

SECTION 8: DESIGN OF FORCE MAINS & LIFT STATIONS

8.1. PURPOSE

MUPB's intent of this section describes the minimum requirements for design of force main(s) and lift station(s). These requirements are listed to ensure that any development/extensions have adequate capacity to transport sanitary sewer while not having a negative impact upon other existing sanitary sewer facility. MUPB requires that planning of gravity sewer mains, force mains, low pressure collection systems and lift stations be based upon ultimate sewershed population and not just the development population, to minimize maintenance and operational costs

8.2. DESIGN APPROACH & CRITERIA

Proposed construction or expansion of the wastewater facilities within the MUPB Service Area shall be in compliance with the approved MUPB Regional Facilities Plan, Recommended Standards for Wastewater Works (Commonly referenced as the 10 State Standards), the MUPB Sewer Use Ordinance, the Kentucky Administrative Regulations (KAR) and guidelines defined in this Manual.

Any person, company, corporation, or other entity proposing to develop land or to install new or replacement force main(s) and/or lift station(s) within the MUPB Service Area must prepare, for review and approval by MUPB, planning and design documents according to the standards and requirements of this Manual. Planning and construction documents must be prepared and certified by a Professional Engineer licensed in the Commonwealth of Kentucky. The service level of proposed facilities shall be according to standards referenced in these documents. Design standards shall be those referenced herein.

8.3. HYDRAULIC LOADINGS

MUPB has established the policy of sizing facilities based upon ultimate sewershed populations. This policy requires the OWNER/DEVELOPER to design based upon all future flows within the sewershed and not just the proposed development. In time, future developments may connect to the existing infrastructure limiting the amount of sanitary sewer facilities to be maintained and operated, thus reducing the maintenance and operational costs for MUPB. Future flows are to be based upon current and anticipated residential, commercial, and industrial uses; and where land is vacant, or based upon customer demands as outlined in SECTION 3 – Design of Water Facilities.

8.3.1. SEWERSHED POPULATION

A. Sewershed population and projected flow rates shall be calculated as a basis of design for all sanitary sewers. Development site plan(s) shall be incorporated into a topographic map, displaying the proposed development in relationship to the sewershed it is to be incorporated into.



B. Estimated sewershed population shall be based upon a 20-year time period, based upon available land and projected population growth. Current zoning and planning maps shall be utilized to estimate flow rates.

8.3.2. FLOW CALCULATIONS & CAPACITIES

- A. In determining the necessary capacity of sanitary sewer facilities, the following factors shall be considered:
 - 1. Peak quantity of domestic sanitary sewer
 - 2. Industrial and/or Commercial sanitary sewer
- B. Sanitary Sewer facilities shall be designed on the basis of an average flow with respect to standardized flow rates of residential structures, Equivalent Residential Units (ERUs). Calculations of sanitary sewer generation shall be based upon water demand, see SECTION 3 – Design of Water Facilities.
- C. Sanitary Sewer facilities shall be designed to transport peak flows (Q_{peak}). The peaking factor shall be based upon the criteria as shown in RECOMMENDED STANDARDS FOR WASTEWATER FACILITIES (2014 Edition), TEN STATE STANDARDS, Hydraulic Capacity for Wastewater Facilities to Serve New Collection Systems (Figure 1). Force mains shall be a minimum of 4-inch diameter.
- 8.3.3. BUOYANCY OF WET WELL/VALVE VAULT
 - A. ENGINEER shall provide calculations to determine the buoyancy of the designed wet well/valve vault. These calculations should be based upon the lift station plans and details.
 - B. Buoyancy shall be analyzed on the wet well/valve vault to determine whether additional methods of restraint are necessary. Mechanical equipment, water weight, and other temporary loads shall not be included in the analysis. A safety factor of 1.5 (minimum) is required.

8.4. CLASSES OF LIFT STATION

MUPB has established a sewershed approach for all lift stations. A lift station will only be constructed in an area to service the entire sewershed and not only the proposed DEVELOPMENT, unless expressly approved by MUPB.

Each sewershed will have differing amounts of sanitary sewer flow being generated within it, thus MUPB has established differing tiers of lift stations based upon flow rates of the pumps. These tiers have different requirements based upon the pumping rate.



8.4.1. CLASS "A" LIFT STATION

Class A Lift Station shall be designed for the ultimate design capacity of the sewershed. Class A lift station shall have submersible pumps depending on the available head conditions. Class A lift stations shall have the following components:

- Flow meter
- Odor Control
- Standby Generator or Secondary Power Source
- Telemetry/SCADA system
- By-pass pumping connections
- Concrete, cast-in-place wet well
- Security Fence
- Access Road
- Landscaping
- Flow rate more than 500 gpm, with a single pump operating

8.4.2. CLASS "B" LIFT STATION

Class B Lift Station shall be designed for the ultimate design capacity of the sewershed. Class B lift station shall have submersible pumps depending on the available head conditions. Class B lift stations shall have the following components:

- Odor Control, as required
- Standby Generator or Secondary Power Source
- Telemetry/SCADA system
- By-pass pumping connections
- Precast concrete wet well
- Security Fence
- Access Road
- Landscaping
- Flow rate greater than 200 gpm and less than 500 gpm, with a single pump operating

8.4.3. CLASS "C" LIFT STATION

Class C Lift Station shall be designed for the ultimate design capacity of the sewershed. Class C lift station shall be a submersible pump. Class C lift stations shall have the following components:

- Odor Control, as required
- Two-hour Emergency Storage
- Telemetry/SCADA system
- By-pass pumping connections
- Precast concrete wet well or fiberglass



- Security Fence
- Access Road
- Landscaping
- Flow rate less than 200 gpm, with a single pump operating

8.4.4. LIFT STATION STYLE

A. SUBMERSIBLE: Submersible lift stations are defined as pumps located within the wet well and have discharge piping that extend up in the wet well into a valve vault. Pumps can be raised and lowered out of the wet well by the guiderails and crane or lifting chain.

8.5. HYDRAULIC MODEL

MUPB requires a hydraulic model to be presented with submittal of plans for review. The hydraulic model shall include all connected lift station(s), grinders and associated force main(s), to demonstrate the impact of the proposed lift station upon the existing sanitary sewer facilities. MUPB will provide OWNER the necessary information regarding the existing pressure network of force mains, grinders and lift stations.

As an alternate to providing a hydraulic model to MUPB, the OWNER/DEVELOPER may elect to have MUPB develop the required hydraulic model of the development/extension with all associated connections and facilities necessary. In order for MUPB to develop the required hydraulic model, the OWNER/DEVELOPER acknowledges that the cost for developing the model will be paid by the OWNER/DEVELOPER at the rate described below.

EXTENSION LENGTH (Total Footage)	FEE
Small Extension (<1,000 Total LF)	\$ 1,000
Medium Extension (1,001 to 5,000 Total LF)	\$ 2,000
Large Extension (> 5,001 Total LF)	\$ TBD

The hydraulic model shall follow guidelines set forth by Kentucky Division of Water (KDOW) in Construction Permit Application (S-1). OWNER/DEVELOPER shall submit the Hydraulic Model Information Sheet in APPENDIX J.

8.5.1. KDOW REQUIREMENTS

KDOW S-1 requires at a minimum the following hydraulic information to be provided with the hydraulic model:

A. Provide pump sizing calculations and the proposed pump's characteristics curve along with the efficiency, horsepower and NPSHR data, if applicable.



- B. Wet well design calculations: cycling of pumps, on/off levels, buoyancy calculations and 2-hour storage.
- C. Hydraulic model must demonstrate the availability of pipe velocity of 2.0 fps, under normal operation of a single pump.

8.5.2. MUPB REQUIREMENTS

MUPB requires the following information to be included in addition to KDOW requirements:

- A. A written hydraulic model summary, area map and electronic copy of the model for review. Identify the computer modeling software utilized and provide all related database files to ensure model will import to PIPE2020 or latest version.
- B. Provide a system map showing the modeled pipe network. Label all pipes, nodes, road names, north arrow, scale, number of units, unit type, demands, elevation contours and outline of the phasing, if applicable.
- C. Save model files to be descriptive of the scenario being modeled (ie both pumps at alarm.p2k, both pumps at off level.p2k, etc.) to ensure that during the review by MUPB it is an accurate representation of the model prepared by ENGINEER.
- D. Model must represent the entire development, including all known future phases.
- E. All existing wastewater flows shall be represented in model to accurately represent actual operating conditions.
- F. If lift station and force mains discharge into a section of gravity sanitary sewer, it shall be demonstrated that new flows will not cause surcharging in the existing system.
- G. If new flows ultimately will be transported by an existing lift station, then ENGINEER shall demonstrate that new wastewater flows will not cause harm (SSOs, continuous pump operation, etc.) to the existing lift station.
- H. Provide a pipe report to display name, diameter, flow, velocity, length and head loss.
- I. Provide a conclusion of results, table listing nodes with maximum and minimum pressures for all situations modeled. Table of Max/Min shall include 10% of the number of nodes within development, minimum of 5 for each.



8.6. LIFT STATION SITE

- A. Sanitary sewer lift station sites will be determined with input from MUPB. Lift stations shall be located outside of flood prone areas, if the station must be located within a flood prone area, specific precautions shall be made to protect the station. All finished floors, tops of all structures (below ground) and equipment shall be above the 100-year flood elevation at minimum at least 1 foot above.
- B. Lift station shall have a dedicated paved access drive, security fence, landscape, and exterior lighting. All lift station sites shall be deeded to MUPB in fee simple prior to MUPB assuming ownership, operational and maintenance controls. An easement for ingress/egress for an access road would be permissible.
- C. Lift station shall be placed in area with ease of access for maintenance equipment including but not limited to the following: crane, excavation equipment (backhoe, excavator, etc.), jetter, vacuum truck and maintenance trucks.
- D. Lift station site shall have an access road with enough room to allow access to the wet well with a vacuum truck, tandem pumper truck and to accommodate deliveries by a chemical tanker. Recommend clearance shall be twenty feet vertically above station all appurtenances.
- E. The requisite amount of exterior lighting shall be determined on a case-by-case basis. The site shall be landscaped so as to require a minimum of maintenance. Wherever possible, lift stations shall be hidden from view of nearby neighbors and roads. If necessary, lift stations shall be hidden through the use of tree/shrub plantings or privacy fencing. Quantity and type of tree/shrub must be approved by MUPB and meet the requirements set forth by MRCP&Z. Required buffers shall comply with MRCP&Z.
- F. A 12-foot wide, paved access road with gravel shoulders shall be provided to the station. The minimum road section will consist of a compacted sub-grade, 8 inches of DGA stone and 3 inches of bituminous pavement. The gradient of the roadway centerline shall not exceed 5 percent. Unrestricted ingress and egress will be granted to MUPB from a public right of way to the lift station. On all access roads, a locking gate shall be provided at the entrance to the access road from the public right of way.
- G. An unrestricted, all weather access road to the station will be maintained by the CONTRACTOR/DEVELOPER until the permanent access road is complete and accepted by MUPB. MUPB must have access to the station at all times.
- H. A 6-foot high, chain link security fence topped with angle arms pointing out and 3 strands of barbed wire shall be provided around the lift station lot. The total height of this assembly is 7 feet. The fence shall be equipped with a top rail and a bottom tension wire. Access into the station will be through a minimum 16-foot wide, lockable gate. Depending upon the location of the lift station an alternative fencing system may be required by MUPB.



- I. OWNER/DEVELOPER shall have all door locks and padlocks in the station will be keyed to MUPB's standard keys. All padlocks will be provided by MUPB.
- J. Adequate provisions will be made for parking and turning large vehicles around at the station.
- K. The project specifications will specify a paint or other protective coating for all corrodible materials not otherwise protected. The type, color and thickness of the paint or other protective coating are subject to the approval of MUPB.

8.7. LIFT STATION DESIGN CRITERIA

The following parameters have been established by MUPB to ensure that future lift stations and modifications made to existing lift stations meet a minimum standard. The parameters listed in the following paragraphs are not a complete listing of all situations that may be encountered but is a minimum standard to be met. Any variance from these parameters requires MUPB approval.

8.7.1. PUMP SIZING

- A. All pump openings and passages shall be large enough to pass a sphere 3-inch in diameter and any debris that can pass through a 4-inch lateral connection, unless a grinder pump is being specified.
- B. All pumps shall be warranted against defects in workmanship and material for 5,000 hours of operation under normal operation, use and service. The warranty shall begin upon final acceptance of the station by MUPB.
- C. New lift stations and force mains shall have a hydraulic model constructed in PIPE2020 or other approved software package. Hydraulic models shall include all potential force main connections, including residential grinders. Roughness factor (Hazen-Williams C factor) for new force mains shall be equal to 120. For existing pump upgrades, field determination of actual C factor is required.
- D. In certain applications, a force main may flow by gravity when the hydraulic grade line is below the ground elevation. This can occur when a force main pumps across high elevation and then discharge to a point significantly below the high point.

8.7.2. WET WELL SIZING

- A. Wet well shall be designed for a minimum pump cycles (on/off) of 2 times per hourwith a maximum pump cycles (on/off) of 6 times per hour.
- B. Wet wells shall be designed such that the distance between alarm points is not less than 1-foot, unless otherwise authorized by MUPB. Wet wells



shall have a 2-foot free board above alarm level from inlet for future expansion.

C. Wet well filets shall be sloped at 1:1 to the hopper bottom. Hopper bottom shall be no larger than necessary per manufacturers recommendations.

8.7.3. TWO-HOUR STORAGE

Two-hour storage is required of all lift stations without a backup generator or secondary power source.

- 8.7.4. BACKUP POWER
 - A. Certain lift stations will require on-site backup power via generator or engine driven motor. All backup power shall be designed to handle full load application with all ancillary items operating. Automatic transfer switches are required for all pumps where generator and/or engine driven motors are on-site.
 - B. Standby generators shall be diesel driven with fuel storage on the underside of the generator in a double-walled containment tank. The tank shall be sized for 48 hours of continuous use at full load, if possible. Skid mounted tanks are not acceptable. A fuel storage level indicator will be provided for the generator. Fuel tank shall be refilled after all startup and testing is complete by OWNER/CONTRACTOR.
 - C. The generator will be equipped with an alarm indicator and output contacts to display the cause of a generator failure, both locally and remotely. The means for starting an emergency generator shall be completely independent of the normal electric power source. The starting system shall be sufficient to start the generator a minimum of 3 times without recharging. The starting system shall be alarmed and instrumented to indicate a loss of readiness.
 - D. Generator to be located as far away as possible from any corrosive gases that will be discharged on a regular basis.

8.7.5. VALVES & PIPING

- A. Isolation valves shall be located on the discharge lines of each pump to allow the pump to be isolated. A check valve shall be installed on each discharge line, between the pump and the isolation valve. Isolation and check valves may be located either inside the lift station building or in a separate valve vault but shall not be located in the wet well under any circumstances. Isolation valves for pumps in wet well shall be full port plug valves.
- B. Valves shall be installed on each side of the flow meter.



- C. The velocity in the suction line shall-not exceed 4 fps. The velocity in the discharge line shall not exceed 6 fps. Pressure gauges with isolation valves will be installed on the pump side of the check valve. Gauge taps with valves will be installed on the suction side of each pump for suction lift pumps. Pressure gauge shall have a range with the operating pressure between 1/3 to 2/3 of the maximum gauge pressure. All pressure gauges shall be 4" in diameter.
- D. Flexible, watertight connections shall be provided for all below grade pipe and conduit connections to wet wells and valve vaults.

8.7.6. LIGHTING

Adequate lighting shall be provided throughout the lift station. All lighting fixtures shall be rated for the environment in which they are installed. Where applicable LED fixtures shall be installed in accordance with the manufacturer's recommendations to provide adequate heat dissipation and maximize the life expectancy of the fixture. LED fixtures shall have a 0° F start ballast and have a plastic lens to protect the lamps.. All lighting shall have a HOA switch.

8.7.7. FLOW METERING

All lift stations with flow rate in excess of 500 gpm shall be provided with a magnetic type flow meter, equipped for wastewater service, with a bypass line and valves to enable lift station to operate when meter is being serviced. ENGINEER shall submit proposed flow meter manufacturer, model, size, and literature to MUPB for approval.

Range of flow meter shall be half (0.5x) to twice (2x) the designed pump output. All flow meters shall have an adequate length of straight pipe both upstream and downstream of the meter in accordance with manufacturer's recommendations. Provide a totalizer and indicator/transmitter in units of gpm. Flow metering equipment except for the sensor will be located in the building/control panel.

8.7.8. CONTROLS

- A. Control panel shall be installed via a strut mounted system not located on top of the wet well. A junction box shall be located on top of wet well for connection of power cords. All efforts shall be made to make control panel air tight from any and all sewer gas entry into the panel.
- B. The pumps shall be controlled by means of a pressure transducer. The pressure transducer shall be programmed to turn the pumps on or off at various levels in the wet well. A spare transducer shall be provided for each lift station wet well.
- C. The transmitter sensor shall be mounted near the top of the wet well and



be removable without entering the wet well. The transmitter shall also report the level in the wet well on an indicator located inside the building or in the control panel for Class B or C.

- D. The lift station shall also have a back-up pressure transducer control system with transducers or a back-up float control system (minimum of two floats) for turning the individual pumps on and off if the primary pressure transducer malfunctions. Back-up transducers or floats shall be wired to individual pump motor starters.
- E. Where variable speed pumps are specified, the most recent model of a DANFOSS (preferred) variable frequency controller shall be used in addition to the pump controller specified. Older VFD models or discontinued VFD models will not be allowed.
- F. Check valve limit switch circuitry shall be used for pump failure logic (Class A & B only).
- G. An elapsed run time indicator shall be provided for each pump.
- H. A press-to-test circuit shall be provided for the control panel indicator lights.
- I. All control wiring and interface wiring shall be number coordinated with schematic. All panel and field wiring shall be identified with non-repeating numbers. All instrumentation and control devices shall be wired with stranded copper conductors.
- J. All motor controls shall be equipped with a motor overload indicator light for each motor equipped with a thermal overload protection device.
- K. Provide an uninterruptible power supply (UPS) with 2-hour battery for the control system.

8.7.9. TELEMETRY

MUPB shall specify the method of communications and specific brands of hardware and software to be used. MUPB may require additional telemetry at a particular lift station. The following minimum signals are required:



Description	Submersible PS	
	Monitor	Required Signals
Pump Run for each pump	Yes	Per # of pumps
Pump Failure	Yes	Per # of pumps
Power Failure	Yes	1
Generator or Backup Power Run	Yes	1
Generator or Backup Power Failure	Yes	1
High Level	Yes	1
Telemetry Failure	Yes	1
Building Intrusion	No	0
Control Panel Intrusion	Yes	1
Overflow	Yes	1

Telemetry equipment shall be housed in a NEMA 4X Stainless Steel enclosure for outdoor use. Costs to modify the master station will be borne by OWNER/DEVELOPER.

8.7.10. POTABLE WATER SUPPLY

All lift stations shall have access to potable water for wash down purposes. Not all of MUPB sewer service area is served by MUPB water service area. If the lift station is within MUPB water service area, then OWNER/CONTRACTOR is to install service line, tap of existing water main, yard hydrant and meter box. MUPB will provide the actual meter. For lift stations located within service areas other than MUPB's, the provider of potable water (Rowan Water, Inc, Bath County Water District or others) shall be contacted for their specific requirements. A yard hydrant shall be provided per MUPB Standard Details – Sewer.

8.7.11. VAULTS

- A. Access hatches shall be located in the vault so as to facilitate the removal of the equipment in the vault without disrupting the operation of the facility. A minimum size hatch shall be 36" x 36" but shall be sized to allow for removal of valves and piping for Class "A" and "B". Class "C" lift stations hatch to be determined per wet well manufacturer and MUPB.
- B. All hatches shall be aluminum with stainless steel hardware. All hatches shall have locking hasps and automatic hold-open arms with safety grates



for fall protection.

C. The valve vault and flow meter vault shall have floor drains, minimum of 6-inch drain lines. The floor drain will have a "P" trap and isolation valve and will discharge into the wet well. The floor drain shall be installed with a flapper valve on the end to prevent sewage from entering the structures if the wet well floods.

8.7.12. ODOR CONTROL

- A. Odor control measures must be designed and installed as part of the station, as determined by MUPB.
- B. Lift stations shall be provided with an odor control system designed to mitigate odors from the wet well and influent manhole via carbon absorption (air scrubbing).
- C. Lift stations should be designed to minimize the possible formation of odors by limiting wet well retention times and avoiding high drops for influent sewers, which cause odors to be released.

8.7.13. ELECTRICAL

- A. All lift stations will be reliability Class I. Electric power shall be provided to the station by distribution lines and by a standby generator. Both power sources shall be sufficient to operate all pumps, critical lighting and ventilation systems during peak flow conditions.
- B. The electrical distribution lines and generator shall have a means of being disconnected before the transfer switch. The generator will automatically switch sources in the event of a power failure. The transfer switch will be fully automatic with the ability to sense a single-phase power condition and switch to the generator power system with a minimum time delay. Both power sources shall be protected by fuses or breakers prior to the transfer switch. The transfer switch shall be capable of being operated manually.
- C. The lift station's power supply shall be protected from lightning (ie lightning arrestor).
- D. A final step-down transformer shall be provided on each electric feed line with adequate physical separation between them to prevent a common mode failure. Separate fuses shall be provided for each power source.
- E. The electric distribution line and the standby generator will remain separate and form separate distributions up to the internal fuse system to preclude a common mode failure of both sources.



- F. Breaker settings or fuse ratings shall be coordinated to effect sequential tripping such that the breaker or fuse nearest the fault will clear the fault prior to activations of other breakers or fuses to the degree practical.
- G. The load distribution panel shall not be an internal part of the transformer.
- H. All motors and control enclosures will be adequately protected from moisture, the weather, and water under pressure.
- I. All equipment shall be installed in accordance with the manufacturer's recommendations. When laying out the location of the equipment in the control and generator building, the engineer will consider the necessary separation between devices to provide adequate ventilation and the location of doors, hatches, and panel covers to avoid conflicts between these items when they are opened and closed. Also, housekeeping pads shall be provided to keep all equipment off of the floor.
- J. Provide arc flash study and rating for the facility, with design of corresponding safety features. Design system to Class 2 or lower rating for arc flash. Arc flash study shall be performed on the design, and again at the substantial completion of the station.

8.8. CONSTRUCTION PLAN REQUIREMENTS

Construction Plans are to prepared by licensed Professional Engineer with a valid and current license in the Commonwealth of Kentucky per KRS Chapter 322. Plans shall be submitted per Section 2, of this MANUAL.