

DC3 – DESIGN CRITERIA FOR LIFT STATIONS AND FORCE MAINS

DC3-001 **GENERAL.** The following discusses the minimum requirements for the contents of the Engineer’s Design Memorandum and Technical Specifications for Lift Stations and Force Mains. The Design Memorandum must be submitted and approved prior to plans and specifications being submitted to the City for approval.

The Memorandum and Specifications must be prepared and stamped by a professional engineer, licensed in the State of Kansas. These criteria are meant as a guide to quality and design of equipment and systems that are acceptable to the City. Any variances from these criteria will require significant backup calculations and data and will be reviewed upon submittal of the complete Design Memorandum.

DC3-002 **INTRODUCTION.** Describe in general the watershed(s) that are included in the service area, the estimated, ultimate growth population or population equivalents served and the type of development. Indicate the projected construction schedule (phasing) for the entire project.

DC3-003 **DESIGN FLOWS.** Present the calculations of the Average Daily Flow and Peak Flows based upon the highest flows/acre wastewater contribution. The table below should be used to establish the Peak Flow for a project. Low density residential shall be considered as up to and including 3.5 residences/acre. Above that value will be considered high density residential. Extrapolations to determine the Peak Flow/Acre may be made for the specific size of the development (acres).

Peak Flows for Design

Area (acres)	Residential		Commercial/Industrial (cfs/acre)
	High Density (cfs/acre)	Low Density (cfs/acre)	
Up to 100	0.022	0.019	0.0175
200	0.021	0.018	0.0165
500	0.017	0.014	0.0125
1000	0.014	0.0118	0.01
1500	0.0135	0.0108	0.009
2000	0.013	0.01	0.008

Peak Flows can be increased by outside circumstances such as other watershed contributions flowing by gravity or being pumped into the design watershed. If this is the case, the system design shall include these external factors.

DC3-004 **SITE DESIGN.** Submit:

- A general location map to indicate the relative position of the project within the City and its proximity to other watersheds.
- An overall system map that includes the gravity and pressure systems shall be provided. This system map should be of a scale that allows the reviewer to see the entire system on one sheet.
- No sheets should be larger than 24” x 36” and are best presented labeled and folded into pockets in the body of the Memorandum.

- One sheet that should be dedicated solely to the proximity of the site to the 100-year Flood Plain.
- Lift Station site Drawing that shall include the coordinates of the Lift Station and other major equipment items. A minimum of 1" = 50' scale shall be used. The Site Drawing shall show all equipment in plan view. Items to include are: Final grade contours, Lift Station, Detention Systems, Standby Generators, Valve Vaults, Measuring Manholes, Quick-disconnect stations for City to pump system (during emergency situations), Davit-Arm Bases, Fencing, Lighting and Paved Access Roads. Some of these items included in this drawing will require typical plan and elevation, sections and detailed drawings in order to illustrate their relative function. A separate electrical power and control drawing should illustrate the equipment selected and its connection to the mechanical equipment proposed.
- Plan and Profile drawing(s) shall be included for the Force Main that includes air release valves, minimum depths, valve pits and valves and connections to other gravity or pressure systems.
- If exhibits for this Design Memorandum are being developed from the Construction Drawings, they shall be simplified by removing layers, such as landscaping, etc., that do not apply to the systems design, in order to clarify the exhibits.
- The Design Memorandum shall also include the Maximum Velocity which shall not exceed 8 feet per second, unless otherwise approved, and the Minimum Velocity shall not be less than 2.5 feet per second, unless otherwise approved. Minimum and Maximum pumping pressures shall be determined and presented. Test pressure for Force Mains shall be 150 psi.

DC3-005 **HYDRAULIC DESIGN.** The Hydraulic Design data will include data from the Measuring Manhole through the entire system to the discharge connection of the Force Main. Minimal exhibits and calculations that will require presentation in the Design Memorandum shall include:

- System Curve(s), indicating operating range with maximum and minimum loads.
- Certified pump curves.
- Static and Dynamic Head Calculations.
- System Losses including all fittings, suction, and discharge points from the pump suction to the discharge connection of the Force Main.
- Hydraulic Grade Line of the Pumps and Force Main.

DC3-006 **PUMP STATION.** Pump stations shall be designed to provide firm pumping capacity to pump a 25-year storm event based on ultimate development. The difference of the design pumping rate and the 50-year storm event shall be detained on site.

The following pumping systems (type and model included in the Design Memorandum) shall be acceptable:

- Wet Well Mounted Lift Stations, manufactured by Smith and Loveless, Inc. for applications less than 18 ft. suction head. The suction pipes, installed by the Contractor, shall be PVC Schedule 80 (IPS), conforming to ASTM D 1785. The pump end of the suction pipe shall be connected using Van Stone Flanges/Slip (Gasket Type) and Grade 304 Stainless Steel hex bolts and nuts conforming to ASTM F593 2002.
- Submersible Pump Lift Stations are recommended for permanent applications, and 18 ft. and greater suction head, where pumps are approved by Department.

- Submittals shall include pump curves with operating points and pump and motor efficiencies. A design target should be to select a pump with a 60% efficiency, or greater. A target for minimum wire to water efficiency is a minimum of 60%.

DC3-007 **CHECK VALVES.** All lift station check valves shall be Swing Flex Check Valves.

DC3-008 **WET WELL SIZING.** Pump start/stop shall be designed according to the following:

- Motors, 30 Horsepower, or less – 10 start/stops (or less) per hour.
- Motors, greater than 30 Horsepower – 6 start/stops (or less) per hour.
- Minimum wet well diameter of 6 ft.

DC3-009 **CONTROLS.** The pump station control panel shall be part of the system that controls all features of the pump station and associated panel or field-mounted instrumentation. The design engineer shall specify a Mission Mydro 850 Monitoring System. The contractor shall have the overall responsibility for the complete system which shall include:

- Design, supply, delivery, installation, certification, calibration and adjustment, software configuration, testing and startup, City personnel training, warranty and routine future field services, of a complete coordinated system.
- All services and hardware to ensure proper communications are established with off-site remote locations that are to be monitored and controlled.

The design engineer shall review and coordinate system technical information submitted by Contractor for software; operating system, database, control strategies and the graphical user interface, specifically: report and log formats, graphics, trends, alarming, and other items.

Component specifications requirements are:

- Functions and features of all equipment of the system meet the requirements of the SCADA system.
- Control panel enclosure shall be NEMA TYPE 4X for outdoor location.
- Controls shall operate from a source of 120 volts, 1 phase, 60 Hz. All controls shall be protected from lightning or other transient voltages by a power arrestor.
- Condensation protection shall be provided. Enclosure shall have a heater which operates continuously to prevent condensation build-up. A freeze protective heater and thermostat shall also be provided.
- All DC power supplies required for operation shall be provided.
- Wiring shall meet all NEC, NEMA, and local electrical codes.
- PLC shall be an Allen-Bradley. Four additional I/O modules shall be provided, where PLC is specified.
- An uninterruptible power supply (UPS) shall be furnished to supply continuously a reliable source of power to the PLC's, computer and peripherals. The UPS shall provide no-break sine wave power, lightning and surge protection, isolation per FIP Standard 94, voltage regulation and be switch-mode power supply rated. The UPS shall utilize sealed, maintenance-free batteries to provide a minimum of 30 minutes of backup power at full load in the event of a failure of the normal AC source.
- All panels and all field modifications shall be in conformance with UL-508. Contractor shall certify that panels have retained their UL labeling or third party certification.

- Programming and documentation software shall run under the latest issue of Microsoft Windows operating system. The system supplier shall program the pump station PLC to operate and monitor its local I/O. The system supplier shall program the master PLC software to incorporate the lift station into the existing SCADA system, if required.

Minimum component requirements for the Mission MyDro 850 Monitoring System (including 8 digital and 2 analog) are:

- Standard package alarms
- Power Failure “built in”
- High Water (transducer is analog) (floats are digital) Back-up System
- Amp Meter (analog)
- Generator Failure (digital)
- Communication “built in”
- Pump Failure (digital) – Can have all combined to one alarm
- Excess Pump Starts “built in”
- Flow Monitoring (as applicable) (Flow meter rate “flow of day” analog)
- Rain Gage (as required) is a pulse counter that is added when purchased
- Seal Failure (as required) (digital) – “can all be combined in one alarm”
- Fuel (analog) – “can be digital if only a low lever alarm is wanted”
- Temperature Monitoring (Motor temperature is digital) (Outside temperature is analog)

The Allen-Bradley PLC Control panel shall monitor the following I/O (list could be different for each lift station):

Discrete Inputs

1. Pump No. 1 – Running
2. Pump No. 1 – In Remote
3. Pump No. 1 – Fail
4. Pump No. 2 – Running
5. Pump No. 2 – In Remote
6. Pump No. 2 – Fail
7. Wet well High Level Float Switch Alarm
8. Wet Well Low Level Float Switch Alarm
9. Power Failure
10. High/High Level Alarm (for systems with Containment)
11. Motor Moisture Alarm (submersible only)
12. Generator running and Generator Failure (set in PLC).

Discrete Outputs

1. Pump Station Enable
2. Remote Generator Test

Analog Inputs (4 to 20 milliamps)

1. Wet Well Level (Ultrasonic transducers with float switches as back-up)
2. Flow Rate
3. VFD Speed Indication (where VFD is used)
4. Force Main Pressure

Analog Outputs

1. VFD Speed Control (where VFD is used)

When an alarm occurs, the following sequence shall be provided:

1. The alarm shall be added to the Event Log.
2. Mission Communications, MyDro 850 System shall be provided.
3. Alarming requirement to be finalized at a coordination meeting with the City and design engineer.

DC3-010 **HEATING, VENTILATING AND AIR CONDITIONING.** Include recommendations for HVAC systems, other than standard equipment (as recommended by the manufacturer) depending upon the complexity of the location and environment.

DC3-011 **ELECTRICAL POWER SUPPLY.** The fundamental requirements of the electrical power supply are:

- 3-phase power supply from the utility
- Emergency disconnect mounted on pole outside the pump station, on a post
- Utility power meter located outside fenced area
- Transfer switch for a 3-phase generator

DC3-012 **LIGHTNING PROTECTION SYSTEM.** A protection system shall consist of air terminals, antennas, grounding electrodes and interconnecting conductors. The motor control center shall include transient voltage surge suppressor. The design of the system shall be prepared by a professional designer certified by the Lighting Protection Institute (LPI). The system shall be installed by a master installer certified by LPI.

Equipment furnished shall meet the following for design, construction and testing: ANSI/NFPA 780-Lightning Protection Code, ANSI/UL 96-Lightning Protection Components, and LPI 175-Lightning Protection Institute Standard Practice. System components shall conform to NFPA 780 Class 1 or 2 and shall be fabricated from the following metals:

Conductors:	Copper
Air Terminals:	Copper and Bronze
Grounding Electrodes:	Copper clad steel
Fasteners:	Copper or bronze
Bimetallic Fasteners:	Bronze and aluminum

All material for the system shall bear the UL inspection label.

DC3-013 **EMERGENCY POWER.** Emergency power may be required and will be reviewed on a case by case basis. Connections for portable power shall be included for all pump stations where permanent stand by power units are not required. Approved generator sets are Caterpillar, or Cummins/Onan. Fuel storage shall provide a minimum of 24-hour supply of diesel. The generator sets shall be furnished and installed in an enclosed outdoor power unit. The system shall meet the following requirements:

- The unit shall consist of a one-piece, seamless fiberglass-reinforced plastic enclosure for weather protection and sound attenuation. The maximum sound additive level shall be 72 dB(A) at 23 feet distance.
- The FRP enclosure shall be able to withstand a wind load of 120 MPH and the roof capable of supporting 30 lbs per square foot loading.
- 150 KW generators and smaller shall require a tip-up style FRP enclosure with gas spring lift assist.
- Generators larger than 150 KW must be provided with a walk-in, seamless FRP enclosure.
- Acceptable fuels are natural gas and propane.
- Controls shall include a terminal strip with alarm and monitoring contacts for connection to the City's telemetry system.
- The generator, automatic transfer switch, environmental systems, fuel tank (where applicable) and ancillary equipment shall be skid-mounted, pre-installed, and tested as an integrated system by the manufacturer. Individual component testing is not acceptable. The manufacturer shall be responsible for system equipment and testing.
- The generator and automatic transfer switch shall be covered by a 5-year, or 1,500 hour warranty.

DC3-014 VARIABLE FREQUENCY DRIVES. Soft Starts are preferred but Variable frequency drives (VFD) may be considered in some situations. Because this benefit varies depending on system variables such as pump size, load profile, amount of static head, and friction, it is important to calculate benefits for each application before specifying a VFD. If a VFD is proposed, harmonic distortion needs to be evaluated and an isolation transformer provided, if required. By-pass contactors need to be installed for emergency power operations if VFDs are used.

Approved VFD manufacturers: ABB, Toshiba, Yaskawa

DC3-015 WET WELL AND DISCHARGE MANHOLE LINING. At a minimum, the wet well and the discharge manhole at the end of the force main shall be lined with a protective coating. The new concrete in these manholes shall be cured prior to application of the protective coating (minimum of 28 days). The lining shall cover all interior surfaces from the bottom to the top including any adjustment rings and underside frame and cover.

Approved manufacturers are:

- Raven Lining systems, Inc, 405 Coating System, Tulsa, OK. This is a 100% solids, solvent-free epoxy grout that can be troweled or sprayed.
- Protective Liner systems, PLS-650 Perpetu Wall Liner System. This is a two-part, 100% solids, epoxy system reinforced with fiberglass.
- Zebtron[®], Zebtron Corporation, Newport Beach, CA. This is a 100% solids, hybrid polyurethane containing no solvents.
- Castagra Ecodur, Castagra Products, Inc., Reno, NV.

Installers of these materials must be trained and certified according to the manufacturer's specifications. Installer certification shall be submitted to the City for review and approval prior to commencement of any work.

DC3-016 **FLOW MEASUREMENT.** Flow measurement shall be provided to measure influent flow to the wet well of the lift station from the upstream gravity sewer system. The primary element of the flow measurement device recommended is a Parshall flume to be designed so as to be on the lift station site but not so close to the wet well that downstream flow will submerge the flume and result in erroneous readings. An ultrasonic level device shall be used to measure the upstream and downstream levels through the flume. These readings that are converted to flow shall be integrated into the control system.

DC3-017 **FLOW MONITORING OF PRESSURE DISCHARGE PIPE.** Using electromagnetic meter and integration into the control system.

Approved meter manufacture: Siemens.

DC3-018 **EMERGENCY OVERFLOW STORAGE.** The difference of the design pumping rate and the 50-year storm event shall be detained on site as emergency overflow storage.

DC3-019 **EMERGENCY BY-PASS PUMPING.** Six (6) inch suction and discharge connections (Bauer connections), above ground, are required. This design shall include the proper joint restraints as well as a concrete vault to provide access to the valve. The asphalt or concrete road into and out of the site shall accommodate the City truck and trailer that will respond to emergency situations. The access road shall be designed to allow along-side access of the trailer to by-pass piping. The road configuration shall be such that the vehicle can drive through on a loop road or maneuver the road configuration under the following conditions: 30 ft. turning radius.

DC3-020 **PERSONAL HOIST SYSTEM.** Adavit-arm hoist is required within five (5) feet of the wet well and/or valve vault for use of confined space entry. The sleeves shall mount to a horizontal concrete or steel structure.

DC3-021 **ACCESS HATCH.** Access to manholes or wet wells shall be through an aluminum hatch designed for pedestrian access rated for a minimum live load of 300 psf with deflection not to exceed 1/150th of the span. Aluminum material shall be used for the bars, angles, extrusions and diamond plate. Stainless steel material shall be used for all hardware. Each hatch shall be supplied with an exposed padlock clip. Nominal opening dimensions shall be a minimum of 24" x 30". Each hatch shall be supplied with a safety grille. Approved equipment are "FLE" access hatch as manufactured by ITT Flygt Corp. or "EC" access hatch as manufactured by Syracuse Castings.

DC3-022 **SITE LIGHTING.** Site lighting shall be required to provide lighting controlled by a photo-electric cell. Manual off/on switch shall also be provided. Intensity of lighting shall be designed to provide safe maintenance at night but not be of the intensity and direction to cause problems with adjacent property owners.

DC3-023 **FORCE MAIN.** As a minimum, the design of the Force Main shall include plan and profile drawings of the route indicating the minimum cover, connection to the receiving system with details if required, air release valve pit location and details, and any required valves (plug valves required) and details.

The Force Main shall be PVC pipe, ANSI/AWWA C900 or C905 with dimension ratios corresponding to working pressures of (150 psi minimum). PVC to PVC joints shall be

ANSI/AWWA C900 or C905, push-on type, with elastomeric synthetic rubber gaskets. PVC to Cast Iron joints shall be ANSI/AWWA C111/A21.11, except gaskets shall be synthetic rubber. All cast iron or ductile iron fittings on PVC pipe shall be properly encased with polyethylene.

Thrust prevention shall be provided with Restrained Joints and distances in both directions from the fittings indicated.

DC3-024 **TRACER WIRE.** Tracer wire for sewer pipeline and discharge piping shall be a (12 AWG) extra-high-strength copper-clad steel conductor (EHS-CCS), insulated with a 45 mil, high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use at 30 volts. EHS-CCS conductor must be a 21% conductivity for locating purposes, Break load will be 1150lbs minimum. HDPE insulation shall be RoHS compliant and utilize virgin grade material. Insulation color shall meet the APWA color code standard for identification of buried utilities. Tracer wire shall be Copperhead Soloshot Extra High Strength, EHS-CCS HDPE 45 mil insulation or equal. The tracer wire shall be installed no more than six inches (6”) above the top of the force main. Tracer wire shall be installed continuously along the new facility route with access points placed every 300 hundred feet maximum. Tracer wire should be brought to the ground surface at the access points. Access points may include valve boxes, handholes, manholes, vaults or other covered access devices. Access point covers shall be clearly marked with the type of facility. Splices in the tracer wire should be avoided and connected by means of a Snake Bite Dryconn Direct Bury Lug by Copperhead Industries Direct Bury Kits to ensure continuity. The contractor shall perform continuity tests on the tracer wire after installation. If the tracer wire fails the continuity test, the Contractor shall repair the wire at no additional cost to the Owner.

DC3-025 **AIR AND VACUUM RELEASE VALVES.** Air and vacuum release valve assemblies shall be installed in the locations indicated on the drawings. Each valve assembly shall be installed complete with appurtenant piping and valve as specified.

The air/vacuum valve assemblies shall be fully automatic float operated valves designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry.

DC3-026 **TESTING.** The contractor shall be responsible for coordinating the testing of all systems. Prior to testing, the contractor shall furnish all required operation and maintenance manuals to the City of Gardner. All special testing materials and equipment shall be provided by the contractor. The contractor shall coordinate and schedule all of his testing and startup work with the City. Testing shall be witnessed by the City and the requirements are as follows:

- All system components shall be checked to verify that they have been installed properly and that all terminations have been made correctly. The manufacturer’s representative performing the test shall furnish a copy to the City of the certified check list that indicates test values measured for proper functioning parts and systems.
- The Manufacturer shall also perform factory-certified tests that shall use the latest test code of the Hydraulic Institute to determine head vs. capacity and kilowatt draw. The results of the factory-certified tests shall be furnished in the operation and maintenance manuals.

- Witnessed field tests shall be performed on the complete system. Each function shall be demonstrated to the satisfaction of the Utilities Department and Design Engineer. These tests shall include:
 1. Megger stator and power cables.
 2. Check seal lubrication.
 3. Check for proper rotation.
 4. Check power supply voltage.
 5. Measure motor operating load and no load current.
 6. Check level control operation and sequence.
 7. Insure that the check valve is closing properly at shut down of the system.
- Each test shall be witnessed and signed off by the Manufacturer upon satisfactory completion. The Contractor shall provide all required operation and maintenance manuals and notify the City at least one (1) week prior to the commencement date of the field tests.

DC3-027 **SUBMITTALS.** Before any components are fabricated, and/or integrated into assemblies or shipped to the job site, the Contractor shall review for conformance with the specifications and then shall furnish to the Design Engineer for his review six (6) copies of submittal documents. Coincident with review and mark-up by the Design Engineer the submittals shall be sent to the Utilities Department Manager for review.

Submittals shall include full details, shop drawings, catalog cuts and such other descriptive matter and documentation as may be required to fully describe the equipment and to demonstrate its conformity to these specifications. The Contractor shall submit the following materials:

1. Operational description of each system showing all major components and their interconnections and interrelationships. Where appropriate, provide block diagrams. Label each diagram and specify all external power and communications interfaces.
2. Drawings of equipment to be supplied shall include, as a minimum: Overall dimension details for each item and arrangement of items included in each unit. Wiring diagrams of equipment including field device connection shall be included and specific installation/wiring requirements identified.
3. Operational description shall include the principal functions/capabilities.
4. Provide a detailed Bill of Materials along with descriptive literature identifying component name, manufacturer, model number, and quantity supplied.

Software Submittals

1. Provide complete user manual for all supplier configured software and firmware. For ancillary software such as operating systems and spreadsheets being supplied under this contract, only a listing of the manual which will be included with the Operations and Maintenance documentation is required.
2. Sample communication and control database programs for project in hardcopy form. As a minimum, hardcopy form shall be fully documented, including code, comments, addressing data and cross-references. Every line or section of code shall be accompanied by a comment describing its function.
3. Provide initial graphic display and report format layouts. List and briefly describe all operator interface functions provided at the PC, including: Alarm annunciation and acknowledgment, status displays, control capabilities, report generation, event logging, charting and trending.

Spare Parts - The contractor shall provide a list of recommended spare parts and expendable items. The list shall be exclusive of any spare parts furnished under this contract. A total purchase cost of the recommended list shall be provided in addition to the unit cost of each item.

DC3-028 **OPERATION AND MAINTENANCE MANUALS.** Adequate operation and maintenance (O & M) information shall be supplied for all equipment requiring maintenance or other attention. As a minimum, O & M manuals shall be supplied for pumps/motors, variable frequency drives, valves, flow measurement devices, generator sets, odor control systems, lightning protection systems, and control systems including instrumentation panels.

- The contractor shall provide two (2) complete sets of hard-covered, ring bound, loose-leaf and digital O & M manuals. In addition to “as-built” system drawings, the manual shall include operating and maintenance literature for all units and components provided for the whole system. Data furnished shall include internal wiring diagrams.
- The submitted literature shall be in sufficient detail to facilitate the operation, removal, installation, programming and configuration, adjustment, calibration, testing and maintenance of each component and/or instrument.
- O & M manuals shall include copies of all PLC programs written to accomplish the monitoring and control functions specified. Programs shall be updated after startup is complete, with the programs provided digitally to the City.
- The O & M manuals shall be organized as follows:
 1. System Equipment/Installation
 2. System software
 3. Operation
 4. Maintenance and Troubleshooting
- Topics required are:
 1. Equipment function, normal operating characteristics, and limiting conditions.
 2. Assembly, installation, alignment, adjustment, and checking instructions.
 3. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.
 4. Lubrication and maintenance instructions.
 5. Guide to troubleshooting.
 6. Parts list and predicted life of parts subject to wear.
 7. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.
 8. Test data and performance curves, where applicable.
 9. Warranties and warranty contact information including names, phone numbers and email addresses.

DC3-029 **TRAINING.** Training shall be provided for each major component or system that requires maintenance (generally furnish training for all equipment that requires an O & M Manual).

The training program shall educate operators, maintenance, engineering, and management personnel with the required levels of system familiarity to provide common working knowledge concerning all significant aspects of the system being supplied. The training program shall consist of a minimum of one (1), 8-hour day, including time for demonstration in the field. At least two (2) weeks prior to the requested start of the program, the proposed dates of training shall be submitted to the Utilities Department and Design Engineer for

approval.

It shall be the responsibility of the Contractor to coordinate and organize the suppliers for the training program. The suppliers shall provide all instructional course material, equipment, and manuals to conduct the training program. The City shall provide the facilities for the training.

DC3-030 **DEFINITION OF ACCEPTANCE.** System acceptance shall be defined as that point in time when the following requirements have been fulfilled:

- All O & M documentation has been submitted, reviewed, and approved.
- The complete controls system and instrumentation have successfully completed all testing requirements and have successfully been started up.
- All City personnel training programs have been completed.
- The Design Engineers and Utilities Department both sign a document indicating the controls system has formally been accepted.