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STORMWATER – Complete Submersible Pump Station Systems

Basic information on the design of this type of pump station system is provided here.

INTRODUCTION

A wide variety of pumps can be utilized for pumping stormwater. Several factors enter into the choice of pumps and other equipment to be included in a complete stormwater pump station:

- 1) Volumes of water to be pumped during or after a storm event and during normal and low precipitation periods
- 2) Availability and storage volume of a detention pond or storage vessels upstream from the pump station
- 3) Total dynamic head (TDH) against which the pumps must work
- 4) Presence of unscreened solids in the water to be pumped
- 5) Possibility of flooding at the site where pumps are located.

Submersible pumps are frequently specified in package stormwater pump stations. Two advantages of submersibles:

- 1) Designed to handle solids, which may be present in the stormwater being pumped
- 2) Best choice for sites that could become flooded, since they are designed to operate while submerged

Upstream Storage

The rate of flow into the pump station may vary significantly between wet and dry periods, thus a detention pond or one or more storage vessels are often sited upstream of the sump to receive and store stormwater during heavy precipitation. With this upstream storage of runoff, a steady rate of flow can be fed to the pump station sump from the pond or storage vessel(s), thus helping to optimize the efficiency of the pumps.

Often, a stormwater pump station will be called upon to discharge at a steady rate or to maintain pressure in a discharge line. In this scenario, there should be adequate upstream storage to handle a large storm, thus allowing the pumps to operate at a steady rate.

Consideration should also be given to planning for possible overflow scenarios. For example, if the upstream storage and pump station are sized for average precipitation, but there is a 50-year storm, would the resulting flooding be simply a nuisance, or would there be property damage? This is important, because designing for the worst-case scenario is expensive. A lower cost design can be suitable for many situations.

Upstream Debris Removal/Separation, Screening & Filtration

Equipment for removing debris and other solids can be installed in the line(s) upstream of the stormwater pumping system. How this equipment may affect the flow to the pump station must be considered in the overall design. Cleaning and maintenance of this equipment must also be considered. In other words, if the screening equipment is offline for maintenance, would it be inadvisable to use the pumps?

Romtec Utilities works with suppliers of upstream debris removal/separation, screening and filtration equipment to ensure the stormwater pumping system operates efficiently and reliably with this equipment.

Non-clog, solids-handling submersible pumps can handle most of these solids. In extreme cases, chopper pumps that chop solids into small pieces before they enter the pump can be utilized. Another option is the installation of a macerator in the influent line ahead of the sump or in the sump itself. This machine pulverizes all solids before they reach the pumps.

Sump or Wet Well

If the fluid to be pumped is generally free of solids, there will be no build-up within the sump or wet well in which the pumps are located. Therefore, the sump can be round or rectangular, vertical or horizontal and made from concrete or



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fiberglass. If the fluid has a significant amount of solids, especially fat, oil or grease (FOG), then a vertical, cylindrical sump is preferred.

The size and depth of the sump are determined by a number of factors (see below). By utilizing an upstream detention basin or storage vessels, flow into the sump can be regulated, thus affecting the size of the sump and reducing the size and number of pumps to do the job.

When operating, the pump impellers can create vortices in the water. This must be considered in selecting pump and sump sizes, so that pump efficiency is optimized for the sump.

The exact location, angle and diameter of influent and discharge lines are predetermined and can be prefabricated in a complete package pump station. Coring of concrete or fabrication of fiberglass is done at the factory to eliminate the need for field work and ensure precise fit of the influent and discharge lines to the sump. Flexible seals in all sump penetrations are also factory installed.

Depending on the type of sump, other equipment such as pump discharge fittings, pump guide rails, influent deflector panels or drop tubes, pump accessories and liquid level sensors can be factory installed or field installed. The sump top includes the access hatch with fall protection. A davit crane for handling the pumps can be mounted on the sump top.

Precast concrete sumps are delivered to the project site in sections. The base, one or more barrels or shaft sections and the top are fitted with sealing gaskets, lifted with a crane and stacked in alignment below ground to create the complete sump. Internal parts are assembled within the sump after it is stacked.

An interior lining or coating can be specified to seal the concrete from damaging chemicals and moisture. Exterior surfaces of the concrete can also be coated to protect the concrete. These materials are installed or applied by Romtec Utilities at the factory, and they are fitted with weld strips and additional sealing in the field.

Fiberglass sumps can be delivered to the site as a single piece with all internal parts fully-assembled. Fiberglass sumps do not require chemical or moisture protection.

Romtec Utilities offers sumps from 4 feet to 12 feet in diameter (ID) and up to 40 feet in depth. The sump in every Romtec Utilities pump station is sized for the specific site requirements, which can be quite varied and include:

- 1) Depths of influent and discharge lines
- 2) Current and future average and peak flows to the pump station
- 3) Storage available in upstream detention pond or storage vessels
- 4) Pump sizes (physical size and power rating)
- 5) Average number of pump starts per hour for optimum pump efficiency
- 6) Relationship between pump area of influence and sump diameter

Pumps

Romtec Utilities offers pumps of virtually every type from the leading manufacturers. The specific type and size of submersible pumps used in a stormwater pumping system are determined by many criteria including: best performance and efficiency, customer preference for a particular brand or type of pump, overall value and other factors.

Several types of submersible pumps are commonly used in submersible pump stations for stormwater:

- 1) Solids-handling, non-clog pumps that pass 3-inch diameter solids
- 2) Grinder pumps with impellers that grind solids
- 3) Chopper pumps that macerate difficult solids such as trash

Each submersible pump is lowered into place near the bottom of the sump with the aid of pump guide rails that align the pump to engage its discharge pipe coupling. The guide rails also steady the pumps whenever they are being lifted out of the sump for maintenance. The pump electrical cables are connected to the pump station control panel through a junction box or pump disconnect panel.



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Some pump stations have pumps of two different sizes. The smaller pump (often called a jockey pump) handles small flows, and the larger pumps operate when the flow into the sump is greater.

In designing a submersible pump station for stormwater applications, the type, size and number of pumps are determined by a variety of factors, including:

- 1) Average and peak flows to the pump station
- 2) Total dynamic head (TDH) against which the pumps must work
- 3) Presence of unscreened solids in the water to be pumped
- 4) Possibility of flooding at the site where pumps and well are located
- 5) Availability of a detention basin or storage vessels upstream from the pumping system

Piping

The types, diameters and lengths of the pump discharge and force main piping are predetermined and can be prefabricated in a package pump station. Romtec Utilities pump stations generally include all piping from the influent through the last valve before the force main. Romtec Utilities designs pump stations with all common pipe materials: stainless steel, ductile and PVC.

It is common for the pump station to have multiple discharge points, i.e. a storage lagoon, an oil-water separator, a municipal sewer line. For example: a stormwater pump station that discharges to a treatment facility during low flow periods can be reconfigured to discharge to a nearby body of water during storms, since the treatment facility cannot handle the higher volume of water at those times. Piping and associated valves for multiple discharge points are part of the pump station design.

Liquid Level Sensors

One or more electronic liquid level sensors are suspended in the well and connected by wire to the pump station control panel. They indicate the fluid level, data which is used by the pump station controller to turn pumps on or off and, in the event of a problem, to turn on alarms and transmit alarm data. Common types of liquid level sensors are: micro switch floats, multi-electrode probes, pressure transducers and ultrasonic sensors.

The type of sensors used is determined by customer preference or by the controller chosen for the pump station. Many controllers can operate with any type of level sensor, while other controllers are exclusive to one type of sensor. Romtec Utilities designs with all types of liquid level sensors and controllers.

Other Sensors

More sophisticated stormwater pump stations can be equipped with various sensors that place higher demands on the controller. Romtec Utilities integrates these functions into the pump station design and the selection of a PLC (programmable logic controller) or a multi-input proprietary controller.

Several examples are:

- 1) Rain gauge sensor to report precipitation
- 2) Level sensor in an upstream storage pond or vessel
- 3) Level sensor at the force main discharge point
- 4) Flow meter in the force main

Valves, Pressure Sensor, Bypass Pumping Port, Pigging Port

The valve assemblies and related equipment in stormwater pump stations can range from very simple to complex. Romtec Utilities designs, preassembles and pressure-tests the complete assemblies, thus eliminating slow and costly field work. The entire preassembled Romtec Utilities valve assembly and vault or slab can be delivered to the project site, set in place and fitted to the pump discharge lines and force main in the shortest possible time.



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Equipment in the pump discharge lines, such as valves, can be located outside the sump in a separate underground vault, or they can be fitted within the sump. They can also be above ground if protected from freezing. The package pump station is usually equipped with a check valve and an isolation or plug valve for each pump.

A single non-contact pressure sensor can be located in the force main, although some pump systems require individual pressure sensors for each pump discharge line. A pressure sensor indicates when the water is being pumped.

Sometimes a bypass pumping port is specified for an industrial pump station. It provides the means of connecting an emergency pump, in the event of a major failure within the pump station. If so equipped, the bypass pumping port can also serve as a pigging port for sending a "pig" into the force main for cleaning and/or removing an obstruction.

Flow Calculating & Metering

Some stormwater pump stations must measure the volume of water being pumped over a period of time. An easy and inexpensive way to accomplish this is by calculating the flow. This is done by multiplying the volume of water pumped with each pump start by the number of pump starts.

Flow metering may be necessary for proving the discharge volume. Romtec Utilities supplies a number of flow metering systems from leading manufacturers, as part of our complete stormwater submersible pump stations.

An electromagnetic flow meter is inserted in the force main after the check and plug valves. The meter and associated piping and valves can also be preassembled in a separate vault. To allow maintenance of the flow meter without disabling the pump station, piping and valves to bypass the flow meter are also located in the flow meter vault.

The flow readout and reporting device, usually located at the pump station control panel, receives electronic flow data and reports it to a display panel at the pump station. Transmission of flow data to a remote computer terminal is also available.

Control Panel & Electrical Power

Typically, the electrical controls of the pump station are located in a control panel within a weatherproof enclosure. Various devices provide power to the pumps, control the pumps, receive operational and fault data from sensors within the pumps and the sump, report elapsed operational time for each pump and report operational status and alarm conditions both locally and to remote sites through telephone circuits, radio transmissions and other means.

The control panel in a Romtec Utilities pump station can be placed in a variety of locations, generally wherever the customer wants and needs it to be. As an important part of the design process, Romtec Utilities produces a scale drawing showing the equipment layout on the site. No two pump stations have the same equipment layout.

The source and type of electrical power to the pump station site is an important design factor. Romtec Utilities can design the pump station for whatever type of single-phase or three-phase power is available to the site. Generally, the control panel is designed to operate just the pump station. Other electrical demands at the site, such as yard lights and building heat can be considered in the pump station design, unless specifically required by the customer.

SCADA

Pump stations can be equipped with SCADA (Supervisory Control and Data Acquisition) devices to both report operational data to remote sites, such as an online computer terminal in the municipal public works department, and to receive operational instructions and requests for operational data from the same computer or other computers or mobile data devices. This two-way communication capability provides many benefits to pump station operators. Romtec Utilities designs stormwater pumping systems to work with all kinds of communications hardware and software.

Electrical Generator

A standby electrical generator that operates the pump station during power outages may be required. The generator is usually sized to operate just the pump station; however a larger generator can be specified for operation of the pump station plus other equipment, such as space heaters and exterior lights.



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A generator using natural gas, propane or diesel fuel can be permanently located at the pump station site and wired to the control panel through an automatic transfer switch that senses the loss and return of grid power and switches the generator on or off accordingly.

The generator can be housed in a sound-attenuating enclosure. This is an important feature if the pump station is located where sound from the generator would be a problem for nearby residents, businesses, schools and the like. The generator can also be installed within a building equipped with a ventilation system.

Alternatively, a portable generator can be brought to the site and plugged into the control panel to temporarily supply electricity until grid power returns.

Other Optional Equipment

All design parameters to accommodate any additional optional equipment are predetermined in the design of a Romtec Utilities package pump station. The optional equipment is thus integral to the complete pump system design for function, power requirements and other factors. Romtec Utilities specializes in designing pump stations that utilize specialized equipment required by the customer or by various regulatory agencies.

Shelter or Building

A structure to shade the control panel enclosure and provide shelter from weather for operation and maintenance personnel is a good idea, and it may be required. It might also be necessary to house the pump station electrical control panel, generator and other equipment within a building for equipment security and shelter. Romtec Utilities supplies a wide range of shelters and buildings that can be custom fitted to the specific requirements of any pumping system.

Stormwater Treatment Systems

Increasingly, within the U.S. and abroad, the treatment requirements for stormwater are not so different from the treatment requirements for wastewater. Romtec Utilities can integrate the pump station into a complete system that sends stormwater to a treatment system, samples the treated effluent to ensure it meets regulations and discharges the treated water to a variety of locations at regulated discharge rates.