
0.119	82.59	0.0780	0.94	769.09	
0.124	86.18	0.0794	0.95	769.09	
0.129	89.77	0.0807	0.97	769.09	
0.134	93.36	0.0820	0.98	769.09	
0.140	96.95	0.0833	1.00	769.09	
0.145	100.54	0.0846	1.02	769.09	
0.150	104.13	0.0858	1.03	769.10	
0.155	107.72	0.0870	1.04	769.10	

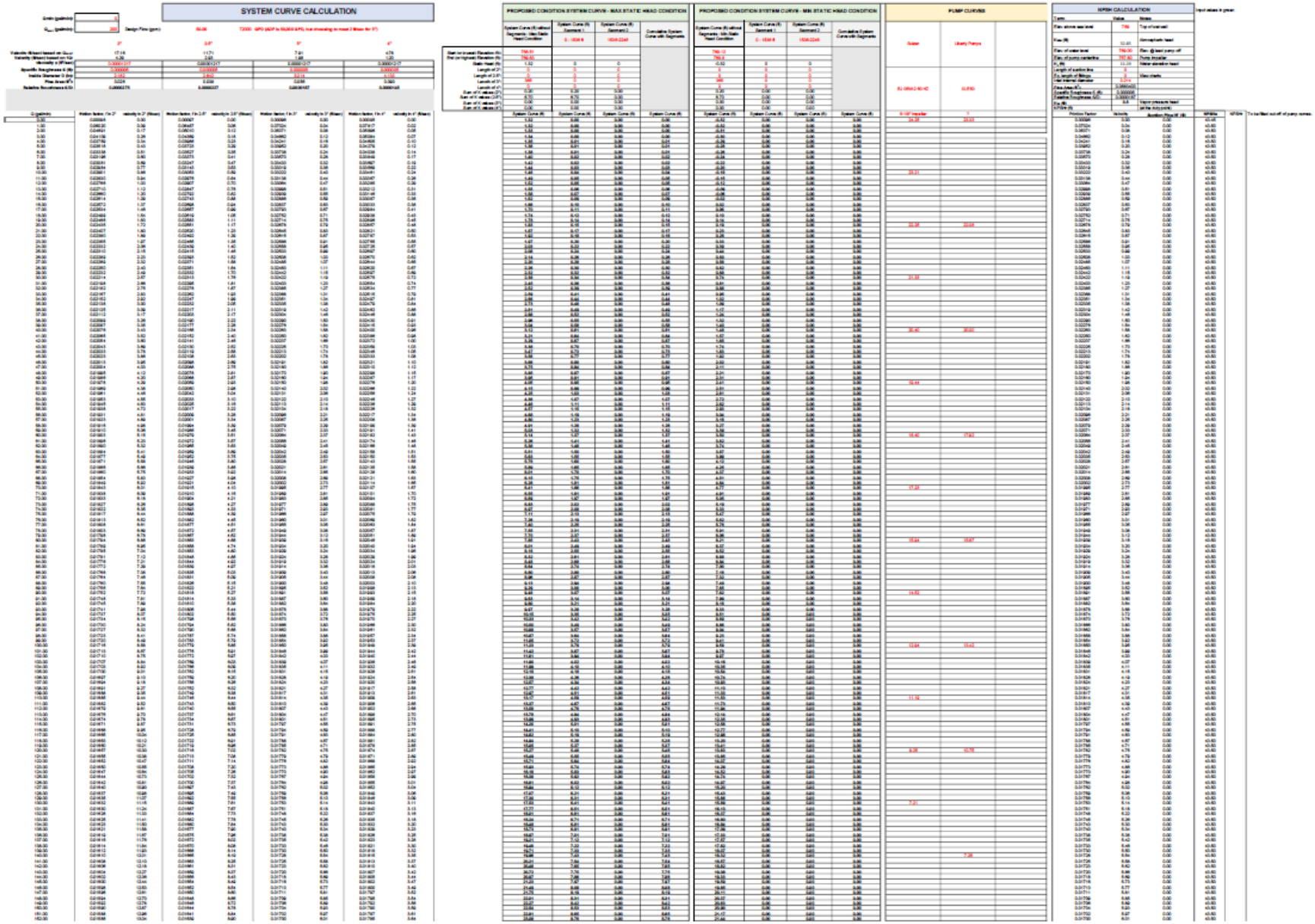


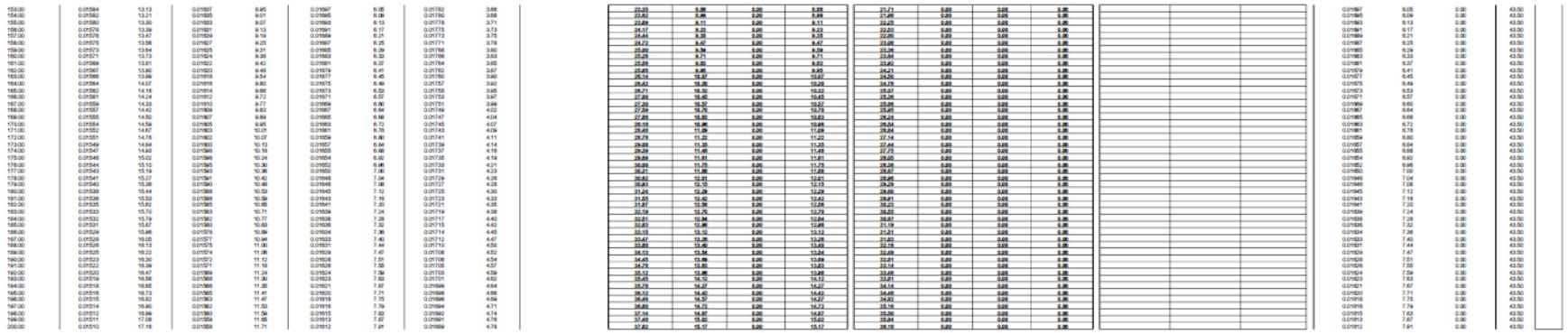
0.160	111.31	0.0882	1.06	769.10	
0.165	114.90	0.0894	1.07	769.10	
0.171	118.49	0.0905	1.09	769.10	
0.176	122.08	0.0917	1.10	769.10	
0.181	125.67	0.0928	1.11	769.10	
0.186	129.26	0.0938	1.13	769.10	
0.191	132.85	0.0949	1.14	769.10	
0.196	136.44	0.0960	1.15	769.11	
0.202	140.04	0.0970	1.16	769.11	
0.207	143.63	0.0980	1.18	769.11	
0.212	147.22	0.0990	1.19	769.11	
0.217	150.81	0.1000	1.20	769.11	
0.222	154.40	0.1010	1.21	769.11	
0.228	157.99	0.1019	1.22	769.11	
0.233	161.58	0.1029	1.23	769.11	
0.238	165.17	0.1038	1.25	769.11	
0.243	168.76	0.1047	1.26	769.11	
0.248	172.35	0.1056	1.27	769.12	
0.253	175.94	0.1065	1.28	769.12	
0.259	179.53	0.1074	1.29	769.12	(peak flow from cell 2 per HEC-HMS)
0.264	183.12	0.1083	1.30	769.12	
0.269	186.71	0.1092	1.31	769.12	
0.274	190.30	0.1100	1.32	769.12	
0.279	193.90	0.1109	1.33	769.12	
0.284	197.49	0.1117	1.34	769.12	
0.290	201.08	0.1125	1.35	769.12	
0.295	204.67	0.1134	1.36	769.12	
0.300	208.26	0.1142	1.37	769.12	
0.305	211.85	0.1150	1.38	769.12	
0.310	215.44	0.1158	1.39	769.13	
0.315	219.03	0.1166	1.40	769.13	
0.321	222.62	0.1173	1.41	769.13	
0.326	226.21	0.1181	1.42	769.13	
0.331	229.80	0.1189	1.43	769.13	
0.336	233.39	0.1196	1.44	769.13	
0.341	236.98	0.1204	1.44	769.13	
0.346	240.57	0.1211	1.45	769.13	
0.352	244.16	0.1219	1.46	769.13	
0.357	247.76	0.1226	1.47	769.13	
0.362	251.35	0.1233	1.48	769.13	
0.367	254.94	0.1240	1.49	769.13	
0.372	258.53	0.1247	1.50	769.13	
0.377	262.12	0.1255	1.51	769.14	
0.383	265.71	0.1262	1.51	769.14	

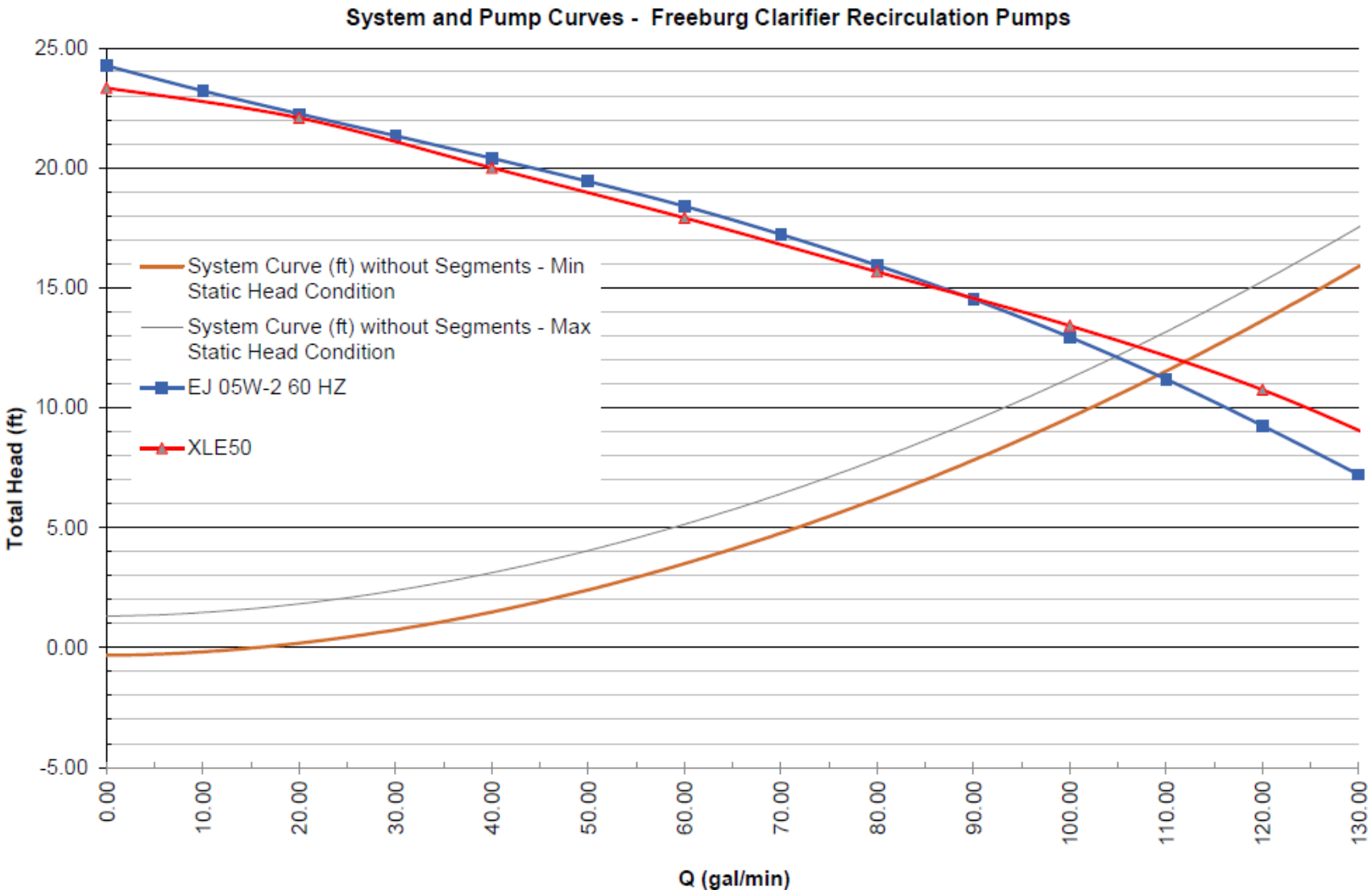
Manning's Equation (for open channels)

Location: Freeburg WEIR TROUGH

input:		
Channel Length (ft):	6	
Channel Slope (ft/ft):	0.0010	verify with jetincorp cut sheet
Bottom Width (ft):	1	verify with jetincorp cut sheet
Left Side Slope (X:1):	vertical walls	
Right Side Slope (X:1):	vertical walls	
Depth (ft):	0.35	or 4.2 inches
Ditch Conditions:	Steel	
output:		
Storm Drain Length (ft):	6.00	
A (ft^2):	0.35	
P (ft):	1.70	
R (ft):	0.205882353	
n:	0.012	
Q (ft^3/s):	0.48	
Q (gpm):	215.05	
Q (GPD):	309,671	
Depth (in):	4.2	
V (ft/s):	1.37	
time in ditch (min):	0.07	


SYSTEM CURVE CALCULATION
PROPOSED CONDITION SYSTEM CURVE - MAX STATIC HEAD CONDITION
PROPOSED CONDITION SYSTEM CURVE - MIN STATIC HEAD CONDITION
PUMP CURVES
NPSH CALCULATION




System and Pump Curves - Freeburg Clarifier Recirculation Pumps
Total Head (ft)
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
Q (gal/min)
System Curve (ft) without Segments - Min Static Head Condition
System Curve (ft) without Segments - Max Static Head Condition
EJ 05W-2 60 HZ
XLE50

DESCRIPTION:	WWTF outfall from lagoon cell 2 through MBBR and mag meter and UV to WWTF outfall		
FLOW (GPD):	258,527	50000.00	42000.00
FLOW (GPM):	179.53	34.72	29.17
FLOW (MGD):	0.26		

ELEMENT	MATERIAL	FLOW (GPM)	C FACTOR	PIPE CLASS	NOM. DIA (IN)	OUT. DIA (IN)	ID (IN)	VELOCITY (FPS)	LENGTH (FT)	PIPE LOSS	K FACTOR	FIT. LOSS (FT)	CUM. LOSS (FT)	HGL (FT)	FLOWLINE ELEV FROM CAD	Partial Flow Mannings Depth	HGL (partial flow - Mannings)	CONTROLLING HGL	COMMENTS
Upstream from outfall through mag meter through UV equipment to MBBR														760.7200	759.40	0.3300	759.7300	760.7200	100 year tailwater elevation
SWING CHECK VALVE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			2.20	0.0371	0.0371	760.7571	759.40	0.3300	759.7300	760.7571	Check valve on discharge
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	13.00	0.0069			0.0440	760.7640	759.58	0.3300	759.9100	760.7640	Pipe from common manhole to discharge
EXIT LOSS	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04				0.0000	0.0440	760.7640	759.58	0.3300	759.9100	760.7640	Exit from discharging MH
SHARP-EDGE ENTRANCE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			0.50	0.0084	0.0524	760.7724	759.65	0.3300	759.9800	760.7724	Entrance to DS manhole
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	16.00	0.0085			0.0609	760.7809	759.65	0.3242	759.9742	760.7809	Pipe from UV to common manhole
45° BEND	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			0.15	0.0025	0.0634	760.7834	759.65	0.3242	759.9742	760.7834	Horizontal bend to align to discharge
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	6.00	0.0032			0.0666	760.7866	759.65	0.3242	759.9742	760.7866	Pipe into UV 90
90° BEND	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			0.30	0.0051	0.0716	760.7916	758.65	0.3242	758.9742	760.7916	Vertical 90
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	6.00	0.0032			0.0748	760.7948		0.3242	0.3242	760.7948	
90° BEND	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			0.30	0.0051	0.0799	760.7999		0.3242	0.3242	760.7999	Vertical 90
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	6.00	0.0032			0.0831	760.8031		0.3242	0.3242	760.8031	
SHARP-EDGE ENTRANCE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			0.50	0.0084	0.0915	760.8115	758.65	0.3242	758.9742	760.8115	Exit from UV/ Free outfall from UV
																			Elevation of HGL on US end of Trojan UV. Per the Braymer UV unit dwg, the WSE behind the internal is 1.57 above the bottom of the unit (which is the top of the housekeeping pad). So the starting HGL (assumed for now using the Braymer D3200K Trojan unit with turnbox is 0.25+7.5/12+1.15. FG is 764.63 plus those numbers
														767.0750			0.0000	767.0750	
EXIT LOSS	DIP	179.53	130	CL 52	6.0	6.900	6.280	1.86			1.00	0.0537	0.0537	767.1287			0.0000	767.1287	Discharge from UV
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	6.00	0.0130			0.0667	767.1417			0.0000	767.1417	
PLUG VALVE	DIP	179.53	130	CL 52	6.0	6.900	6.280	1.86			0.50	0.0269	0.0936	767.1686			0.0000	767.1686	Plug Valve on UV
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	6.00	0.0130			0.1066	767.1816			0.0000	767.1816	
PLUG VALVE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86			0.50	0.0269	0.1334	767.2084			0.0000	767.2084	Plug Valve on UV
90° BEND	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86			0.30	0.0161	0.1495	767.2245	759.83		759.8300	767.2245	90 in UV
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	5.00	0.0108			0.1604	767.2354			0.0000	767.2354	
90° BEND	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86			0.30	0.0161	0.1765	767.2515	759.83		759.8300	767.2515	90 in UV
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	25.00	0.0542			0.2307	767.3057	759.8300		759.8300	767.3057	Pipe from mag meter and bypass
PLUG VALVE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86			0.50	0.0269	0.2575	767.3325			0.0000	767.3325	
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	1.00	0.0022			0.2597	767.3347			0.0000	767.3347	
TEE - BRANCH FLOW	DIP	179.53	130	CL 52	6.0	6.900	6.280	1.86			1.80	0.0967	0.3564	767.4314			0.0000	767.4314	
REDUCER	DIP	179.53	140	CL 52	4.0	4.800	4.220	4.12			0.20	0.0527	0.4090	767.4840			0.0000	767.4840	Reducer back up to 6"
PIPE	DIP	179.53	140	CL 52	4.0	4.800	4.220	4.12	4.00	0.0600			0.4690	767.5440			0.0000	767.5440	Mag Meter Lay Length
REDUCER	DIP	179.53	140	CL 52	4.0	4.800	4.220	4.12			0.20	0.0527	0.5217	767.5967	759.9100		759.9100	767.5967	Reducer for mag meter flow
45° BEND	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86			0.15	0.0081	0.5298	767.6048					
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	8.00	0.0173			0.5471	767.6221					
45° BEND	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86			0.15	0.0081	0.5552	767.6302					
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	47.00	0.1019			0.6236	767.6986	766.50		766.5000	767.6986	
BAFFLE												0.6000	1.2236	768.2986			0.0000	768.2986	Placeholder for future nutrient removal
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	47.00	0.1019			1.3255	768.4005			0.0000	768.4005	
REDUCER	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86			0.20	0.0107	1.3363	768.4113			0.0000	768.4113	Reducer to 6" for yard piping
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	4.00	0.0021			1.3384	768.4134			0.0000	768.4134	
90° BEND	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			0.30	0.0051	1.3434	768.4184			0.0000	768.4184	Vertical 90 out of triplepoint
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	2.00	0.0011			1.3445	768.4195			0.0000	768.4195	Wall Pipe
SHARP-EDGE ENTRANCE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			0.50	0.0084	1.3529	768.4279			0.0000	768.4279	Free outfall from weir
														769.1200			0.0000	769.1200	HGL over the weir at peak flow
EXIT LOSS	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			1.00	0.0169	0.0169	769.1369			0.0000	769.1369	
TEE - BRANCH FLOW	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			1.80	0.0303	0.0472	769.1672			0.0000	769.1672	
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	4.00	0.0021			0.0493	769.1693			0.0000	769.1693	
												0.0833	0.1327	769.2527			0.0000	769.2527	PLACE HOLDER FOR MBBR MEDIA RETENTION SEIVE HEADLOSSES - (HGL of Nitros 2) this headloss is pulled from duckbill headloss spreadsheet that was built from
RUBBER FLAPPER CHECK: V < 6 FPS												0.4700	0.6027	769.7227			0.0000	769.7227	headlosses provided by vendor - may need to be modified
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	4.00	0.0021			0.6048	769.7248			0.0000	769.7248	wall penetration
												0.0833	0.6881	769.8081			0.0000	769.8081	PLACE HOLDER FOR MBBR MEDIA RETENTION SEIVE HEADLOSSES - (HGL of Nitros 1) this headloss is pulled from duckbill headloss spreadsheet that was built from
RUBBER FLAPPER CHECK: V < 6 FPS												0.4700	1.1581	770.2781			0.0000	770.2781	headlosses provided by vendor - may need to be modified
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	3.00	0.0016			1.1597	770.2797			0.0000	770.2797	
90° BEND	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			0.30	0.0051	1.1648	770.2848			0.0000	770.2848	90 into the air lift discharge
PIPE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04	6.00	0.0032			1.1679	770.2879			0.0000	770.2879	vertical pipe in air lift structure
PROJECTING ENTRANCE	DIP	179.53	140	CL 52	8.0	9.050	8.390	1.04			0.80	0.0135	1.1814	770.3014			0.0000	770.3014	HGL IN AIR LIFT VERTICAL OUTFALL PIPING (We are lifting to 770.8
																	0.0000	0.0000	
																	0.0000	0.0000	

Freeburg, MO WWTF
HYDRAULIC CALCULATIONS FOR Peak Flow

DESCRIPTION:	WWTF outfall from lagoon cell 2 through MBBR and mag meter and UV to WWTF outfall		
FLOW (GPD):	50,000	50000.00	42000.00
FLOW (GPM):	34.72	34.72	29.17
FLOW (MGD):	0.05		

ELEMENT	MATERIAL	FLOW (GPM)	C FACTOR	PIPE CLASS	NOM. DIA (IN)	OUT. DIA (IN)	ID (IN)	VELOCITY (FPS)	LENGTH (FT)	PIPE LOSS	K FACTOR	FIT. LOSS (FT)	CUM. LOSS (FT)	HGL (FT)	FLOWLINE ELEV FROM CAD	Partial Flow Mannings Depth	HGL (partial flow - Mannings)	CONTROLLING HGL	COMMENTS
Upstream from outfall through mag meter through UV equipment to MBBR														760.7200	759.40	0.3300	759.7300	760.7200	100 year tailwater elevation
SWING CHECK VALVE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			2.20	0.0014	0.0014	760.7214	759.40	0.3300	759.7300	760.7214	Check valve on discharge
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	13.00	0.0003			0.0017	760.7217	759.58	0.3300	759.9100	760.7217	Pipe from common manhole to discharge
EXIT LOSS	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20				0.0000	0.0017	760.7217	759.58	0.3300	759.9100	760.7217	Exit from discharging MH
SHARP-EDGE ENTRANCE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			0.50	0.0003	0.0020	760.7220	759.65	0.3300	759.9800	760.7220	Entrance to DS manhole
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	16.00	0.0004			0.0024	760.7224	759.65	0.3242	759.9742	760.7224	Pipe from UV to common manhole
45° BEND	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			0.15	0.0001	0.0025	760.7225	759.65	0.3242	759.9742	760.7225	Horizontal bend to align to discharge
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	6.00	0.0002			0.0027	760.7227	759.65	0.3242	759.9742	760.7227	Pipe into UV 90
90° BEND	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			0.30	0.0002	0.0029	760.7229	758.65	0.3242	758.9742	760.7229	Vertical 90
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	6.00	0.0002			0.0030	760.7230		0.3242	0.3242	760.7230	
90° BEND	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			0.30	0.0002	0.0032	760.7232		0.3242	0.3242	760.7232	Vertical 90
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	6.00	0.0002			0.0034	760.7234		0.3242	0.3242	760.7234	
SHARP-EDGE ENTRANCE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			0.50	0.0003	0.0037	760.7237	758.65	0.3242	758.9742	760.7237	Exit from UV/ Free outfall from UV
																			Elevation of HGL on US end of Trojan UV. Per the Braymer UV unit dwg, the WSE behind the internal is 1.57 above the bottom of the unit (which is the top of the housekeeping pad). So the starting HGL (assumed for now using the Braymer D3200K Trojan unit with turnbox is 0.25+7.5/12+1.15. FG is 764.63 plus those numbers
														767.0750			0.0000	767.0750	
EXIT LOSS	DIP	34.72	130	CL 52	6.0	6.900	6.280	0.36			1.00	0.0020	0.0020	767.0770			0.0000	767.0770	Discharge from UV
PIPE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36	6.00	0.0006			0.0026	767.0776			0.0000	767.0776	
PLUG VALVE	DIP	34.72	130	CL 52	6.0	6.900	6.280	0.36			0.50	0.0010	0.0036	767.0786			0.0000	767.0786	Plug Valve on UV
PIPE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36	6.00	0.0006			0.0043	767.0793			0.0000	767.0793	
PLUG VALVE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36			0.50	0.0010	0.0053	767.0803			0.0000	767.0803	Plug Valve on UV
90° BEND	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36			0.30	0.0006	0.0059	767.0809	759.83		759.8300	767.0809	90 in UV
PIPE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36	5.00	0.0005			0.0064	767.0814			0.0000	767.0814	
90° BEND	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36			0.30	0.0006	0.0070	767.0820	759.83		759.8300	767.0820	90 in UV
PIPE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36	25.00	0.0026			0.0096	767.0846	759.8300		759.8300	767.0846	Pipe from mag meter and bypass
PLUG VALVE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36			0.50	0.0010	0.0106	767.0856			0.0000	767.0856	
PIPE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36	1.00	0.0001			0.0107	767.0857			0.0000	767.0857	
TEE - BRANCH FLOW	DIP	34.72	130	CL 52	6.0	6.900	6.280	0.36			1.80	0.0036	0.0143	767.0893			0.0000	767.0893	
REDUCER	DIP	34.72	140	CL 52	4.0	4.800	4.220	0.80			0.20	0.0020	0.0163	767.0913			0.0000	767.0913	Reducer back up to 6"
PIPE	DIP	34.72	140	CL 52	4.0	4.800	4.220	0.80	4.00	0.0029			0.0191	767.0941			0.0000	767.0941	Mag Meter Lay Length
REDUCER	DIP	34.72	140	CL 52	4.0	4.800	4.220	0.80			0.20	0.0020	0.0211	767.0961	759.9100		759.9100	767.0961	Reducer for mag meter flow
45° BEND	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36			0.15	0.0003	0.0214	767.0964					
PIPE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36	8.00	0.0008			0.0222	767.0972					
45° BEND	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36			0.15	0.0003	0.0225	767.0975					
PIPE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36	47.00	0.0049			0.0260	767.1010	766.50		766.5000	767.1010	
BAFFLE												0.6000	0.6260	767.7010			0.0000	767.7010	Placeholder for future nutrient removal
PIPE	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36	47.00	0.0049			0.6309	767.7059			0.0000	767.7059	
REDUCER	DIP	34.72	140	CL 52	6.0	6.900	6.280	0.36			0.20	0.0004	0.6313	767.7063			0.0000	767.7063	Reducer to 6" for yard piping
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	4.00	0.0001			0.6314	767.7064			0.0000	767.7064	
90° BEND	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			0.30	0.0002	0.6316	767.7066			0.0000	767.7066	Vertical 90 out of triplepoint
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	2.00	0.0001			0.6316	767.7066			0.0000	767.7066	Wall Pipe
SHARP-EDGE ENTRANCE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			0.50	0.0003	0.6319	767.7069			0.0000	767.7069	Free outfall from weir
														769.1200			0.0000	769.1200	HGL over the weir at peak flow
EXIT LOSS	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			1.00	0.0006	0.0006	769.1206			0.0000	769.1206	
TEE - BRANCH FLOW	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			1.80	0.0011	0.0018	769.1218			0.0000	769.1218	
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	4.00	0.0001			0.0019	769.1219			0.0000	769.1219	
												0.0833	0.0852	769.2052			0.0000	769.2052	PLACE HOLDER FOR MBBR MEDIA RETENTION SEIVE HEADLOSSES - (HGL of Nitrox 2) this headloss is pulled from duckbill headloss spreadsheet that was built from headlosses provided by vendor - may need to be modified
RUBBER FLAPPER CHECK: V < 6 FPS												0.4700	0.5552	769.6752			0.0000	769.6752	
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	4.00	0.0001			0.5553	769.6753			0.0000	769.6753	wall penetration
												0.0833	0.6386	769.7586			0.0000	769.7586	PLACE HOLDER FOR MBBR MEDIA RETENTION SEIVE HEADLOSSES - (HGL of Nitrox 1) this headloss is pulled from duckbill headloss spreadsheet that was built from headlosses provided by vendor - may need to be modified
RUBBER FLAPPER CHECK: V < 6 FPS												0.4700	1.1086	770.2286			0.0000	770.2286	
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	3.00	0.0001			1.1087	770.2287			0.0000	770.2287	
90° BEND	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			0.30	0.0002	1.1089	770.2289			0.0000	770.2289	90 into the air lift discharge
PIPE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20	6.00	0.0002			1.1091	770.2291			0.0000	770.2291	vertical pipe in air lift structure
PROJECTING ENTRANCE	DIP	34.72	140	CL 52	8.0	9.050	8.390	0.20			0.80	0.0005	1.1096	770.2296			0.0000	770.2296	HGL IN AIR LIFT VERTICAL OUTFALL PIPING (We are lifting to 770.8
																	0.0000	0.0000	
																	0.0000	0.0000	

Freeburg, MO WWTF
HYDRAULIC CALCULATIONS FOR Peak Flow

DESCRIPTION: **WWTF cell 2 outfall 4" into the airlift**
FLOW (GPD): **258,527** 50000.00 42000.00
FLOW (GPM): **179.53** **34.72** **29.17**
FLOW (MGD): **0.26**

ELEMENT	MATERIAL	FLOW (GPM)	C FACTOR	PIPE CLASS	NOM. DIA (IN)	OUT. DIA (IN)	ID (IN)	VELOCITY (FPS)	LENGTH (FT)	PIPE LOSS	K FACTOR	FIT. LOSS (FT)	CUM. LOSS (FT)	HGL (FT)	COMMENTS
Cell 2 into airlift														**767.2500**	
EXIT LOSS	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86			1.00	0.0537	0.0537	767.3037	
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	18.00	0.0390			0.0927	767.3427	
11.25° BEND	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86			0.04	0.0021	0.0949	767.3449	
PIPE	DIP	179.53	140	CL 52	6.0	6.900	6.280	1.86	51.00	0.1106			0.2054	767.4554	
REDUCER	DIP	179.53	140	CL 52	4.0	4.500	4.220	4.12			0.20	0.0527	0.2581	767.5081	
TEE - BRANCH FLOW	DIP	179.53	140	CL 52	4.0	4.500	4.220	4.12			1.80	0.4741	0.7322	767.9822	
SHARP-EDGE ENTRANCE	DIP	179.53	140	CL 52	4.0	4.500	4.220	4.12			0.50	0.1317	0.8639	768.1139	

Freeburg, MO WWTF
HYDRAULIC CALCULATIONS FOR Peak Flow

DESCRIPTION: Transfer pipe from cell 1 to cell 2, 4" and 10" run
FLOW (GPD): 323,158 50000.00 42000.00
FLOW (GPM): 224.42 34.72 29.17
FLOW (MGD): 0.32

ELEMENT	MATERIAL	FLOW (GPM)	C FACTOR	PIPE CLASS	NOM. DIA (IN)	OUT. DIA (IN)	ID (IN)	VELOCITY (FPS)	LENGTH (FT)	PIPE LOSS	K FACTOR	FIT. LOSS (FT)	CUM. LOSS (FT)	HGL (FT)	COMMENTS	
Cell 1 to 2														769.4000		
EXIT LOSS	DIP	224.42	140	CL 52	10.0	11.100	10.400	0.85			1.00	0.0112	0.0112	769.4112		
PIPE	DIP	224.42	140	CL 52	10.0	11.100	10.400	0.85	45.82	0.0129			0.0241	769.4241		
90° BEND	DIP	224.42	140	CL 52	10.0	11.100	10.400	0.85			0.30	0.0033	0.0274	769.4274		279.08
PIPE	DIP	224.42	140	CL 52	10.0	11.100	10.400	0.85	136.38	0.0384			0.0658	769.4658		
45° BEND	DIP	224.42	140	CL 52	10.0	11.100	10.400	0.85			0.15	0.0017	0.0128	769.4128		
PIPE	DIP	224.42	140	CL 52	10.0	11.100	10.400	0.85	96.88	0.0273			0.0401	769.4401		
SHARP-EDGE ENTRANCE	DIP	224.42	140	CL 52	10.0	11.100	10.400	0.85			0.50	0.0056	0.0457	769.4457	769.28 (from flowmaster)	
EXIT LOSS	DIP	224.42	140	CL 52	6.0	6.900	6.280	2.32			1.00	0.0839	0.1296	769.5296		
PIPE	DIP	224.42	140	CL 52	6.0	6.900	6.280	2.32	61.25	0.2007			0.3302	769.7302		
REDUCER	DIP	224.42	140	CL 52	4.0	4.800	4.220	5.15			0.20	0.0823	0.4125	769.8125		
SHARP-EDGE ENTRANCE	DIP	224.42	140	CL 53	4.0	4.800	4.160	5.30			0.50	0.2179	0.6304	770.0304		

C_o = 0.62 Berm Height 771.31 ductile iron class 52 OD

768.50 NO CELL 3 in FREEBURG

	#1:	#2:	#3:	
FL orifice =	768.60 ft	769.80 ft	0.84	ft
Number of orifices =	1	1		
Diameter of Orifice =	4 in	8 in		in

Bartlet

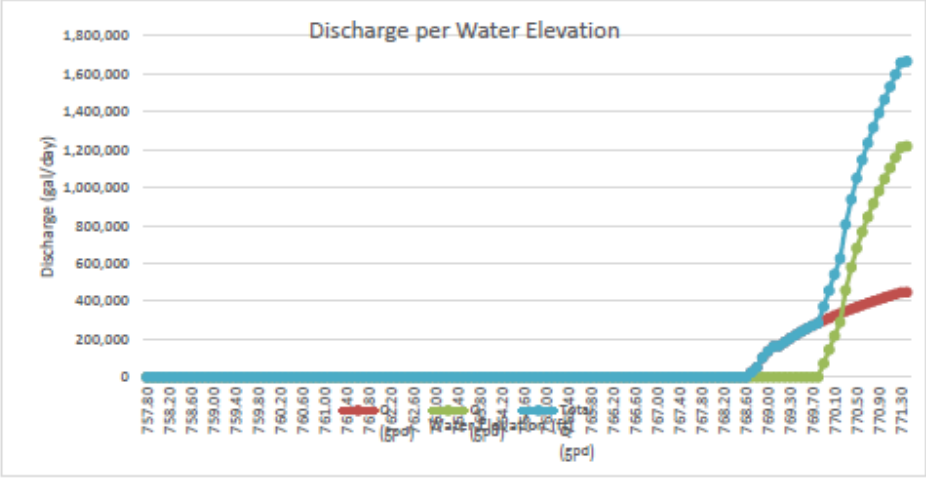
Water Elevation (ft)	H (ft)	Q (cfs)	Q (gpd)	H (ft)	Q (cfs)	Q (gpd)				Q (cfs)	Q (gpd)
757.80	-10.97	0.00	0	-12.33	0.00	0				0.00	0
757.90	-10.87	0.00	0	-12.23	0.00	0				0.00	0
758.00	-10.77	0.00	0	-12.13	0.00	0				0.00	0
758.10	-10.67	0.00	0	-12.03	0.00	0				0.00	0
758.20	-10.57	0.00	0	-11.93	0.00	0				0.00	0
758.30	-10.47	0.00	0	-11.83	0.00	0				0.00	0
758.40	-10.37	0.00	0	-11.73	0.00	0				0.00	0
758.50	-10.27	0.00	0	-11.63	0.00	0				0.00	0
758.60	-10.17	0.00	0	-11.53	0.00	0				0.00	0
758.70	-10.07	0.00	0	-11.43	0.00	0				0.00	0
758.80	-9.97	0.00	0	-11.33	0.00	0				0.00	0
758.90	-9.87	0.00	0	-11.23	0.00	0				0.00	0
759.00	-9.77	0.00	0	-11.13	0.00	0				0.00	0
759.10	-9.67	0.00	0	-11.03	0.00	0				0.00	0
759.20	-9.57	0.00	0	-10.93	0.00	0				0.00	0
759.30	-9.47	0.00	0	-10.83	0.00	0				0.00	0
759.40	-9.37	0.00	0	-10.73	0.00	0				0.00	0
759.50	-9.27	0.00	0	-10.63	0.00	0				0.00	0
759.60	-9.17	0.00	0	-10.53	0.00	0				0.00	0
759.70	-9.07	0.00	0	-10.43	0.00	0				0.00	0
759.80	-8.97	0.00	0	-10.33	0.00	0				0.00	0
759.90	-8.87	0.00	0	-10.23	0.00	0				0.00	0
760.00	-8.77	0.00	0	-10.13	0.00	0				0.00	0
760.10	-8.67	0.00	0	-10.03	0.00	0				0.00	0
760.20	-8.57	0.00	0	-9.93	0.00	0				0.00	0
760.30	-8.47	0.00	0	-9.83	0.00	0				0.00	0
760.40	-8.37	0.00	0	-9.73	0.00	0				0.00	0
760.50	-8.27	0.00	0	-9.63	0.00	0				0.00	0
760.60	-8.17	0.00	0	-9.53	0.00	0				0.00	0
760.70	-8.07	0.00	0	-9.43	0.00	0				0.00	0
760.80	-7.97	0.00	0	-9.33	0.00	0				0.00	0
760.90	-7.87	0.00	0	-9.23	0.00	0				0.00	0
761.00	-7.77	0.00	0	-9.13	0.00	0				0.00	0
761.10	-7.67	0.00	0	-9.03	0.00	0				0.00	0
761.20	-7.57	0.00	0	-8.93	0.00	0				0.00	0
761.30	-7.47	0.00	0	-8.83	0.00	0				0.00	0
761.40	-7.37	0.00	0	-8.73	0.00	0				0.00	0
761.50	-7.27	0.00	0	-8.63	0.00	0				0.00	0
761.60	-7.17	0.00	0	-8.53	0.00	0				0.00	0
761.70	-7.07	0.00	0	-8.43	0.00	0				0.00	0
761.80	-6.97	0.00	0	-8.33	0.00	0				0.00	0
761.90	-6.87	0.00	0	-8.23	0.00	0				0.00	0
762.00	-6.77	0.00	0	-8.13	0.00	0				0.00	0
762.10	-6.67	0.00	0	-8.03	0.00	0				0.00	0
762.20	-6.57	0.00	0	-7.93	0.00	0				0.00	0
762.30	-6.47	0.00	0	-7.83	0.00	0				0.00	0
762.40	-6.37	0.00	0	-7.73	0.00	0				0.00	0
762.50	-6.27	0.00	0	-7.63	0.00	0				0.00	0
762.60	-6.17	0.00	0	-7.53	0.00	0				0.00	0
762.70	-6.07	0.00	0	-7.43	0.00	0				0.00	0
762.80	-5.97	0.00	0	-7.33	0.00	0				0.00	0
762.90	-5.87	0.00	0	-7.23	0.00	0				0.00	0
763.00	-5.77	0.00	0	-7.13	0.00	0				0.00	0

763.10	-5.67	0.00	0	-7.03	0.00	0				0.00	0
763.20	-5.57	0.00	0	-6.93	0.00	0				0.00	0
763.30	-5.47	0.00	0	-6.83	0.00	0				0.00	0
763.40	-5.37	0.00	0	-6.73	0.00	0				0.00	0
763.50	-5.27	0.00	0	-6.63	0.00	0				0.00	0
763.60	-5.17	0.00	0	-6.53	0.00	0				0.00	0
763.70	-5.07	0.00	0	-6.43	0.00	0				0.00	0
763.80	-4.97	0.00	0	-6.33	0.00	0				0.00	0
763.90	-4.87	0.00	0	-6.23	0.00	0				0.00	0
764.00	-4.77	0.00	0	-6.13	0.00	0				0.00	0
764.10	-4.67	0.00	0	-6.03	0.00	0				0.00	0
764.20	-4.57	0.00	0	-5.93	0.00	0				0.00	0
764.30	-4.47	0.00	0	-5.83	0.00	0				0.00	0
764.40	-4.37	0.00	0	-5.73	0.00	0				0.00	0
764.50	-4.27	0.00	0	-5.63	0.00	0				0.00	0
764.60	-4.17	0.00	0	-5.53	0.00	0				0.00	0
764.70	-4.07	0.00	0	-5.43	0.00	0				*0.00*	*0*
764.80	-3.97	0.00	0	-5.33	0.00	0				*0.00*	*0*
764.90	-3.87	0.00	0	-5.23	0.00	0				0.00	0
765.00	-3.77	0.00	0	-5.13	0.00	0				0.00	0
765.10	-3.67	0.00	0	-5.03	0.00	0				0.00	0
765.20	-3.57	0.00	0	-4.93	0.00	0				0.00	0
765.30	-3.47	0.00	0	-4.83	0.00	0				0.00	0
765.40	-3.37	0.00	0	-4.73	0.00	0				0.00	0
765.50	-3.27	0.00	0	-4.63	0.00	0				0.00	0
765.60	-3.17	0.00	0	-4.53	0.00	0				0.00	0
765.70	-3.07	0.00	0	-4.43	0.00	0				0.00	0
765.80	-2.97	0.00	0	-4.33	0.00	0				0.00	0
765.90	-2.87	0.00	0	-4.23	0.00	0				0.00	0
766.00	-2.77	0.00	0	-4.13	0.00	0				0.00	0
766.10	-2.67	0.00	0	-4.03	0.00	0				0.00	0
766.20	-2.57	0.00	0	-3.93	0.00	0				0.00	0
766.30	-2.47	0.00	0	-3.83	0.00	0				0.00	0
766.40	-2.37	0.00	0	-3.73	0.00	0				0.00	0
766.50	-2.27	0.00	0	-3.63	0.00	0				*0.00*	*0*
766.60	-2.17	0.00	0	-3.53	0.00	0				*0.00*	*0*
766.70	-2.07	0.00	0	-3.43	0.00	0				*0.00*	*0*
766.80	-1.97	0.00	0	-3.33	0.00	0				0.00	0
766.90	-1.87	0.00	0	-3.23	0.00	0				0.00	0
767.00	-1.77	0.00	0	-3.13	0.00	0				0.00	0
767.10	-1.67	0.00	0	-3.03	0.00	0				0.00	0
767.20	-1.57	0.00	0	-2.93	0.00	0				0.00	0
767.30	-1.47	0.00	0	-2.83	0.00	0				0.00	0
767.40	-1.37	0.00	0	-2.73	0.00	0				0.00	0
767.50	-1.27	0.00	0	-2.63	0.00	0				0.00	0
767.60	-1.17	0.00	0	-2.53	0.00	0				0.00	0
767.70	-1.07	0.00	0	-2.43	0.00	0				0.00	0
767.80	-0.97	0.00	0	-2.33	0.00	0				0.00	0
767.90	-0.87	0.00	0	-2.23	0.00	0				0.00	0
768.00	-0.77	0.00	0	-2.13	0.00	0				0.00	0
768.10	-0.67	0.00	0	-2.03	0.00	0				0.00	0
768.20	-0.57	0.00	0	-1.93	0.00	0				0.00	0
768.30	-0.47	0.00	0	-1.83	0.00	0				0.00	0
768.40	-0.37	0.00	0	-1.73	0.00	0				0.00	0
768.50	-0.27	0.00	0	-1.63	0.00	0				0.00	0
768.60	-0.17	0.00	0	-1.53	0.00	0				0.00	0
768.70	-0.07	0.04	25,616	-1.43	0.00	0				0.04	25,616
768.80	0.03	0.08	51,231	-1.33	0.00	0				0.08	51,231
768.90	0.13	0.16	102,463	-1.23	0.00	0				0.16	102,463
769.00	0.23	0.21	135,546	-1.13	0.00	0				0.21	135,546
769.10	0.33	0.25	162,008	-1.03	0.00	0				0.25	162,008
769.11	0.34	0.25	164,420	-1.02	0.00	0				0.25	164,420
769.20	0.43	0.29	184,718	-0.93	0.00	0				0.29	184,718
769.30	0.53	0.32	204,926	-0.83	0.00	0				0.32	204,926
769.40	0.63	0.35	223,313	-0.73	0.00	0				0.35	223,313

769.50	0.73	0.37	240,297
769.60	0.83	0.40	256,157
769.70	0.93	0.42	271,091
769.80	1.03	0.44	285,245
769.90	1.13	0.46	298,728
770.00	1.23	0.48	311,629
770.10	1.33	0.50	324,016
770.20	1.43	0.52	335,947
770.30	1.53	0.54	347,469
770.40	1.63	0.55	358,620
770.50	1.73	0.57	369,435
770.60	1.83	0.59	379,943
770.70	1.93	0.60	390,167
770.80	2.03	0.62	400,130
770.90	2.13	0.63	409,852
771.00	2.23	0.65	419,348
771.10	2.33	0.66	428,633
771.20	2.43	0.68	437,722
771.30	2.53	0.69	446,625
771.31	2.54	0.69	447,506

-0.63	0.00	0
-0.53	0.00	0
-0.43	*0.00*	0
-0.33	*0.00*	0
-0.23	*0.11*	72,452
-0.13	*0.22*	144,904
-0.03	*0.34*	217,357
0.07	0.45	289,809
0.17	0.71	458,228
0.27	0.90	579,618
0.37	1.05	679,662
0.47	1.19	766,762
0.57	1.31	844,931
0.67	1.42	916,456
0.77	1.52	982,790
0.87	1.62	1,044,921
0.97	1.71	1,103,559
1.07	1.79	1,159,236
1.17	1.88	1,212,358
1.18	1.88	1,217,542

0.37	240,297
0.40	256,157
0.42	271,091
0.44	285,245
0.57	371,180
0.71	456,533
0.84	541,373
0.97	625,756
1.25	805,697
1.45	938,238
1.62	1,049,097
1.77	1,146,705
1.91	1,235,098
2.04	1,316,587
2.15	1,392,641
2.27	1,464,268
2.37	1,532,192
2.47	1,596,957
2.57	1,658,983
2.58	1,665,048



Project No. 21134.003
Project: Freeburg Wastewater System Improvements
Subject: Lagoon Storage and Flow Control Structures
Location: Freeburg, MO

Cell 2 Discharge Calculations

Orifice calcs:

Equations Used:

$$Q_o = C_o A_o \sqrt{2g(H - E_o)}$$

Q_o = orifice outflow
C_o = orifice discharge coefficient
g = acceleration due to gravity 32.2 ft/s²
A_o = net opening area = $\pi d^2/4$
H = water Elevation

C_o = 0.62

NO CELL 3 in FREEBURG

	#1:	#2:	#3:
FL orifice =	768.50 ft	769.40 ft	ft
Number of orifices =	1	1	
Diameter of Orifice =	4 in	8 in	in

Water Elevation (ft)	H (ft)	Q (cfs)	Q (gpd)	H (ft)	Q (cfs)	Q (gpd)				Total Q (cfs)	Total Q (gpd)	
758.20	-10.47	0.00	0	-11.53	0.00	0				0.00	0	Bottom Cell 2
758.30	-10.37	0.00	0	-11.43	0.00	0				0.00	0	
758.40	-10.27	0.00	0	-11.33	0.00	0				0.00	0	
758.50	-10.17	0.00	0	-11.23	0.00	0				0.00	0	
758.60	-10.07	0.00	0	-11.13	0.00	0				0.00	0	
758.70	-9.97	0.00	0	-11.03	0.00	0				0.00	0	
758.80	-9.87	0.00	0	-10.93	0.00	0				0.00	0	
758.90	-9.77	0.00	0	-10.83	0.00	0				0.00	0	
759.00	-9.67	0.00	0	-10.73	0.00	0				0.00	0	
759.10	-9.57	0.00	0	-10.63	0.00	0				0.00	0	
759.20	-9.47	0.00	0	-10.53	0.00	0				0.00	0	
759.30	-9.37	0.00	0	-10.43	0.00	0				0.00	0	
759.40	-9.27	0.00	0	-10.33	0.00	0				0.00	0	
759.50	-9.17	0.00	0	-10.23	0.00	0				0.00	0	
759.60	-9.07	0.00	0	-10.13	0.00	0				0.00	0	
759.70	-8.97	0.00	0	-10.03	0.00	0				0.00	0	
759.80	-8.87	0.00	0	-9.93	0.00	0				0.00	0	
759.90	-8.77	0.00	0	-9.83	0.00	0				0.00	0	
760.00	-8.67	0.00	0	-9.73	0.00	0				0.00	0	
760.10	-8.57	0.00	0	-9.63	0.00	0				0.00	0	
760.20	-8.47	0.00	0	-9.53	0.00	0				0.00	0	
760.30	-8.37	0.00	0	-9.43	0.00	0				0.00	0	
760.40	-8.27	0.00	0	-9.33	0.00	0				0.00	0	
760.50	-8.17	0.00	0	-9.23	0.00	0				0.00	0	
760.60	-8.07	0.00	0	-9.13	0.00	0				0.00	0	
760.70	-7.97	0.00	0	-9.03	0.00	0				0.00	0	
760.80	-7.87	0.00	0	-8.93	0.00	0				0.00	0	
760.90	-7.77	0.00	0	-8.83	0.00	0				0.00	0	
761.00	-7.67	0.00	0	-8.73	0.00	0				0.00	0	
761.10	-7.57	0.00	0	-8.63	0.00	0				0.00	0	
761.20	-7.47	0.00	0	-8.53	0.00	0				0.00	0	
761.30	-7.37	0.00	0	-8.43	0.00	0				0.00	0	
761.40	-7.27	0.00	0	-8.33	0.00	0				0.00	0	
761.50	-7.17	0.00	0	-8.23	0.00	0				0.00	0	
761.60	-7.07	0.00	0	-8.13	0.00	0				0.00	0	
761.70	-6.97	0.00	0	-8.03	0.00	0				0.00	0	
761.80	-6.87	0.00	0	-7.93	0.00	0				0.00	0	
761.90	-6.77	0.00	0	-7.83	0.00	0				0.00	0	
762.00	-6.67	0.00	0	-7.73	0.00	0				0.00	0	
762.10	-6.57	0.00	0	-7.63	0.00	0				0.00	0	
762.20	-6.47	0.00	0	-7.53	0.00	0				0.00	0	
762.30	-6.37	0.00	0	-7.43	0.00	0				0.00	0	
762.40	-6.27	0.00	0	-7.33	0.00	0				0.00	0	
762.50	-6.17	0.00	0	-7.23	0.00	0				0.00	0	
762.60	-6.07	0.00	0	-7.13	0.00	0				0.00	0	
762.70	-5.97	0.00	0	-7.03	0.00	0				0.00	0	

Bartlett & West

Project No. 21134.003
Project: Freeburg Wastewater System Improvements
Subject: Lagoon Storage and Flow Control Structures
Location: Freeburg, MO

762.80	-5.87	0.00	0	-6.93	0.00	0					0.00	0
762.90	-5.77	0.00	0	-6.83	0.00	0					0.00	0
763.00	-5.67	0.00	0	-6.73	0.00	0					0.00	0
763.10	-5.57	0.00	0	-6.63	0.00	0					0.00	0
763.20	-5.47	0.00	0	-6.53	0.00	0					0.00	0
763.30	-5.37	0.00	0	-6.43	0.00	0					0.00	0
763.40	-5.27	0.00	0	-6.33	0.00	0					0.00	0
763.50	-5.17	0.00	0	-6.23	0.00	0					0.00	0
763.60	-5.07	0.00	0	-6.13	0.00	0					0.00	0
763.70	-4.97	0.00	0	-6.03	0.00	0					0.00	0
763.80	-4.87	0.00	0	-5.93	0.00	0					0.00	0
763.90	-4.77	0.00	0	-5.83	0.00	0					0.00	0
764.00	-4.67	0.00	0	-5.73	0.00	0					0.00	0
764.10	-4.57	0.00	0	-5.63	0.00	0					0.00	0
764.20	-4.47	0.00	0	-5.53	0.00	0					0.00	0
764.30	-4.37	0.00	0	-5.43	0.00	0					0.00	0
764.40	-4.27	0.00	0	-5.33	0.00	0					0.00	0
764.50	-4.17	0.00	0	-5.23	0.00	0					0.00	0
764.60	-4.07	0.00	0	-5.13	0.00	0					0.00	0
764.70	-3.97	0.00	0	-5.03	0.00	0					0.00	0
764.80	-3.87	0.00	0	-4.93	0.00	0					0.00	0
764.90	-3.77	0.00	0	-4.83	0.00	0					0.00	0
765.00	-3.67	0.00	0	-4.73	0.00	0					0.00	0
765.10	-3.57	0.00	0	-4.63	0.00	0					0.00	0
765.20	-3.47	0.00	0	-4.53	0.00	0					0.00	0
765.30	-3.37	0.00	0	-4.43	0.00	0					0.00	0
765.40	-3.27	0.00	0	-4.33	0.00	0					0.00	0
765.50	-3.17	0.00	0	-4.23	0.00	0					0.00	0
765.60	-3.07	0.00	0	-4.13	0.00	0					0.00	0
765.70	-2.97	0.00	0	-4.03	0.00	0					0.00	0
765.80	-2.87	0.00	0	-3.93	0.00	0					0.00	0
765.90	-2.77	0.00	0	-3.83	0.00	0					0.00	0
766.00	-2.67	0.00	0	-3.73	0.00	0					0.00	0
766.10	-2.57	0.00	0	-3.63	0.00	0					0.00	0
766.20	-2.47	0.00	0	-3.53	0.00	0					0.00	0
766.30	-2.37	0.00	0	-3.43	0.00	0					0.00	0
766.40	-2.27	0.00	0	-3.33	0.00	0					0.00	0
766.50	-2.17	0.00	0	-3.23	0.00	0					0.00	0
766.60	-2.07	0.00	0	-3.13	0.00	0					0.00	0
766.70	-1.97	0.00	0	-3.03	0.00	0					0.00	0
766.80	-1.87	0.00	0	-2.93	0.00	0					0.00	0
766.90	-1.77	0.00	0	-2.83	0.00	0					0.00	0
767.00	-1.67	0.00	0	-2.73	0.00	0					0.00	0
767.10	-1.57	0.00	0	-2.63	0.00	0					0.00	0
767.20	-1.47	0.00	0	-2.53	0.00	0					0.00	0
767.30	-1.37	0.00	0	-2.43	0.00	0					0.00	0
767.40	-1.27	0.00	0	-2.33	0.00	0					0.00	0
767.50	-1.17	0.00	0	-2.23	0.00	0					0.00	0
767.60	-1.07	0.00	0	-2.13	0.00	0					0.00	0
767.70	-0.97	0.00	0	-2.03	0.00	0					0.00	0
767.80	-0.87	0.00	0	-1.93	0.00	0					0.00	0
767.90	-0.77	0.00	0	-1.83	0.00	0					0.00	0
768.00	-0.67	0.00	0	-1.73	0.00	0					0.00	0
768.10	-0.57	0.00	0	-1.63	0.00	0					0.00	0
768.20	-0.47	0.00	0	-1.53	0.00	0					0.00	0
768.30	-0.37	0.00	0	-1.43	0.00	0					0.00	0
768.40	-0.27	0.00	0	-1.33	0.00	0					0.00	0
768.50	-0.17	0.00	0	-1.23	0.00	0					0.00	0
768.51	-0.16	*0.00*	953	-1.22	0.00	0					0.00	953
768.52	-0.15	*0.00*	1,906	-1.21	0.00	0					0.00	1,906
768.53	-0.14	*0.00*	2,859	-1.20	0.00	0					0.00	2,859
768.54	-0.13	*0.01*	3,812	-1.19	0.00	0					0.01	3,812
768.55	-0.12	*0.01*	4,765	-1.18	0.00	0					0.01	4,765
768.56	-0.11	*0.01*	5,718	-1.17	0.00	0					0.01	5,718
768.57	-0.10	*0.01*	6,671	-1.16	0.00	0					0.01	6,671
768.58	-0.09	*0.01*	7,624	-1.15	0.00	0					0.01	7,624
768.59	-0.08	*0.01*	8,577	-1.14	0.00	0					0.01	8,577
768.60	-0.07	*0.01*	9,530	-1.13	0.00	0					0.01	9,530
768.61	-0.06	*0.02*	10,483	-1.12	0.00	0					0.02	10,483
768.62	-0.05	*0.02*	11,436	-1.11	0.00	0					0.02	11,436
768.63	-0.04	*0.02*	12,389	-1.10	0.00	0					0.02	12,389

Bartlett & West

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Project: Freeburg Wastewater System Improvements
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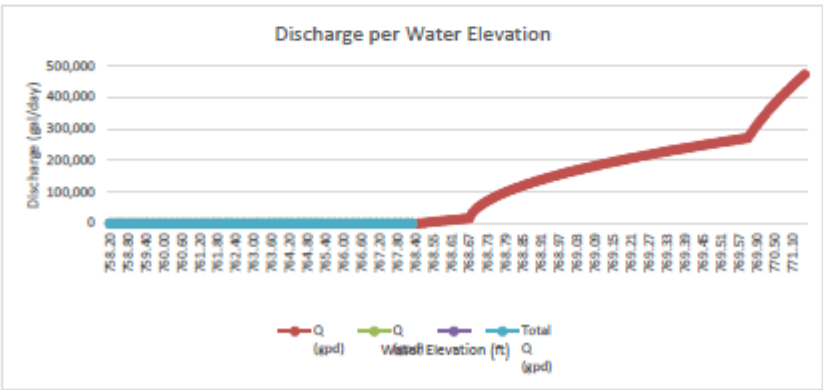
Location: Freeburg, MO

768.64	-0.03	*0.02*	13,342	-1.09	0.00	0				0.02	13,342
768.65	-0.02	*0.02*	14,295	-1.08	0.00	0				0.02	14,295
768.66	-0.01	*0.02*	15,248	-1.07	0.00	0				0.02	15,248
768.67	0.00	0.03	16,201	-1.06	0.00	0				0.03	16,201
768.68	0.01	0.05	32,402	-1.05	0.00	0				0.05	32,402
768.69	0.02	0.07	42,863	-1.04	0.00	0				0.07	42,863
768.70	0.03	0.08	51,231	-1.03	0.00	0				0.08	51,231
768.71	0.04	0.09	58,413	-1.02	0.00	0				0.09	58,413
768.72	0.05	0.10	64,803	-1.01	0.00	0				0.10	64,803
768.73	0.06	0.11	70,618	-1.00	0.00	0				0.11	70,618
768.74	0.07	0.12	75,989	-0.99	0.00	0				0.12	75,989
768.75	0.08	0.13	81,004	-0.98	0.00	0				0.13	81,004
768.76	0.09	0.13	85,727	-0.97	0.00	0				0.13	85,727
768.77	0.10	0.14	90,202	-0.96	0.00	0				0.14	90,202
768.78	0.11	0.15	94,466	-0.95	0.00	0				0.15	94,466
768.79	0.12	0.15	98,546	-0.94	0.00	0				0.15	98,546
768.80	0.13	0.16	102,463	-0.93	0.00	0				0.16	102,463
768.81	0.14	0.16	106,236	-0.92	0.00	0				0.16	106,236
768.82	0.15	0.17	109,879	-0.91	0.00	0				0.17	109,879
768.83	0.16	0.18	113,406	-0.90	0.00	0				0.18	113,406
768.84	0.17	0.18	116,826	-0.89	0.00	0				0.18	116,826
768.85	0.18	0.19	120,148	-0.88	0.00	0				0.19	120,148
768.86	0.19	0.19	123,382	-0.87	0.00	0				0.19	123,382
768.87	0.20	0.20	126,532	-0.86	0.00	0				0.20	126,532
768.88	0.21	0.20	129,606	-0.85	0.00	0				0.20	129,606
768.89	0.22	0.21	132,609	-0.84	0.00	0				0.21	132,609
768.90	0.23	0.21	135,546	-0.83	0.00	0				0.21	135,546
768.91	0.24	0.21	138,420	-0.82	0.00	0				0.21	138,420
768.92	0.25	0.22	141,235	-0.81	0.00	0				0.22	141,235
768.93	0.26	0.22	143,996	-0.80	0.00	0				0.22	143,996
768.94	0.27	0.23	146,705	-0.79	0.00	0				0.23	146,705
768.95	0.28	0.23	149,364	-0.78	0.00	0				0.23	149,364
768.96	0.29	0.24	151,977	-0.77	0.00	0				0.24	151,977
768.97	0.30	0.24	154,546	-0.76	0.00	0				0.24	154,546
768.98	0.31	0.24	157,073	-0.75	0.00	0				0.24	157,073
768.99	0.32	0.25	159,559	-0.74	0.00	0				0.25	159,559
769.00	0.33	0.25	162,008	-0.73	0.00	0				0.25	162,008
769.01	0.34	0.25	164,420	-0.72	0.00	0				0.25	164,420
769.02	0.35	0.26	166,798	-0.71	0.00	0				0.26	166,798
769.03	0.36	0.26	169,141	-0.70	0.00	0				0.26	169,141
769.04	0.37	0.27	171,453	-0.69	0.00	0				0.27	171,453
769.05	0.38	0.27	173,734	-0.68	0.00	0				0.27	173,734
769.06	0.39	0.27	175,986	-0.67	0.00	0				0.27	175,986
769.07	0.40	0.28	178,209	-0.66	0.00	0				0.28	178,209
769.08	0.41	0.28	180,405	-0.65	0.00	0				0.28	180,405
769.09	0.42	0.28	182,574	-0.64	0.00	0				0.28	182,574
769.10	0.43	0.29	184,718	-0.63	0.00	0				0.29	184,718
769.11	0.44	0.29	186,837	-0.62	0.00	0				0.29	186,837
769.12	0.45	0.29	188,932	-0.61	0.00	0				0.29	188,932
769.13	0.46	0.30	191,005	-0.60	0.00	0				0.30	191,005
769.14	0.47	0.30	193,055	-0.59	0.00	0				0.30	193,055
769.15	0.48	0.30	195,084	-0.58	0.00	0				0.30	195,084
769.16	0.49	0.30	197,091	-0.57	0.00	0				0.30	197,091
769.17	0.50	0.31	199,079	-0.56	0.00	0				0.31	199,079
769.18	0.51	0.31	201,047	-0.55	0.00	0				0.31	201,047
769.19	0.52	0.31	202,996	-0.54	0.00	0				0.31	202,996
769.20	0.53	0.32	204,926	-0.53	0.00	0				0.32	204,926
769.21	0.54	0.32	206,838	-0.52	0.00	0				0.32	206,838
769.22	0.55	0.32	208,733	-0.51	0.00	0				0.32	208,733
769.23	0.56	0.33	210,611	-0.50	0.00	0				0.33	210,611
769.24	0.57	0.33	212,472	-0.49	0.00	0				0.33	212,472
769.25	0.58	0.33	214,317	-0.48	0.00	0				0.33	214,317
769.26	0.59	0.33	216,146	-0.47	0.00	0				0.33	216,146
769.27	0.60	0.34	217,960	-0.46	0.00	0				0.34	217,960
769.28	0.61	0.34	219,758	-0.45	0.00	0				0.34	219,758
769.29	0.62	0.34	221,543	-0.44	0.00	0				0.34	221,543
769.30	0.63	0.35	223,313	-0.43	0.00	0				0.35	223,313
769.31	0.64	0.35	225,069	-0.42	0.00	0				0.35	225,069
769.32	0.65	0.35	226,811	-0.41	0.00	0				0.35	226,811
769.33	0.66	0.35	228,541	-0.40	0.00	0				0.35	228,541
769.34	0.67	0.36	230,257	-0.39	0.00	0				0.36	230,257

Bartlett & West

Project No. 21134.003
Project: Freeburg Wastewater System Improvements
Subject: Lagoon Storage and Flow Control Structures
Location: Freeburg, MO

769.35	0.68	0.36	231,960	-0.38	0.00	0				0.36	231,960
769.36	0.69	0.36	233,651	-0.37	0.00	0				0.36	233,651
769.37	0.70	0.36	235,330	-0.36	0.00	0				0.36	235,330
769.38	0.71	0.37	236,997	-0.35	0.00	0				0.37	236,997
769.39	0.72	0.37	238,653	-0.34	0.00	0				0.37	238,653
769.40	0.73	0.37	240,297	-0.33	0.00	0				0.37	240,297
769.41	0.74	0.37	241,930	-0.32	0.05	35,161				0.43	277,091
769.42	0.75	0.38	243,552	-0.31	0.11	70,323				0.49	313,874
769.43	0.76	0.38	245,163	-0.30	0.16	105,484				0.54	350,646
769.44	0.77	0.38	246,763	-0.29	0.22	140,645				0.60	387,408
769.45	0.78	0.38	248,354	-0.28	0.27	175,806				0.66	424,160
769.46	0.79	0.39	249,934	-0.27	0.33	210,968				0.71	460,901
769.47	0.80	0.39	251,504	-0.26	0.38	246,129				0.77	497,633
769.48	0.81	0.39	253,065	-0.25	0.44	281,290				0.83	534,355
769.49	0.82	0.39	254,616	-0.24	0.49	316,451				0.88	571,067
769.50	0.83	0.40	256,157	-0.23	0.54	351,613				0.94	607,770
769.51	0.84	0.40	257,690	-0.22	0.60	386,774				1.00	644,463
769.52	0.85	0.40	259,213	-0.21	0.65	421,935				1.05	681,148
769.53	0.86	0.40	260,727	-0.20	0.71	457,096				1.11	717,824
769.54	0.87	0.41	262,233	-0.19	0.76	492,258				1.17	754,491
769.55	0.88	0.41	263,730	-0.18	0.82	527,419				1.22	791,149
769.56	0.89	0.41	265,219	-0.17	0.87	562,580				1.28	827,799
769.57	0.90	0.41	266,699	-0.16	0.92	597,741				1.34	864,440
769.58	0.91	0.41	268,171	-0.15	0.98	632,903				1.39	901,074
769.59	0.92	0.42	269,635	-0.14	1.03	668,064				1.45	937,699
769.60	0.93	0.42	271,091	-0.13	1.09	703,225				1.51	974,316
769.70	1.03	0.44	285,245	-0.03	1.63	1,054,838				2.07	1,340,082
769.80	1.13	0.46	298,728	0.07	0.46	296,966				0.92	595,694
769.90	1.23	0.48	311,629	0.17	0.72	462,788				1.20	774,416
770.00	1.33	0.50	324,016	0.27	0.90	583,229				1.40	907,245
770.10	1.43	0.52	335,947	0.37	1.06	682,744				1.58	1,018,692
770.20	1.53	0.54	347,469	0.47	1.19	769,496				1.73	1,116,964
770.30	1.63	0.55	358,620	0.57	1.31	847,412				1.87	1,206,032
770.40	1.73	0.57	369,435	0.67	1.42	918,744				1.99	1,288,180
770.50	1.83	0.59	379,943	0.77	1.52	984,924				2.11	1,364,867
770.60	1.93	0.60	390,167	0.87	1.62	1,046,928				2.22	1,437,095
770.70	2.03	0.62	400,130	0.97	1.71	1,105,460				2.33	1,505,591
770.80	2.13	0.63	409,852	1.07	1.80	1,161,045				2.43	1,570,897
770.90	2.23	0.65	419,348	1.17	1.88	1,214,088				2.53	1,633,436
771.00	2.33	0.66	428,633	1.27	1.96	1,264,909				2.62	1,693,542
771.10	2.43	0.68	437,722	1.37	2.03	1,313,765				2.71	1,751,487
771.20	2.53	0.69	446,625	1.47	2.11	1,360,868				2.80	1,807,493
771.30	2.63	0.70	455,355	1.57	2.18	1,406,394				2.88	1,861,750
771.40	2.73	0.72	463,921	1.67	2.24	1,450,493				2.96	1,914,413
771.50	2.83	0.73	472,331	1.77	2.31	1,493,289				3.04	1,965,620



Vulcan Mensch - Severe Duty Bar Screen Evaluation

Mensch Severe Duty™ Bar Screen

Vulcan

Project Location:	Freeburg, MO
Project Engineering Firm:	Barlett & West
Vulcan Representative:	Ray Lindsey

Cells highlighted in BLUE are to be filled out by the user

Flow Conditions		
Peak Hour Flow Per Screen	0.042	MGD

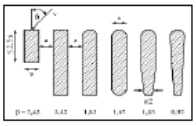
Channel Characteristics		
Width	2	ft
Depth	5	ft
Normal Depth (Flow Master)	0.3031	in
Downstream Water Level	0.03	ft

Bar Rack Characteristics		
Screen Frame Type	Insert Type Frame	
Desired Bar Spacing	1	inch
(1/4, 3/8, 1/2, 3/4, 1, 2, & 3" Options)		
Resulting Bar Size (leading edge)	0.3750	inch
Resulting Free Space Between Bars	0.85	ft
Resulting Effective Channel Width	1.17	ft

Clean Screen Condition Evaluation (Bernoulli's Equation)		
Clean Screen Condition	0%	blinded
Downstream Channel Velocity	1.29	ft/sec
Velocity Through Bars	3.03	ft/sec
WEF MOP No. 8 suggests 2 to 4 ft/s at clean screen		
Headloss	0.17	ft
Upstream Water Level	0.19	ft
Upstream Channel Velocity	0.17	ft/sec
Channel Freeboard	4.81	ft
Min. Recommended Channel Depth	1.69	ft
Cell highlighted red if minimum recommended is less than Channel Characteristics		

Blinded Condition Evaluation (Bernoulli's Equation)		
Alternative 1: Blinded Percent	25%	blinded
Headloss	0.33	ft
Upstream Water Level	0.35	ft
Channel Freeboard	4.65	ft
Min. Recommended Channel Depth	1.85	ft
Cell highlighted red if minimum recommended is less than Channel Characteristics		
Alternative 2: Blinded Percent	50%	blinded
Headloss	0.78	ft
Upstream Water Level	0.80	ft
Channel Freeboard	4.20	ft
Min. Recommended Channel Depth	2.30	ft
Cell highlighted red if minimum recommended is less than Channel Characteristics		

**Note that hydraulics calculations made above are based on Bernoulli's Principle and are considered to be conservative. Less conservative approaches include Kirschmer's Method and can be completed upon request



Kirschmer's Constants	
Screen Angle	45
Bar Shape Factor	2.42

Kirschmer's Comparison	
1.29	ft/sec
2.14	ft/sec
0.03	ft
0.06	ft
0.54	ft/sec
4.94	ft
1.56	ft

Blinded Conditions (Kirschmer)	
25%	blinded
0.05	ft
0.08	ft
4.92	ft
1.58	ft
50%	blinded
0.09	ft
0.11	ft
4.89	ft
1.61	ft

Kirschmer's hydraulic calculations provide more realistic results of what should be expected for bar screen hydraulics, however, there is little conservativism in this approach.

Flows:

ADF	Dry Weather Average Daily (Flow Monitoring)	42,000	GPD	0.042 MGD
	Permitted Design Flow	50,000	GPD	0.050 MGD
PHF	Peak Hour Influent Flow (1.5 CFS Peak Discharge into Cell 1 (From HECHMS)	914,080	GPD	0.91 MGD
	Minimum Flow (Lowest Diurnal on DWF - SSOAP)	2,866	GPD	0.00 MGD
MIN	Minimum Flow (Average Diurnal on DWF - SSOAP)	28,576	GPD	0.03 MGD
MAX	Maximum Flow through default Channel (estimate)	250,000	GPD	0.25 MGD

Kirschmer's Head Loss - Vulcan Bar Screens
Full Width Bar Rack
PROJECT:

Calculate Head Loss based on Flow Rate, Channel Width, Water Depth, Screen Angle, and Bar Shape Factor

Variable Description:	Variable:	Units:	Value:	
Flow Rate	Q	MGD	0.042	0.1 cfs
Channel Width	W	ft.	2	
Downstream Water Depth	Dd	ft.	0.025258	
Bar Width	w	in.	0.375	
Bar Clear Spacing	c	in.	1.00	
Bar Shape Factor	s	unitless	2.42	
Head Loss	Hf	ft.	0.01	0.1 in.
Velocity Head	vf	ft.	0.03	
Gravity Factor	g	ft/sec 2	32.20	
Downstream Channel Velocity	Vd	ft/sec	1.29	MOP 8 >/= 1.25
Screen Field Velocity	Vsc	ft/sec	1.29	
Effective Area	A	sq. ft.	0.05	
Angle of Bar	<	Deg.	45	0.8 rad.
Upstream Water Depth	Du		0.04	
Upstream Channel Velocity	Vu		0.87	
Velocity Between Bars	Vs	ft/sec	1.25	MOP 8 </= 4.0
Blinding Factor	bf	percent	0	0.00 fraction

Calculate Head Loss based on Flow Rate, Channel Width, Water Depth, Screen Angle, and Bar Shape Factor

Variable Description:	Variable:	Units:	Value:	
Flow Rate	Q	MGD	0.042	0.1 cfs
Channel Width	W	ft.	2	
Downstream Water Depth	Dd	ft.	0.025258	
Bar Width	w	in.	0.375	
Bar Clear Spacing	c	in.	1	
Bar Shape Factor	s	unitless	2.42	
Head Loss	Hf	ft.	0.02	0.2 in.
Velocity Head	vf	ft.	0.03	
Gravity Factor	g	ft/sec 2	32.20	
Downstream Channel Velocity	Vd	ft/sec	1.29	MOP 8 >/= 1.25
Screen Field Velocity	Vsc	ft/sec	1.29	
Effective Area	A	sq. ft.	0.04	
Angle of Bar	<	Deg.	45	0.8 rad.
Upstream Water Depth	Du		0.04	
Upstream Channel Velocity	Vu		0.76	
Velocity Between Bars	Vs	ft/sec	1.67	
Blinding Factor	bf	percent	25	0.25 fraction

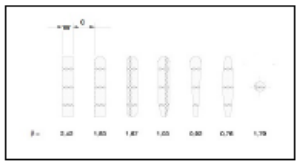
Calculate Head Loss based on Flow Rate, Channel Width, Water Depth, Screen Angle, and Bar Shape Factor

Variable Description:	Variable:	Units:	Value:	
Flow Rate	Q	MGD	0.042	0.1 cfs
Channel Width	W	ft.	2	
Downstream Water Depth	Dd	ft.	0.025258	
Bar Width	w	in.	0.375	
Bar Clear Spacing	c	in.	1	
Bar Shape Factor	s	unitless	2.42	
Head Loss	Hf	ft.	0.03	0.4 in.
Velocity Head	vf	ft.	0.03	
Gravity Factor	g	ft/sec 2	32.20	
Downstream Channel Velocity	Vd	ft/sec	1.29	MOP 8 >/= 1.25
Screen Field Velocity	Vsc	ft/sec	1.29	
Effective Area	A	sq. ft.	0.03	
Angle of Bar	<	Deg.	45	0.8 rad.
Upstream Water Depth	Du		0.06	
Upstream Channel Velocity	Vu		0.59	
Velocity Between Bars	Vs	ft/sec	2.50	
Blinding Factor	bf	percent	50.00	0.50 fraction

Formulas:
Velocity head: vf = Vsc^2/2g
Velocity between bars = Q/A
Head Loss: Hf = ((w/c)^4/3) * s * vf * sin <

Bar Shape Factors:
Rect Bar - Sq ends: 2.42
Rect Bar - Rnd Ends: 1.67
Trap. Bar: 0.92

Head Loss (blinded) Hfb = (w/(c-(c*bf)))^4/3 * s * vf * sin<



Kirschmer's Head Loss - Vulcan Bar Screens
Frames Inside Channel (bar rack width is channel width minus 10 inches)
PROJECT:

Calculate Head Loss based on Flow Rate, Channel Width, Water Depth, Screen Angle, and Bar Shape Factor

Variable Description:	Variable:	Units:	Value:	
Flow Rate	Q	MGD	0.042	0.1 cfs
Channel Width	W	ft.	2	
Downstream Water Depth	Dd	ft.	0.025258	
Bar Width	w	in.	0.375	
Bar Clear Spacing	c	in.	1.00	
Bar Shape Factor	s	unitless	2.42	
Head Loss	Hf	ft.	0.03	0.4 in.
Velocity Head	vf	ft.	0.08	
Gravity Factor	g	ft/sec 2	32.20	
Downstream Channel Velocity	Vd	ft/sec	1.29	MOP 8 >/= 1.25
Screen Field Velocity	Vsc	ft/sec	2.20	
Effective Area	A	sq. ft.	0.03	
Angle of Bar	<	Deg.	45	0.8 rad.
Upstream Water Depth	Du		0.06	
Upstream Channel Velocity	Vu		0.54	
Velocity Between Bars	Vs	ft/sec	2.14	MOP 8 </= 4.0
Blinding Factor	bf	percent	0	0.00 fraction

Calculate Head Loss based on Flow Rate, Channel Width, Water Depth, Screen Angle, and Bar Shape Factor

Variable Description:	Variable:	Units:	Value:	
Flow Rate	Q	MGD	0.042	0.1 cfs
Channel Width	W	ft.	2	
Downstream Water Depth	Dd	ft.	0.025258	
Bar Width	w	in.	0.375	
Bar Clear Spacing	c	in.	1	
Bar Shape Factor	s	unitless	2.42	
Head Loss	Hf	ft.	0.05	0.6 in.
Velocity Head	vf	ft.	0.08	
Gravity Factor	g	ft/sec 2	32.20	
Downstream Channel Velocity	Vd	ft/sec	1.29	MOP 8 >/= 1.25
Screen Field Velocity	Vsc	ft/sec	2.20	
Effective Area	A	sq. ft.	0.02	
Angle of Bar	<	Deg.	45	0.8 rad.
Upstream Water Depth	Du		0.08	
Upstream Channel Velocity	Vu		0.42	
Velocity Between Bars	Vs	ft/sec	2.86	
Blinding Factor	bf	percent	25.00	0.25 fraction

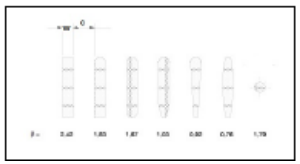
Calculate Head Loss based on Flow Rate, Channel Width, Water Depth, Screen Angle, and Bar Shape Factor

Variable Description:	Variable:	Units:	Value:	
Flow Rate	Q	MGD	0.042	0.1 cfs
Channel Width	W	ft.	2	
Downstream Water Depth	Dd	ft.	0.025258	
Bar Width	w	in.	0.375	
Bar Clear Spacing	c	in.	1	
Bar Shape Factor	s	unitless	2.42	
Head Loss	Hf	ft.	0.09	1.1 in.
Velocity Head	vf	ft.	0.08	
Gravity Factor	g	ft/sec 2	32.20	
Downstream Channel Velocity	Vd	ft/sec	1.29	MOP 8 >/= 1.25
Screen Field Velocity	Vsc	ft/sec	2.20	
Effective Area	A	sq. ft.	0.02	
Angle of Bar	<	Deg.	45	0.8 rad.
Upstream Water Depth	Du		0.11	
Upstream Channel Velocity	Vu		0.29	
Velocity Between Bars	Vs	ft/sec	4.29	
Blinding Factor	bf	percent	50.00	0.50 fraction

Formulas:
Velocity head: vf = Vsc^2/2g
Velocity between bars = Q/A
Head Loss: Hf = ((w/c)^4/3) * s * vf * sin <

Bar Shape Factors:
Rect Bar - Sq ends: 2.42
Rect Bar - Rnd Ends: 1.67
Trap. Bar: 0.92

Head Loss (blinded) Hfb = (w/(c-(c*bf)))^4/3 * s * vf * sin<



MISSOURI DEPARTMENT OF NATURAL RESOURCES
WATER PROTECTION PROGRAM

APPLICATION FOR CONSTRUCTION PERMIT – WASTEWATER TREATMENT FACILITY

FOR DEPARTMENT USE ONLY	
APP NO.	CP NO.
FEE RECEIVED	CHECK NO.
DATE RECEIVED	

APPLICATION OVERVIEW

The Application for Construction Permit – Wastewater Treatment Facility form has been developed in a modular format and consists of Part A and B. **All applicants must complete Part A.** Part B should be completed for applicants who currently land-apply wastewater or propose land application for wastewater treatment. **Please read the accompanying instructions before completing this form. Submittal of an incomplete application may result in the application being returned.**

PART A – BASIC INFORMATION

1.0 APPLICATION INFORMATION (Note – If any of the questions in this section are answered NO, this application may be considered incomplete and returned.)

1.1 Is this a Federal/State funded project? ☑ YES ☐ N/A Funding Agency: SRF Project #: C295922-01

1.2 Has the Missouri Department of Natural Resources approved the proposed project's antidegradation review?
☐ YES Date of Approval: _____ ☑ N/A

1.3 Has the department approved the proposed project's facility plan*?
☐ YES Date of Approval: _____ ☑ NO (If No, complete No. 1.4.)

1.4 [Complete only if answered No on No. 1.3.] Is a copy of the facility plan* for wastewater treatment facilities included with this application?
☑ YES ☐ NO ☐ Exempt because Report funded by CWSRF ERG Program and submitted 02/24/2023.

1.5 Is a copy of the appropriate plans* and specifications* included with this application?
☑ YES Denote which form is submitted: ☑ Hard copy ☑ Electronic copy (See instructions.) ☐ NO

1.6 Is a summary of design* included with this application? ☑ YES ☐ NO

1.7 Has the appropriate operating permit application (A, B, or B2) been submitted to the department?
☑ YES Date of submittal: 10/2025
☑ Enclosed is the appropriate operating permit application and fee submittal. Denote which form: ☐ A ☑ B ☐ B2
☐ N/A: However, In the event the department believes that my operating permit requires revision to permit limitation such as changing equivalent to secondary limits to secondary limits or adding total residual chlorine limits, please share a draft copy prior to public notice? ☐ YES ☐ NO

1.8 Is the facility currently under enforcement with the department or the Environmental Protection Agency? ☐ YES ☑ NO

1.9 Is the appropriate fee or JetPay confirmation included with this application? ☑ YES ☐ NO
See Section 7.0

* Must be affixed with a Missouri registered professional engineer's seal, signature and date.

2.0 PROJECT INFORMATION

2.1 NAME OF PROJECT
Freeburg, MO Wastewater System Improvements

2.2 ESTIMATED PROJECT CONSTRUCTION COST
$ 3,765,990

2.3 PROJECT DESCRIPTION
Project consists of improvements to Freeburg's existing treatment process to allow for the removal of ammonia and E. Coli by adding post-lagoon MBBR and UV disinfection. Project also includes an influent headworks for solids removal along with other hydraulic improvements.

2.4 SLUDGE HANDLING, USE AND DISPOSAL DESCRIPTION
stored in lagoon

2.5 DESIGN INFORMATION

A. Current population: 464 ; Design population: 1000

B. Actual Flow: 42000 gpd; Design Average Flow: 50000 gpd;
Actual Peak Daily Flow: _____ gpd; Design Maximum Daily Flow: 106K gpd; Design Wet Weather Event: 969K

2.6 ADDITIONAL INFORMATION

A. Is a topographic map attached? ☑ YES ☐ NO

B. Is a process flow diagram attached? ☑ YES ☐ NO

3.0 WASTEWATER TREATMENT FACILITY

NAME	TELEPHONE NUMBER WITH AREA CODE	E-MAIL ADDRESS
Village of Freeburg WWTF	573-690-6689	villageoffreeburg@gmail.com

ADDRESS (PHYSICAL)	CITY	STATE	ZIP CODE	COUNTY
0.45 mi E of Gilbert Ave. & Hwy 63	Freeburg	MO	65035	Osage

Wastewater Treatment Facility: Mo- 0058220 (Outfall 1 Of 1)

3.1 Legal Description: _____ ¼, _____ ¼, _____ ¼, Sec. 10, T 41N, R 09W
(Use additional pages if construction of more than one outfall is proposed.)

3.2 UTM Coordinates Easting (X): 594956 Northing (Y): 4241266
For Universal Transverse Mercator (UTM), Zone 15 North referenced to North American Datum 1983 (NAD83)

3.3 Name of receiving streams: Tributary to Steuber Hollow Creek

4.0 PROJECT OWNER

NAME	TELEPHONE NUMBER WITH AREA CODE	E-MAIL ADDRESS
Village of Freeburg, MO	573-690-6689	villageoffreeburg@gmail.com

ADDRESS	CITY	STATE	ZIP CODE
304 S. Highway 63, PO Box 237	Freeburg	MO	65035

5.0 CONTINUING AUTHORITY: A continuing authority is a company, business, entity or person(s) that will be operating the facility and/or ensuring compliance with the permit requirements.

NAME	TELEPHONE NUMBER WITH AREA CODE	E-MAIL ADDRESS
Village of Freeburg, MO	573-690-6689	villageoffreeburg@gmail.com

ADDRESS	CITY	STATE	ZIP CODE
304 S. Highway 63, PO Box 237	Freeburg	MO	65035

5.1 A letter from the continuing authority, if different than the owner, is included with this application. ☐ YES ☐ NO ☑ N/A

5.2 COMPLETE THE FOLLOWING IF THE CONTINUING AUTHORITY IS A MISSOURI PUBLIC SERVICE COMMISSION REGULATED ENTITY.

A. Is a copy of the certificate of convenience and necessity included with this application? ☐ YES ☐ NO

5.3 COMPLETE THE FOLLOWING IF THE CONTINUING AUTHORITY IS A PROPERTY OWNERS ASSOCIATION.

A. Is a copy of the as-filed restrictions and covenants included with this application? ☐ YES ☐ NO

B. Is a copy of the as-filed warranty deed, quitclaim deed or other legal instrument which transfers ownership of the land for the wastewater treatment facility to the association included with this application? ☐ YES ☐ NO

C. Is a copy of the as-filed legal instrument (typically the plat) that provides the association with valid easements for all sewers included with this application? ☐ YES ☐ NO

D. Is a copy of the Missouri Secretary of State's nonprofit corporation certificate included with this application? ☐ YES ☐ NO

6.0 ENGINEER

ENGINEER NAME / COMPANY NAME	TELEPHONE NUMBER WITH AREA CODE	E-MAIL ADDRESS
Kyle J. Landwehr P.E. / Bartlett & West	573-659-6727	kyle.landwehr@bartwest.com

ADDRESS	CITY	STATE	ZIP CODE
601 Monroe St., Ste. 201	Jefferson City	MO	65101

7.0 APPLICATION FEE

☐ CHECK NUMBER ☑ JETPAY CONFIRMATION NUMBER 20070825

8.0 PROJECT OWNER: I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

PROJECT OWNER SIGNATURE: Darryl Haller

PRINTED NAME	DATE
Darryl Haller	November 3, 2025

TITLE OR CORPORATE POSITION	TELEPHONE NUMBER WITH AREA CODE	E-MAIL ADDRESS
Board Chairman	573-690-6689	dhaller@quakerwindows.com

Mail completed copy to: MISSOURI DEPARTMENT OF NATURAL RESOURCES
WATER PROTECTION PROGRAM
P.O. BOX 176
JEFFERSON CITY, MO 65102-0176

END OF PART A.
REFER TO THE APPLICATION OVERVIEW TO DETERMINE WHETHER PART B NEEDS TO BE COMPLETE.

PART B – LAND APPLICATION ONLY
(Submit only if the proposed construction project includes land application of wastewater.)

8.0 FACILITY INFORMATION

8.1 Type of wastewater to be irrigated: ☐ Domestic ☐ State/National Park ☐ Seasonal business
☐ Municipal ☐ Municipal with a pretreatment program or significant industrial users
☐ Other (explain) _____

8.2 Months when the business or enterprise will operate or generate wastewater:
☐ 12 months per year ☐ Part of the year (list months): _____

8.3 This system is designed for:
☐ No-discharge.
☐ Partial irrigation when feasible and discharge rest of time.
☐ Irrigation during recreational season, April – October, and discharge during November – March.
☐ Other (explain) _____.

9.0 STORAGE BASINS

9.1 Number of storage basins: _____ (Use additional pages if greater than three basins.)

9.2 Type of basins: ☐ Steel ☐ Concrete ☐ Fiberglass ☐ Earthen ☐ Earthen with membrane liner

9.3 Storage basin dimensions at inside top of berm (feet). Report freeboard as feet from top of berm to emergency spillway or overflow pipe.
Basin #1: Length _____ Width _____ Depth _____ Freeboard _____ Depth _____ Safety _____ % Slope _____
Basin #2: Length _____ Width _____ Depth _____ Freeboard _____ Depth _____ Safety _____ % Slope _____
Basin #3: Length _____ Width _____ Depth _____ Freeboard _____ Depth _____ Safety _____ % Slope _____

9.4 Storage Basin operating levels (report as feet below emergency overflow level).
Basin #1: Maximum operating water level _____ ft Minimum operating water level _____ ft
Basin #2: Maximum operating water level _____ ft Minimum operating water level _____ ft
Basin #3: Maximum operating water level _____ ft Minimum operating water level _____ ft

9.5 Design depth of sludge in storage basins.
Basin #1: _____ ft Basin #2: _____ ft Basin #3: _____ ft

9.6 Existing sludge depth, if the basins are currently in operation.
Basin #1: _____ ft Basin #2: _____ ft Basin #3: _____ ft

9.7 Total design sludge storage: _____ dry tons and _____ cubic feet

10.0 LAND APPLICATION SYSTEM

10.1 Number of irrigation sites _____ Total Acres _____ Maximum % field slopes _____
Location: _____ ¼, _____ ¼, _____ ¼, _____ Sec. _____ T _____ R _____ County _____ Acres
Location: _____ ¼, _____ ¼, _____ ¼, _____ Sec. _____ T _____ R _____ County _____ Acres
Location: _____ ¼, _____ ¼, _____ ¼, _____ Sec. _____ T _____ R _____ County _____ Acres
(Use additional pages if greater than three irrigation sites.)

10.2 Type of vegetation: ☐ Grass hay ☐ Pasture ☐ Timber ☐ Row crops
☐ Other (describe) _____

10.3 Wastewater flow (dry weather) gallons per day: Average annual _____ Seasonal _____ Off-season _____

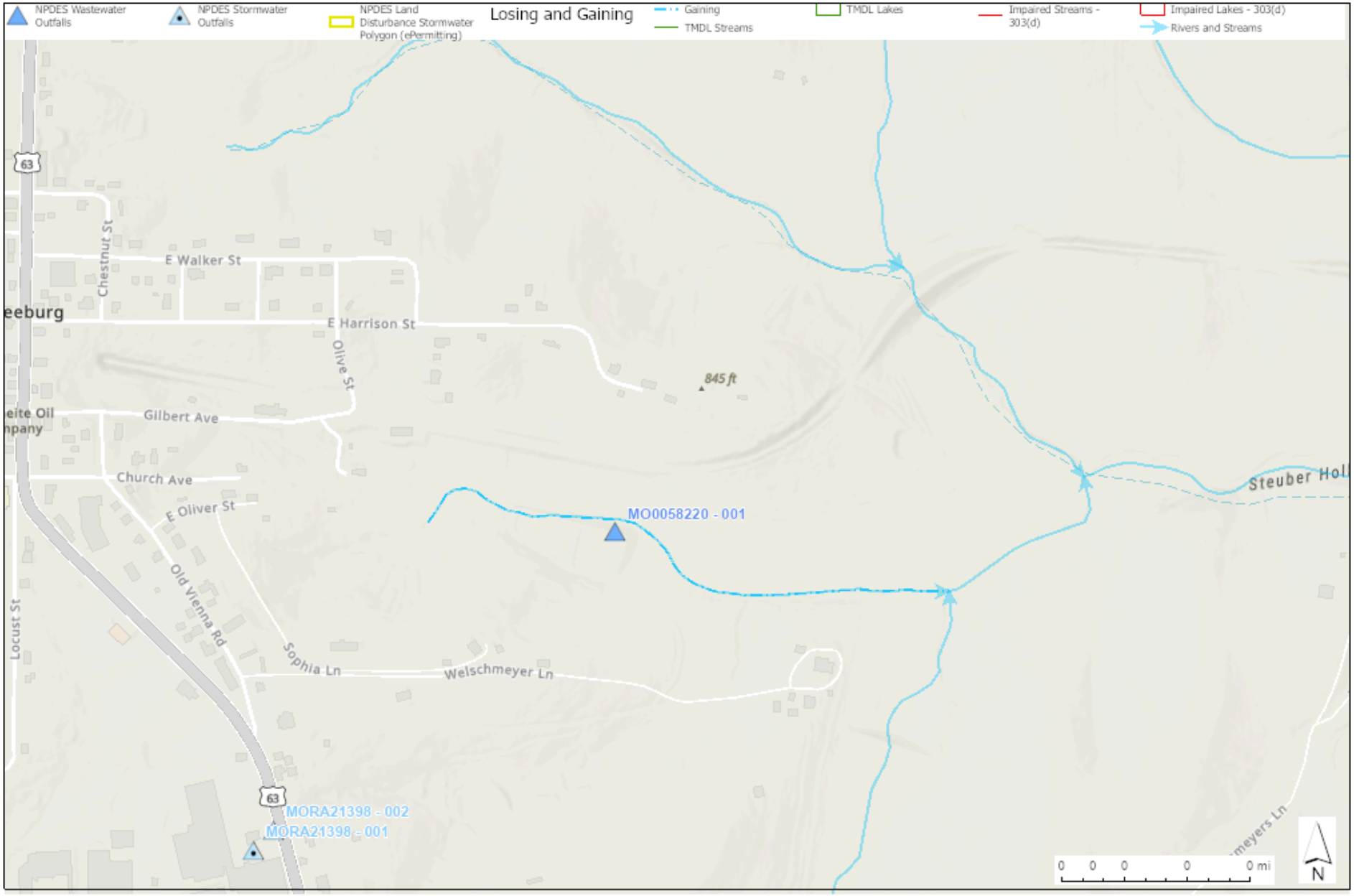
10.4 Land application rate (design flow including 1-in-10 year storm water flows):
Design: _____ inches/year _____ inches/hour _____ inches/day _____ inches/week
Actual: _____ inches/year _____ inches/hour _____ inches/day _____ inches/week

10.5 Total irrigation per year (gallons): Design: _____ gal Actual: _____ gal

10.6 Actual months used for irrigation (check all that apply):
☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☐ Dec

10.7 Land application rate is based on:
☐ Hydraulic Loading ☐ Other (describe) _____
☐ Nutrient Management Plan (N&P) If N&P is selected, is the plan included? ☐ YES ☐ NO

Missouri Accessible Permitting Information Tool



World Hillshade: Esri, NASA, NGA, USGS, FEMA

October 29, 2025 1:00 PM CDT

MISSOURI DEPARTMENT OF NATURAL RESOURCES

BAR IS ONE INCH ON OFFICIAL DRAWINGS. 0 1" IF NOT ONE INCH, ADJUST SCALE ACCORDINGLY.

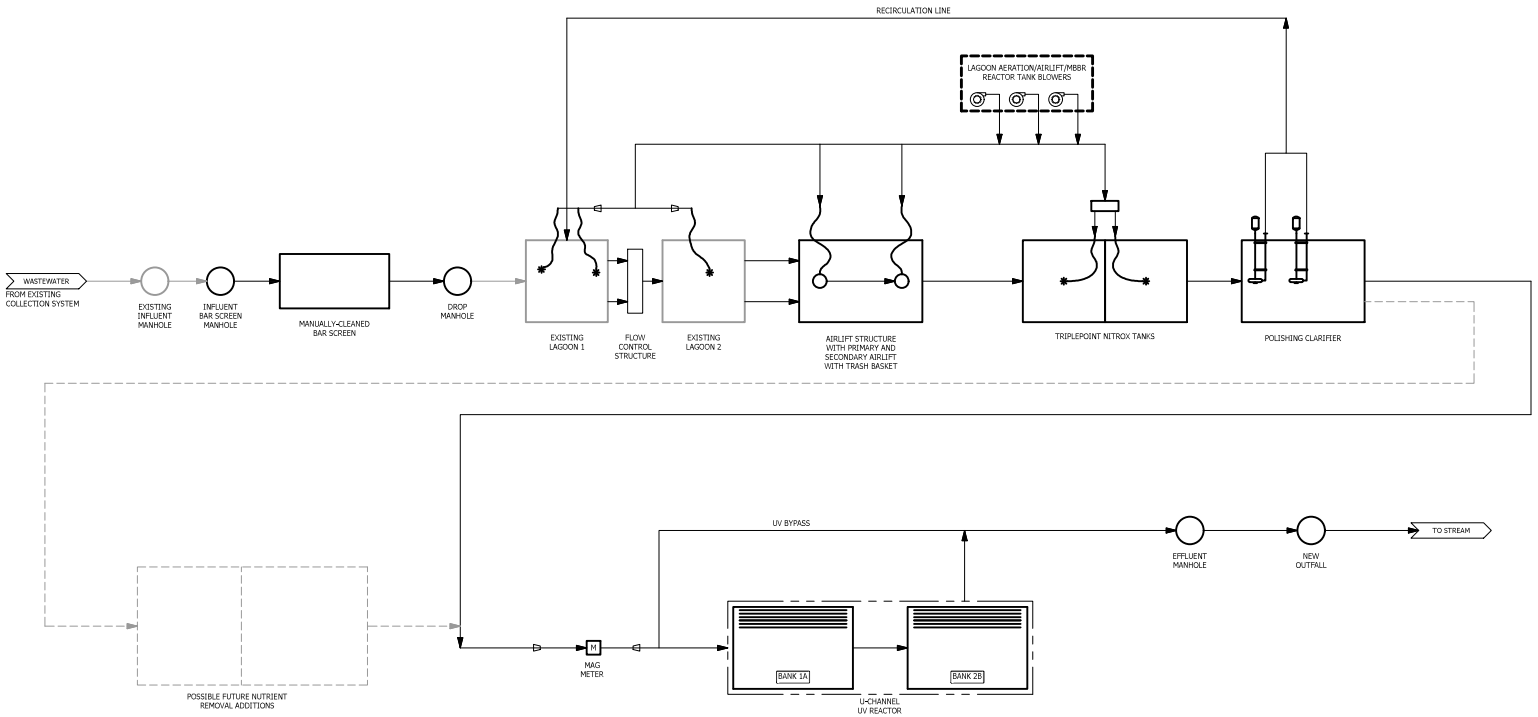
PROPOSED DESIGN CRITERIA	UNITS	VALUE
WWTF PLANT (INTO LAGOONS)		
DRY WEATHER AVERAGE DAILY FLOW	GPD	42,000
MAXIMUM MONTYLY AVERAGE DAILY FLOW	GPD	50,000
PEAK HOURLY INFLUENT FLOW	GPD	969,475
TREATMENT THROUGHPUT (INTO MBBR REACTOR TANKS)		
AVERAGE DAILY FLOW	GPD	50,000
PERMITTED DESIGN FLOW	GPD	100,000
PEAK DAILY FLOW	GPD	106,250
PEAK HOURLY FLOW (MAXIMUM PEAK DAILY HYDRAULIC THROUGHPUT)	GPD	258,527
INFLUENT LOADING @ AVERAGE DAILY FLOW OF 50,000 GPD:		
RAW WASTEWATER INFLUENT BOD	MG/L	250
RAW WASTEWATER INFLUENT TSS	MG/L	420
RAW WASTEWATER INFLUENT TKN	MG/L	45
RAW WASTEWATER INFLUENT ALKALINITY	MG/L	294
RAW WASTEWATER INFLUENT AMMONIA	MG/L	35

GENERAL NOTES:

1. PIPE, FITTINGS, VALVES, EQUIPMENT, ETC., TAGS AND LABELS ARE PROVIDED AS A COURTESY FOR THE CONTRACTOR. IT IS NOT THE INTENT OF THESE CALLOUTS, LABELS, AND TAGS TO BE A BILL OF MATERIAL LIST. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL ITEMS EITHER CALLED OUT OR SHOWN IN THE DRAWINGS AND/OR SPECIFICATIONS.
2. NOT ALL PIPE SUPPORTS AND HANGERS ARE SHOWN. CONTRACTOR SHALL ADEQUATELY SUPPORT ALL PIPING PER SPECIFICATION SECTION 400521.

LEGEND

- PRIMARY LINE SEGMENT
- SECONDARY LINE SEGMENT
- PRIMARY LINE SEGMENT - FUTURE
- PRIMARY LINE SEGMENT - EXISTING
- EQUIPMENT
- EQUIPMENT BOUNDARY



PROCESS FLOW DIAGRAM

WASTEWATER SYSTEM FACILITY
CITY OF FREEBURG WASTEWATER FACILITY
OSAGE COUNTY, MISSOURI

Bartlett & West
601 MONROE STREET, SUITE 201 • JEFFERSON CITY, MO 65101-2180
PHONE 573.634.2691
FAX 573.635.3017
www.bartlettwest.com
CERTIFICATE OF AUTHORITY NO. 000822

STATE OF MISSOURI
MAX A KURINSKY
PE-2025042269
PROFESSIONAL ENGINEER
10/28/2025

SEALED DATE:	10/27/2025
DESIGNED BY:	MAK
DRAWN BY:	AJW
APPROVED BY:	KJL
DESIGN PROJ:	21134J003
DATE:	OCTOBER 2025
DRAWING NO:	G-601
SHEET NO:	4 of 69

Last edit on: 9/10/2025 3:56 PM by: BSM00992
Drawing Name: W:\Proj\21000\21134\21134.A003\AutoCad\Plan Set\01 General\21134.A003G_PFD.dwg Layout Name: G-601 Plotted By: BSM00992 Plotted on: 10/27/2025 5:06:00 PM