Calgary

Sewer Bypass Pumping Guidelines

January 2018

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Sewer Bypass Pumping Guidelines

1.0 SCOPE

Work covered in this document consists of bypass pumping design, installation and operation of existing City sewer systems that require temporary diversion of flow to provide adequate and reliable sewer services at all times during any construction-related activities.

Pursuant to the Alberta Environmental Protection and Enhancement Act, the bypass system shall meet all applicable regulatory requirements such as *AR 117/1993 Release Reporting Regulation* and *AR 119/1993 Wastewater and Storm Drainage Regulation.* In addition, the bypass system shall comply with the current edition of the following documents:

1. Standard Specifications, Sewer Construction
2. Standard Specifications, Waterworks Construction
3. Wastewater Bylaw #14M2012, Part VI, Section 20
4. Drainage Bylaw #37M2005
5. Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems (Part 3)

2.0 SUBMISSION REQUIREMENTS

The Contractor engaged by the Owner shall prepare and submit a Bypass Pumping Plan (BPP) to Water Services at least 6 weeks prior to starting any portion of the proposed scope of work. The plan must be approved by The City prior to mobilization of any equipment for use in the bypass operation.

A pre-design meeting with stakeholders is recommended 6 weeks prior to submission of BPP application to discuss preliminary design information such as project background, site condition, pump placements, flow rates and allowable manhole surcharge levels. Contact the *Team Lead, Operations Engineering, Water Services,* to arrange for a kick-off meeting and for any BPP application questions.

Submission requirements are outlined below to guide applicants with The City's minimum requirements and other regulatory compliance requisites.

The following must be submitted as part of the BPP:

a. Coverletter with the following information:
   - Project name, location and detailed description of the planned bypass pumping work to be performed
   - Name and address of Contractor / Consultant

- Name and contact information of Project Manager
- Emergency contact information (name, cell phone number and title of person(s) onsite responsible for bypass pumping operation)

b. Detailed plan, design and description of the proposed pumping system:
   - Detail drawing showing suction pipe depth, plug and pump connections (See Appendix A)
   - Locations and sizes of temporary pipe supports, thrust blocks and restraints
   - Redundancy plan (Back-up pump, power and piping equipment)
   - Calculations of static lift, friction losses, TDH and flow velocity
   - Calculations for selection of bypass pumps and piping sizes
   - Pump curves showing pump operating range (capacity, head, power, $NPSH_A$ and $NPSH_R$ values)
   - Design plans and access to bypass pumping locations
   - Method of noise control for each pump and/or generator
   - Methods to protect suction/discharge manholes and other structures such as existing interior drop from being damaged due to bypass operations
   - Schedule for installation and maintenance of bypass pumping lines
   - Procedures to monitor upstream mains for back-up impacts
   - Procedures for setting-up and dismantling pumping operations

   Note: Design plans and calculations must be reviewed and signed by a Professional Engineer registered in the Province of Alberta.

c. Description of the minimum and maximum amount of sanitary sewer flows to be bypassed and how flow conditions will be monitored during operations. All flow measurement devices, calculations, equipment and other data sources must be included in the report.

   Note: For storm bypass systems, design flow shall be based on the 1:2 year storm event or at the discretion of the Design Engineer.

d. Descriptions of all proposed bypass pumping components to be used
   - Bypass pump sizes, capacity, number of each size to be on site and power requirements
   - Capacity of suction and discharge piping
   - Size, depth and location of manhole or access points for suction and discharge piping
   - Plugging method and type of plugs to be used

- Method of establishing flow rates (flow metered, modeled flow or physically measured flow depths)
- Flowmeter installation locations

e. Suction and discharge piping material(s) and capacity to be used for the bypass pumping operation including material(s) used for any bends and valves

f. Indicate the date and time the bypass pumping is expected to begin and be completed

g. Drawings showing location of pump(s) and route of the suction and discharge piping complete with legible dimensions. Manholes to be used for suction and discharge shall be clearly labelled including names of streets and major intersections in the area

h. A site specific Emergency Spill Response Plan detailing procedures to be followed in the event of pump failures, sewer overflows, service backups and sewage spillage which include:
   - Plan for containing the spill and addressing the source of the spill
   - Plan for preventing public exposure to the spill including procedures for redirecting pedestrians and traffic away from the impacted area
   - Identification of any service connections, storm drains, watercourses or other infrastructure that can be negatively impacted by the spill
   - Measures to be taken to avoid or mitigate the adverse effects of the spill on the environment

   The contractor will maintain a copy of emergency/spill response plan on site for the duration of project

i. Environmental Risk Assessment and Mitigation Plan (Appendix C)

j. Traffic Control Plan (when applicable) that pertains mainly to the bypass pumping operation which include all required permits, pedestrian and vehicular access

k. Submit a checklist (Appendix B) confirming that all items required on this section are included in the application package.

3.0 DESIGN REQUIREMENTS

The following are essential factors to be considered when designing bypass pump systems for both storm and sanitary sewer lines.

a. Pump Sizing

Centrifugal pumps are commonly used in most bypass pumping systems. It allows suction pipes to be managed through most manhole openings and can be installed in parallel for larger flows or in series for higher heads. The following are information required to adequately size centrifugal pumps:

1. Peak flow rate (l/s) – Provided by Water Services or measured in the field
2. Total suction lift (m) = Suction lift + Friction losses
3. Total discharge head (m) = Discharge head + Friction losses
4. Total Dynamic Head (TDH) = Total suction lift + Total discharge head
5. Net Positive Suction Head Available ($NPSH_A$)
6. Net Positive Suction Head Required ($NPSH_R$)
7. Net Positive Suction Head (NPSH)

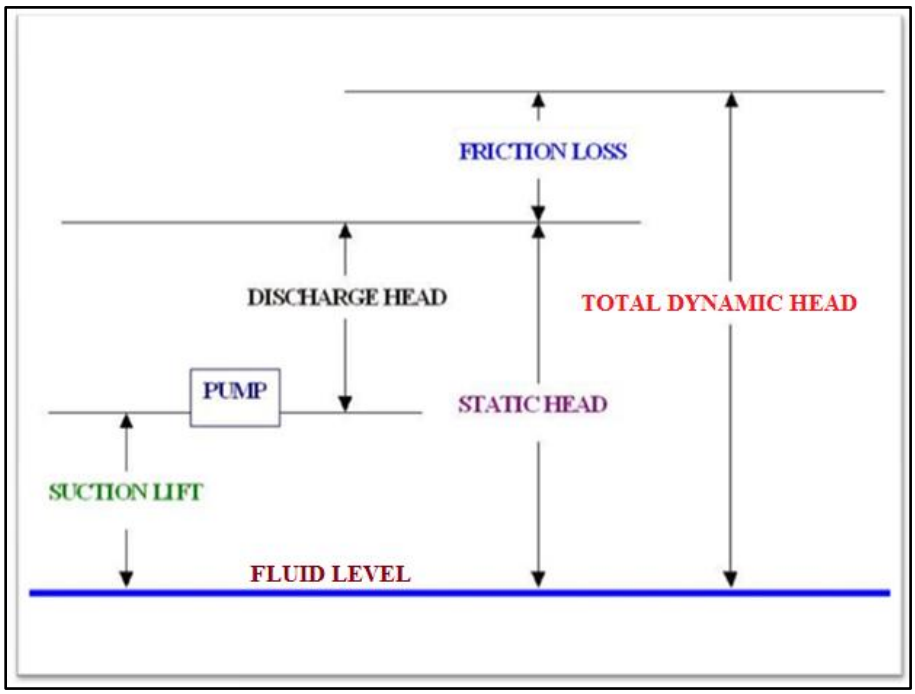


Figure 1: Calculating Total Dynamic Head on Suction Lift Applications

Pumps are sized primarily to accommodate the required flow in l/s (or gpm) and the TDH of the system. Another key factor to be considered is the system's **NPSH** value to prevent cavitation.

Pump cavitation occurs when the pressure at the pump inlet drops below the liquid's vapor pressure creating vapor bubbles. The bubbles trigger shockwaves causing premature wear and ultimately leading to its failure. Cavitation is depicted by:

- Loud noise often described as marble sounds in the pump
- Loss of capacity because bubbles are now taking up space instead of liquid
- Pitting damage to parts as material is removed by the collapsing bubbles

$NPSH = NPSH_A - NPSH_R$

Minimum NPSH value required is 0.9m (3').

$NPSH_A$ = Static head + surface pressure head – liquid vapor pressure – friction losses in the piping, valves and fittings.

$NPSH_R$ – The required pressure head acting on a liquid as it enters the pump impeller to avoid excessive cavitation and degradation of pump performance.

$NPSH_A$ must be calculated as a function of the bypass system, whereas $NPSH_R$ is a function of the pump and must be provided by the pump manufacturer. $NPSH_A$ must be greater than $NPSH_R$ for the pump to operate efficiently, in other words, the system must have more suction pressure available than the pump requires.

b. Overall System Design

Suction Manhole Depth: The construction or repair area must be isolated from the suction and discharge locations. The plug must be installed at least one manhole upstream. Lift is a key component in the assessment of pumping systems therefore selection of the suction manhole is critical. Suction lift determines the type of pump the system requires.

Allowable Manhole Surcharge: The allowable surcharge in a specific manhole will vary. Once the manhole is plugged it is important to determine how high the level in that specific manhole can be reached before negatively impacting surrounding properties.

Distance between Manhole and Pump: This horizontal distance is significant in determining friction losses as it will add distance to the fluid travelling through the system. The additional suction/discharge distance will increase the time that the pump needs to self-prime as there is more air to evacuate with the additional line added.

Pressure at Discharge Point: A bypass system will have to reach a certain TDH to pump to a physical location. Once pumped to a certain location the fluid may only have to exit the end of the pipe and be influenced by gravity down into the receiving manhole.

Redundancy or Pump Back-up: Include a 100% redundant bypass pumping capacity to allow continuous flow in case of emergencies due to clogging or pump failure. Clogging indicators include fluid level starting to rise in the suction manhole or when the pump begins to shake because the suction bin is clogged and the pump impeller is not receiving enough liquid.

Pumps in Parallel: Peak flows can easily exceed the capacity of any single pump therefore multiple pumps operating in parallel may be necessary. This system enables two or more pumps to take suction from a common structure and discharge into one destination but operating against the same discharge head. The combination of pump head-capacity curve is determined by adding the respective flow rates of each pump with specific head values.

c. Submersible Pumps

Submersibles are centrifugal pumps attached directly to a motor and the entire assembly is submerged in the fluid to be pumped. This pump type is recommended on bypass operations with suction lifts of greater than 4m (13 ft.) as this reduces the likelihood of cavitation. Submersible pumps push fluid to the discharge port while suction pumps have to pull the fluids then be able to release. Most common are electric motor-driven and hydraulically driven.

Though not published on most pump manufacturer's curves, submersibles require a specific amount of submergence in order to operate properly and for motor cooling characteristics. Submersible pumps therefore also need NPSHA but not as critical as it is for above-ground centrifugal pumps.

4.0 EQUIPMENT and PIPING

Plugs must be in good condition and shall not have any visible damage such as cracks, holes, tears, cuts, abrasions, loose or damaged fittings; selected and installed according to the size of the line to be plugged. They must be adequately secured and anchored to prevent plug movement.

All pumps must be either automatic self-priming or prime-assisted units that do not require the use of foot-valves or vacuum pumps in the priming system. They can be electric or diesel powered. Each pump must have the Stop/Start control.

Piping shall be homogeneous throughout, free of visible cracks, discoloration, pitting, varying wall thickness, holes, foreign material, or other deleterious faults. Piping shall be assembled and joined onsite using couplings, flanges or butt-fusion method to provide leak proof joint.

Flexible hose, couplings and connectors shall be abrasive resistant and rated for external and internal loads anticipated including test pressure. External load design shall incorporate anticipated traffic loadings.

All rigid or hard piping shall be constructed with positive restrained joints.

5.0 EXECUTION

It is the Contractor's responsibility to protect the environment, public and private properties from any damage during the construction, operation and removal of the bypass system. All provisions stated in the BPP must be followed throughout the course of any bypass operations.

Contractor is responsible for locating any existing utilities in the area selected to place the bypass operation and for obtaining any approvals for placement of temporary pipelines from other regulatory agencies.

a. Prior to actual operation, Contractor shall perform leakage and pressure testing of the discharge line to withstand at least twice the maximum system pressure based on the approved BPP for a period of 2 hours.

b. The Contractor shall have full time (24-hour), onsite qualified pump personnel including supervision for monitoring the entire bypass installation while it is in operation. The entire length shall be inspected hourly to check for leaks. Contractor shall provide all necessary monitoring devices to notify crews of any pump failure.

c. Prior to installing any plugs, the Contractor must inspect the existing pipe for any flaws that might cause plug damage or not being able to seal properly. Always provide a secondary plug in the event the primary plug fails. Sanitary odors shall be minimized by using snug lids and shroud covers.

d. When the bypass pipeline crosses local streets and private driveways, use roadway ramps or place the pipe in trenches and cover with temporary pavement or other protective means of pipe crossing.

e. Contractor must protect all components of the bypass operation from vandalism and vehicular damage by securing the site.

f. Use low noise pumps and generators on residential areas or places where excessive noise levels can create disturbance while in operation. Implement sound attenuation measures such as soundproof canopy if necessary.

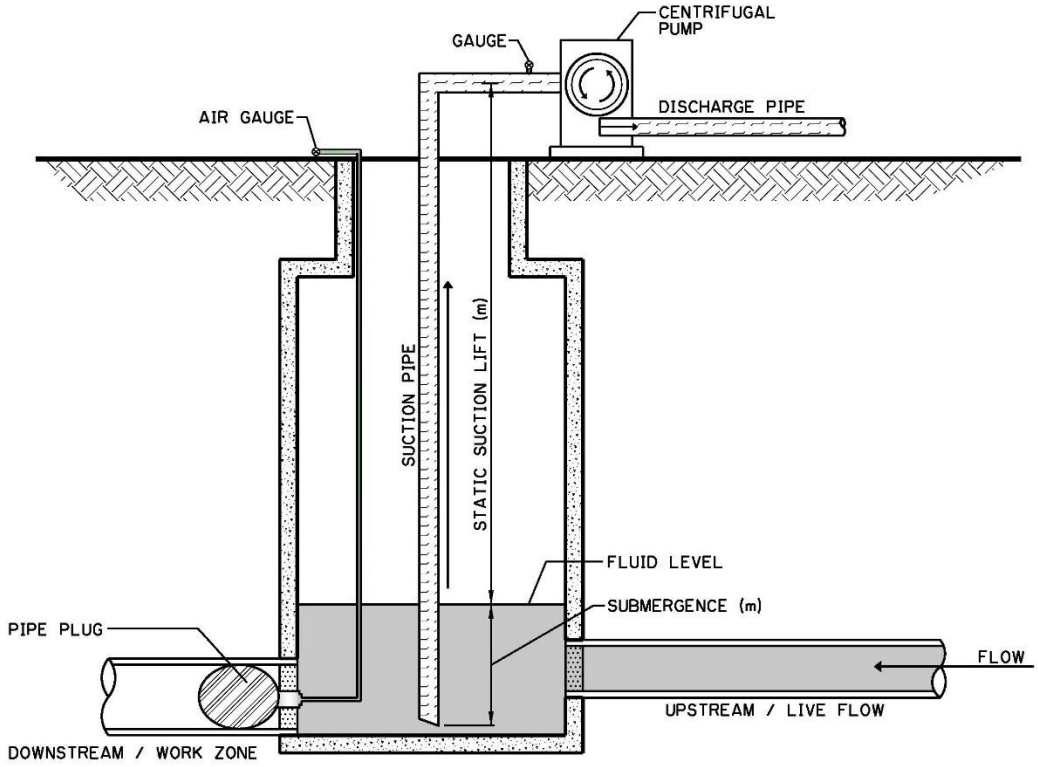
6.0 REMOVAL, CLEANUP and RESTORATION

Ensure all sewage from the bypass pipes, pumps and fittings are discharged to the specified sanitary or storm sewer system. Flush the bypass line before removal.

When a plug is no longer needed, remove it gradually to allow flow to return gradually to the normal flow condition.

Upon completion of the bypass pumping operations, Contractor shall remove all piping, restore all properties at least equal to pre-bypass condition including restoration of pavement and opening of roadways to normal traffic.

Appendix A – Suction Manhole Detail



TYPICAL SUCTION MANHOLE CROSS SECTION

SUCTION MANHOLE DETAILS		
ITEM	VALUES	NOTES
PIPE SIZE	mm	
PIPE LENGTH	m	
SUBMERGENCE	m	
STATIC SUCTION LIFT	m	
MAX. FLUID SURCHARGE LEVEL IN MH		
NPSHa	m	
NPSHr	m	
NPSH	m	
PUMP SIZE		
SUBMERGENCE REQUIRED BY PUMP	m	

Appendix B – Design and Submission Checklist

Project Name and Location: _____

Contractor: _____

YES	NO	
☐	☐	1. Cover Letter
☐	☐	2. Site Details • Site location indicated on the development map showing street names and major intersections in the affected area • Location and access of pumps and suction/discharge manholes • Route of piping with flow direction arrows complete with dimensions
☐	☐	3. Design Considerations • Calculations of static lift, friction losses, TDH, velocity, air valves, etc. • Calculations for pump size selection and piping sizes • Anchorage design (pipe supports, thrust blocks, restraints) • Methods of noise control for pumps and generators
☐	☐	4. Suction Manhole Detail
☐	☐	5. Pump Curves and System Information (Capacity, Head, Model, Power, Voltage, Amperage, $NPSH_A$ and $NPSH_R$ values)
☐	☐	6. Piping information (diameter, material, length, pressure rating, etc.)
☐	☐	7. Redundancy Plan
☐	☐	8. Emergency Spill Response Plan
☐	☐	9. Risk Assessment and Mitigation Plan
☐	☐	10. Bypass Pumping Schedule (set-up, operation, maintenance and removal)
☐	☐	11. Methods to protect suction/discharge manholes and appurtenances
☐	☐	12. Traffic Control Plan (if applicable)
☐	☐	13. Others, please specify _____

Appendix C – Risk and Mitigation Plan Example

(Excerpt from ECO Plan – Potential Environmental Impacts and Controls)

Construction Activity	Potential Environmental Impact(s)	Environmental Mitigation Measures
Bypass pumping	**Sewage release**	**Predesign** - Identify proximity to water courses, catch basins and other water related structures. Alberta Water Act approval may be required. - Use of jointless pipe in proximity to water courses to mitigate leakage from joints - Plug or provide protection for catch basins - Provide 100% redundancy in pumping design to accommodate potential pump failure or unexpected flows - Protect system from traffic impacts by putting barricades, fencing, road ramps, etc. **Setup** - Pressure test system with clean water to identify leaks - Place pumps in drip trays **Preconstruction** - Perform a 24-hr. system test to monitor system performance **Operation** - Have spill kits on hand - Have back-up plugs on hand - Have spare gaskets and parts on hand - Have monitoring and release response plan **Decommission** - Flush/purge piping with clean water prior to removal
	Gasoline spill when fueling equipment (also a safety hazard)	Have a spill kit available and workers trained in its use in case of a spill No smoking allowed or use of electronic devices such as cell phones while fuelling, as spark could cause ignition Ensure a fire extinguisher is available in the fuelling station Ensure fuelling stations are setup in a well-ventilated areas Provide health and safety training to refueling staff to understand potential risks and to ensure correct machinery operation (total shutoff) when refueling **Fuel Storage Tanks** - Locate in areas with sufficient space for vehicles to manoeuver easily reducing the chances of hitting storage tanks - Ensure storage facilities are maintained and inspected regularly to prevent fuel leakage

Appendix D – Link to Specified Regulatory Requirements

- http://www.calgary.ca/UEP/Water/Pages/Specifications/Submission-for-approval-/Development-Approvals-Submissions.aspx#spec
- https://www.calgary.ca/CA/city-clerks/Documents/Legislative-services/Bylaws/14M2012-Wastewater.pdf?noredirect=1
- https://www.calgary.ca/CA/city-clerks/Documents/Legislative-services/Bylaws/37m2005-Drainage.pdf?noredirect=1
- http://www.calgary.ca/UEP/ESM/Documents/ESM-Documents/ECO-Plan-Framework.pdf
- http://www.qp.alberta.ca/documents/Regs/1993_117.pdf
- http://www.qp.alberta.ca/documents/Regs/1993_119.pdf
- http://aep.alberta.ca/water/programs-and-services/drinking-water/legislation/documents/Part3-WastewaterSystemsStandards-2013.pdf