Surface Water Monitoring Guide

Stormwater • TMDLs • Watersheds

ISCO®

CONTENTS

Isco thanks Johnny Barron of Douglasville, Georgia for his assistance in compiling this guide.

In 1987, the revision to the federal Clean Water Act included an order for states to evaluate the impact of surface water run-off. This run-off is a potential vehicle for transporting pollutants into surface waters. Today there are federal and state laws that regulate pollutants in virtually all surface water.

The United States Congress created the National Pollutant Discharge Elimination System *(NPDES)* as part of the Water Pollution Control Act of 1972.

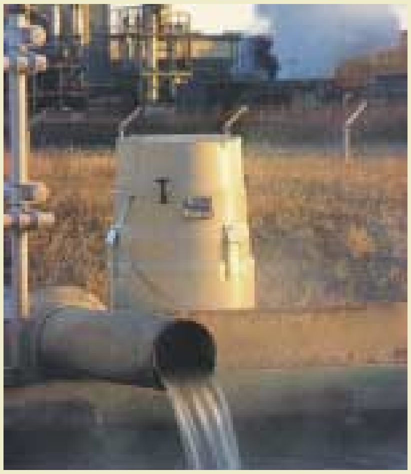
The initial goal of the program was to eliminate pollutant discharges by 1985. When first conceived, the prevailing thought was that all pollution came from "point source" discharges. Examples of point sources include pipe discharges from industrial plants or municipal wastewater treatment plants.

By 1987, perspectives had changed. The NPDES program grew to cover "non-point source" discharges such as stormwater run-off.

Since then, the federal government has initiated several programs to reduce pollutant discharges into surface waters.

Complete details of federal programs and their requirements are available on the U.S. Environmental Protection Agency's website:
http://cfpub.epa.gov/npdes/.

Check locally for state-sponsored websites.



Industrial Run-off

This program regulates stormwater run-off from industrial facilities with activities (identified in 40 CFR 122.26[b] [14] [i] through [ix] and [xi] *Code of Federal Regulations*). These facilities must sample run-off annually from a storm that has an accumulation of rain greater than 0.1 inch – and only after a 72 hour dry period. Industries are typically required to sample during the first 30 minutes of discharge and take flow-weighted composite samples for the first three hours of discharge. The sample is then tested for conventional, as well as toxic, pollutants reasonably expected to be present. NPDES also requires that these facilities develop and implement a Stormwater Pollution Prevention Plan (SWPPP). The EPA estimates that 400,000 facilities in 50 industrial categories qualify for NPDES permits.

Construction Site Run-off

This federal regulation includes construction as an industrial activity. Therefore, construction sites where one acre or more is disturbed, are subject to regulation. These sites also need a SWPPP. The federal NPDES program does not require regular sampling of such run-off, but some states may.

One example is Georgia. It has required the collection and testing of samples from stormwater discharges from the first inch of rainfall that occurs after clearing and grading. A second sample set is required within 90 days. Additionally, if best management practices are not properly designed, installed, and maintained, run-off from all 0.5 inch storms must be sampled. Samples must be collected within 45 minutes of target rainfall accumulation, then tested for turbidity.

Municipal Run-off

NPDES also regulates municipalities that own storm sewer systems. These systems discharge into surface waters and contribute to the pollutant loading. Consequently, NPDES requires municipalities to develop and implement a stormwater management plan. The plan must provide effective controls in these six areas:

- Public education
- Public involvement
- Construction site enforcement
- Post-construction maintenance
- Elimination of illicit discharges and connections
- Pollution prevention practices at municipally-owned facilities.

Continual sampling of the storm sewer system and screening of potential polluters is necessary to monitor program effectiveness.

TMDLs

Total Maximum Daily Loads (TMDLs) are the latest effort to regulate pollutant discharges. Mandated by the EPA, the TMDL program requires states to evaluate water quality in major streams and rivers. States then estimate what pollutant loadings the waterway can support without adversely affecting the ecosystem.

The intent is for pollution control measures to conform to the health of the receiving water. Consequently, a state may implement minimum controls for all stream basins. If the state determines the ecology of certain watersheds is especially fragile, it can apply more stringent measures.

A TMDL Implementation Plan must be prepared to specify pollution control measures for each major watershed. Periodic sampling is usually included as part of TMDL implementation.

Water Quality Assessments

In certain cases, a water quality assessment may be required to obtain a discharge permit under NPDES. There may also be other reasons to assess water quality, such as public complaints or third-party litigation. Private environmental organizations may invest their own time and money to monitor water quality. Whatever the reason, such assessments can provide valuable data regarding the current health of an aquatic ecosystem.

State and Local Water Quality Programs

The programs mentioned here are based on federal law. Remember that states can, and do, have their own programs – sometimes with more stringent regulations than those promulgated by the EPA. In fact, at the time of this printing, 45 states and one U.S. territory have their own NPDES permit programs. Therefore, permit conditions, including sampling requirements, should be expected to vary from state to state.

Make sure you also read and comply with current regulations from state and local authorities.

Note: Some sources for additional information are listed on page 20.

It's possible develop a sound sampling program with manual or automatic methods. Either way, it's important to produce reliable, defensible data.

Manual Sampling

Manual sampling involves filling a container by hand. The container type and volume collected are dependent on the constituents to be tested. Refer to 40 CFR 126 (Code of Federal Regulations) for guidance on container types, minimum volumes, and preservatives for various pollutants. Typically, when filling a bottle from a stream, you should:

- Sample at the vertical and horizontal centers of the channel.
- Face the mouth of the bottle upstream.
- Avoid floating debris.
- Avoid stirring bottom sediment (if bottom sediment is disturbed, move upstream).
- Label the containers prior to collection to reduce the risk of sample mix-ups.

Manual sampling can be used for any sampling event. However, it is best suited for base flow sampling during dry weather or as a back up for automatic sampling.

Advantages

Simplicity is the biggest advantage with manual sampling. It isn't complicated to fill a bottle with water. Still, collecting a representative sample requires care. The sampling technician can observe the bottle being filled and can always resample if there are doubts as to whether the sample is indeed representative of conditions. All sampling technicians need some degree of training, but those requirements for manual sampling are minimal.

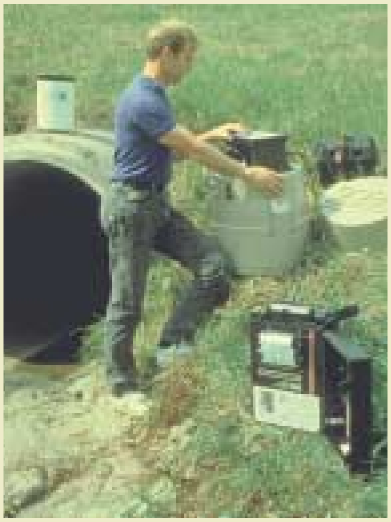
Low equipment cost is a major advantage. Equipment needed includes only bottles, coolers, a sampling pole, and perhaps a machete. Of course, chest waders or hip boots are a must for anyone entering a stream to collect samples.

Disadvantages

Safety hazards experienced during manual sampling can be significant. Even in good weather, technicians can encounter barbed wire, rocks, steep banks, snakes, bees, poison ivy, etc. Also keep in mind that stormwater run-off must be sampled during or immediately after storms. Lightning, tornados, and flash floods can be deadly. For those reasons it is wise to perform manual sampling in teams. A portable weather radio is also advisable to alert sampling teams to dangerous weather conditions.

Labor costs are another drawback. When sampling runoff for any target rainfall accumulation, the sampling technicians must be on stand-by and able to get to the site quickly to collect samples. Sometimes, they may travel to the site only to find that the level in the rain gauge falls short of event requirements. Such false alarms can be costly.

When using a manual rain gauge, a technician must inspect and empty the gauge at 24 hour intervals. And what about weekends or holidays? Will rainfall be recorded on these days as well? Labor costs can quickly add up.



Automatic Sampling

Automatic sampling systems are mechanical devices that monitor site conditions and perform sample collection when needed, without the presence of a technician. See "*Automatic Sampling Equipment*" (Pg. 8) for more details on individual system devices.

A technician may install the system days or weeks before a sample event occurs. This allows the technician to work on-site when conditions are favorable. When a defined event occurs, such as a targeted rainfall accumulation, the equipment collects the sample per advance programming.

Automatic systems record or "log" the monitored conditions and sample collection data which may be used for compliance records or detailed analysis. Following the event, when conditions are favorable once again, a technician can return to the site when convenient, to retrieve the sample and data.

Advantages

Lower labor cost and convenience are the biggest advantages. With automatic rain gauges and samplers, technicians will likely make fewer trips and spend considerably less time on-site. This increases the number of projects that a single technician can sample simultaneously. As productivity increases, labor and overhead decrease.

Safer working conditions are possible when using automatic sampling equipment. Technicians can wait to retrieve samples after storms have passed. This is substantially less hazardous, making it more feasible for technicians to work solo.

Disadvantages

Equipment cost can be significant. An initial investment of several thousand dollars may be needed to begin a project. Fortunately, reduced labor costs throughout the project can allow the recovery of this investment.

Risk of device failure is another disadvantage. Power failure, programming error, flood damage, theft, and vandalism, are all possible. Although preventive measures can reduce these risks, no device is totally foolproof.

Equipment failures due to improper programming, low battery power, or lack of maintenance, are rare occurrences for experienced crews. Training technicians in best-practices of installation, operation, and maintenance helps to ensure automatic systems perform as intended.

Begin selecting your sample collection station by reviewing maps and other available data for potential locations. Visit each potential site to assess physical hazards and accessibility.

It is important to consider the intended use of the data when selecting sampling locations. Remember, if the sample collection stations are not defensible, neither is the sampling data.

Sample downstream of the discharge point and make sure there are no other pollutant sources that could contaminate the samples. If conducting a water quality assessment, target certain geographic areas or land use categories.

After selecting a general location, consider the stream channel. There are three types of channels to draw samples from; storm run-off pipe, drainage ditch, and natural streams.

Note: If private property must be crossed, be sure to obtain permission from property owners.

Storm Run-off Pipes *(Figure 1)*

This is usually a uniform round pipe that discharges into a water body. These pipes can be made of any number of materials: corrugated steel, PVC, concrete, or carbon steel. When using automatic equipment, a rain gauge will trigger the sampler once a predetermined amount of rain has fallen. Optionally, a water level indicator can provide an additional trigger condition.

Figure 1 – Typical stormwater run-off pipe

Drainage Ditches *(Figure 2)*

These can have natural boundaries or use man-made materials, such as concrete, but are not covered. When monitoring stormwater run-off in lined ditches, automatic equipment can often be identical to what's used for stormwater run-off from a pipe.

Since unlined ditches include natural materials, like soils and vegetation, debris is often present, and can clog the collection tube intake. Where this potential exists, it's best to secure the intake away from the bottom of the channel.

Figure 2 – Unlined drainage ditch

Natural Streams *(Figure 3)*

This type of channel is unlined and not uniform in shape. Natural streams have three categories:

- **Perennial stream:** Fed by natural springs and groundwater, and flowing year round. These streams have the most diverse aquatic ecosystems.
- **Intermittent stream:** Charged by springs with only seasonal flow, they do not support aquatic life year-round.
- **Ephemeral streams:** Receive no groundwater or water from springs. They are charged solely by stormwater run-off.

If sampling run-off for permit compliance, any of these streams will do, but for biological assessments, a perennial stream must be sampled.

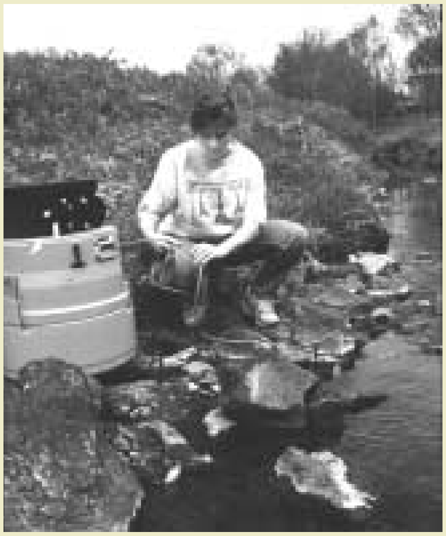


Figure 3 – Natural stream sampling

Regardless of the stream type, each will have one or more of the following basic elements.

- **Riffles:** *Shallow, swift moving water.* Water moves fastest over riffles, lifting sediment and leaving a cobble stream bottom. Riffles entrain air into the water boosting its dissolved oxygen content. Consequently, water quality parameters such as dissolved oxygen, turbidity, and conductivity can vary from section to section.
- **Pools:** *Deep, slow moving water.* This is where sediment is normally deposited and oxygen is consumed by biological and chemical activity.
- **Runs:** *Sections of moderate depth and velocity.* These are generally considered to have average values of water quality parameters. Runs typically offer the most-representative water quality sample because of moderate stream characteristics. Therefore, collect samples from a mid-depth, mid-stream position of a run.

Another consideration is the meander of the stream channel. Streams naturally meander, forming multiple curves along the channel.

It helps to understand that as water flows around a bend, the outside edge is moving swifter that the inside edge. Thus, the outside edge is usually a cutting bank, where higher velocities cause erosion. Conversely, the inside edge receives deposits of sediment, forming sand or point bars.

The inside bank of a curve is usually more stable and less steep, providing the safest access to the water. Flow often undercuts the outside banks, which can shear off and fall into the stream – taking equipment (or people!) with them. Remember that during high flow conditions (after storms), any stream bank can be unstable and may collapse. The best advice is to stay away until conditions have stabilized.

Rain Gauges *(Figure 4)*

The rain gauge is a key element in a stormwater runoff monitoring system. The instrument measures on-site rainfall (typically in increments of 0.01 inch or 0.1 millimeter). It allows system components to remain idle (conserving power) until there has been a sufficient amount of rainfall to warrant monitoring activity. Once a pre-set rainfall amount is detected, a signal from the rain gauge activates another instrument – usually a sampler or flow meter. The system can also be configured to require additional rainfall parameters for activation.

Figure 4 – Pole-mounted rain gauge

Install automatic rain gauges in the open so that there are no obstructions to rainfall, such as an overhead tree canopy or nearby structure. Locate the rain gauge away from traffic or facility operations.
A cable connects the gauges to the instrument.
If traffic cannot be avoided, protect the cable inside a buried conduit.

The elevation of the rain gauge should allow access for routine inspection and maintenance – generally less than five feet above the ground.

Other Parameter-measurement Devices

(Figure 5)

Just as rainfall can trigger stormwater sample collection, a number of other water quality parameters can also be used to initiate sampling. Those may include pH, dissolved oxygen, conductivity, temperature, turbidity, and more. Appropriate in-situ probes or multi-parameter sondes are used as triggers in those cases.

Such sensors can save costs and eliminate unnecessary analysis. Enforcement and compliance monitoring programs use them selectively to trigger automatic samplers only when conditions exceed normal ranges.

Figure 5 – Multi-parameter sampling site

Water Level Indicators *(Figure 6)*

It is impossible to collect a sample if the water level does not cover the collection tube intake. One example of this condition is an ephemeral stream. A rain gauge may indicate an event, but the stormwater has not yet filled the stream bed. A simple water level indicator, installed alongside the intake, can trigger the sampler once the water level is sufficient. The simplest water level indicator is a conductivity sensor which detects moisture.

Other types of water level indicators are a bubbler meter or submerged pressure transducer. Many of these devices can measure level and flow rate for later analysis. Refer to “*Flow Monitoring*” (Pg. 13) for more information.

Figure 6 – Isco Flow Logger in use to indicate water level

Samplers *(Figures 7 & 8)*

The best automatic samplers use a peristaltic pump (driven by a battery-powered motor) to draw water through a strainer and flexible sample tube. It is then deposited into a collection bottle.

Most use a computer processor, with LCD display. This allows programming of sampler functions, such as collection intervals, sample volumes, and bottle positions. Data logging capabilities are also common features.

The automatic sampler is the primary component of a sampling system, and often the most expensive single part. Because many types of samplers are available, take care in specifying this key component to ensure that it will meet your sample program requirements.

Some considerations should be:

- Is the sampler rugged and reliable enough to meet the environmental demands?
- Do its collection capacity and sample preservation capabilities meet all program requirements?
- Does its software support the monitoring requirements?

Seek out a manufacturer with experienced sales representatives and sound technical support to assist you with these considerations and assure long-term follow-up.

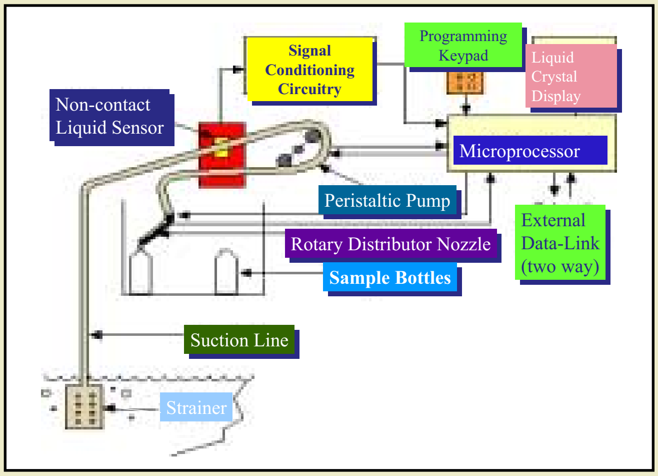


Figure 7 – Typical sampler schematic

Figure 8 – Isco Avalanche® field installation

Ideally the automatic sampler should be located outside of the primary channel and above the flood plain.

Sampler pumps typically draw 25-28 vertical feet of head. While sufficient to reach outside most stream channels, that sometimes falls short of allowing sampler installation outside the flood plain. Compounding this problem is the fact that the collection tube should be installed in a mid-stream, mid-depth location.

Consequently, samplers are often installed in flood prone areas. Wherever possible, place them outside of the main floodway channel. Look for a wooded location at the floodway fringe and chain or strap the sampler to a tree. If there are no trees, drive a steel post (better yet, several) well into the ground and secure the sampler that way (Fig. 9). This greatly reduces the risk of high flows washing away your sampler. It's equally important to secure the sampler in an upright position so that wind or water cannot tip it over.

Figure 9– Post-anchored sampler

Sample Intake Installation

To ensure a representative sample, correctly position the collection tube in the stream. Sample collection tubes usually include a strainer attached at the end of the suction line tubing.

In pipes, install the strainer by simply laying it at the bottom of the pipe (Fig. 10). The weight of the strainer usually holds it in place. If there is potential for very high stream velocity at the height of a storm, adding weight or attaching it to a mounting plate or pole will prevent the strainer from riding on the surface of the flow.

In drainage ditches and natural streams, secure the suction line in the channel at its vertical center. This avoids drawing bottom sediments into the sample while assuring that the tube remains submerged.

Figure 10 – Sampler intake in storm pipe

For small to moderate sandy-bottom channels, drive two steel posts into the stream bed. These posts should have tie-off holes. If possible, drive the top of the posts below the water surface to reduce the likelihood of snagging floating debris. Using wire, cable ties, or hose clamps, fasten the end of the sample collection tube to a post as close as practical to the horizontal center of a run. Be careful not to crimp the tubing.

Due to tube length limitations, it may be necessary to place the strainer near the edge of the stream. If so, choose the cutting side rather than the deposition side to minimize the possibility of sediment burying your strainer.

After securing the end, tie off the tubing to at least one other stake below the water surface. Also, secure the tubing to stakes or trees on the bank of the channel. Make sure there are no areas of loose tubing that can be snagged by floating debris. Avoid vertical loops that can trap water in the tubing. Trim off excess tubing.

If unable to drive posts (into a rocky stream bed, for instance), drive stakes horizontally into a cutting bank, just above the water surface. Then, secure the sampling tube to the post(s) so that the strainer hangs down to the mid-depth point. Anchor this stake firmly, or a passing log may take it downstream. This technique can also be used for deep streams where you're not able to anchor the tubing to the stream bottom. Alternatively, feed sample tubing through a rigid pipe into deep water so that it protrudes down into the water about 24 inches. Or, secure your tubing to a wooden plank (2"× 4") that protrudes into the water. As always, make sure the pipe or plank is securely mounted to the bank so it won't be washed away.

Security

Sampling equipment is subject to vandalism and theft. Remember, "out of sight, out of mind." For long-term installations, a protective shelter (elevated beyond potential high-water level is ideal (Fig. 11).

Otherwise, locate samplers in inconspicuous places whenever practical. Place units inside boxes or sections of pipe, or bury equipment inside a waterproof container. A less extreme measure is to secure items to a post or tree using chains and padlocks to keep them from being opened.

Figure 11 – Permanent sampler shelter

In some cases, electrical hazard labels may be enough to deter a curious visitor.

Figure 12 – Electrical hazard notice

Some installations post a sign briefly explaining what the device is for along with a phone number or website address where people can find out more information.

Don't forget to place contact information inside the sampler in case high waters carry it downstream.

Power Source

Automatic sampling equipment needs power – generally supplied by DC batteries. A secondary, internal battery retains program and data storage memory when replacing primary batteries.

A solar panel can be ideal for many sites. Install it in the open, angled for maximum exposure, according to manufacturers instructions. For stormwater systems, the solar panel can sometimes mount below the rain gauge, sharing the same post.

Figure 13 – Typical solar panel installation

Data Collection

Depending on their level of sophistication, automatic samplers can log flow rate, rainfall, multi-parameter data, and sample information. Systems including a flow meter, to measure level or flow rate, may log data in the flow meter instead. If required, routinely retrieve the stored data with a laptop computer or other type of data transfer device. A comprehensive software program can then analyze the data.

Communication

Advanced automatic sampling systems may include remote monitoring and data retrieval. For long term sites, a phone line can be hard-wired to the sampling site and connected to an internal modem. For short-term use, digital cellular phone options may be the most practical. Whether wired or wireless, these remote connections allow:

- Monitoring of the system status
- Data retrieval
- Programming corrections or updates
- Dial-out notification when a sample event is occurring, or when the equipment requires service

For dial-out notification, telephone modems can deliver a voice message to telephone users. Digital Modems can send text messages to cellular phone users who have text-messaging service.

Figure 14 – Data retrieval using a cellular modem

Another remote option is spread-spectrum radio. This allows a user to retrieve data from inside a vehicle, with line-of-sight proximity to the transmitter. Communication at distances of up to 0.5 miles is often possible with Isco's 2102 Wireless and 2103 Modem Modules.

Figure 15 – Drive-up data retrieval

Test run

Test your installation by manually tipping the rain gauge tray to trigger the sampler. Make sure the pump draws the minimum volume of sample required.

If not, check the tubing for obstructions or kinks. If water never reaches the bottle, the sampler may be too high above the sampling point.

Whether monitoring stormwater or for surface water quality, flow rate data may be of interest. With flow data, you can calculate loading of certain parameters or better indicate the impact of a storm on a receiving water body. There are several site-specific conditions to consider when choosing a flow measurement technology.

Primary Measuring Devices

Primary measuring devices are various structures that restrict flow, establishing a known level-to-flow rate relationship in a waterway. A discharge table or formula then allows flow to be accurately calculated.

Figure 16 – Temporary weir

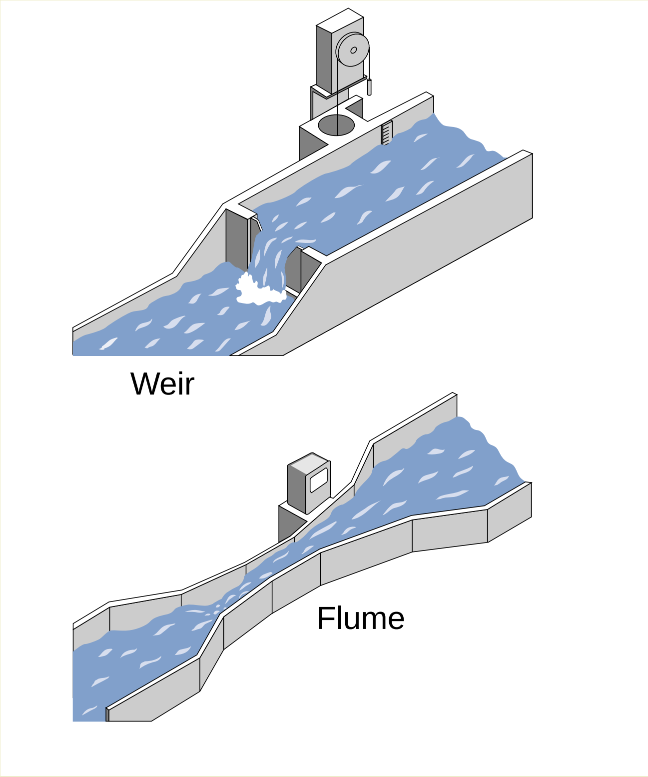


Figure 17 – Typical weir/flume configurations

There are two types of primary measuring devices; flumes and weirs. Here are some factors to consider when making your choice:

Flumes

Advantages	*Disadvantages*
Low maintenance	More costly than weirs
Low head loss	More difficult to install
	Less accurate than weirs

Weirs

Advantages	*Disadvantages*
Low cost	High head loss
Easy to install	Solids can build up

Secondary Measuring Devices

A secondary measuring devices are water level measuring instruments that can calculate flow, based on the primary measuring device's discharge table. There are several different ways to measure water level and no technology is suitable for all applications. Following are the most commonly used level measurement technologies and a chart showing which technology best suits various conditions.

Ultrasonic (Figure 18)

These are non-contacting sensors that mount above a measuring point in the channel. Ultrasonic sound waves are sent to the surface of the water, then reflected back to the sensor. Water level is calculated from the signal's return time.

Figure 18 – Ultrasonic sensor

Submerged Pressure Transducer (Figure 19)

The sensors mount in the stream and read the amount of pressure at the bottom of the flow (at the sensor). The amount of pressure indicates water depth.

Figure 19 – Submerged pressure transducer in flow stream

Bubbler (Figure 20)

This technology uses a compressor to send air bubbles into the stream through a tube. The amount of pressure needed to push the bubbles into the stream indicates water level.

Figure 20 – Close-up of bubbler hose end

Secondary Device Suitability

Site Condition	Ultrasonic	Pressure	Bubbler
Strong wind	No	Yes	Yes
Air temp fluctuations	Yes[1]	Yes	Yes
Steam above channel	No	Yes	Yes
Foam on water surface	No	Yes	Yes
Flow stream turbulence	No	Yes	Yes
Floating debris	No	Yes	Yes
Floating oil or grease	No	Yes	Yes
High suspended solids	Yes	Yes[2]	Yes[2]
High suspended grease	Yes	Yes[2]	Yes[2]
Silting in	Yes	Yes	Yes[3]
Water temp fluctuations	Yes	Yes[4]	Yes
Submerged flow	No	No	No
Full pipe flow	No	No	No
Surcharged flow	No	No	No
Reverse flow	No	No	No

1. Large air temperature fluctuations will affect accuracy.
2. Will require routine cleaning.
3. Increase the automatic routine purge to keep the end of the tube from clogging. Manual cleaning may also be required.
4. Large water temperature fluctuations will affect accuracy.

Manning Formula

This is an accepted method by which – under certain circumstances – the rate of flow in an open channel can be closely estimated without the use of a weir or flume. With this technique the flow conduit itself serves as the primary device.

$$Q = \frac{K A R^{2/3} S^{1/2}}{n}$$

For satisfactory results, apply the Manning formula only when channels demonstrate the following characteristics:

- A uniform cross section
- A consistent, measurable slope
- The degree of roughness* is known
- Flow moves by force of gravity only (not under pressure)

*Refer to *"Isco Open Channel Flow Measurement Handbook"* or similar reference.

Area Velocity (Figures 21 & 22)

The area velocity method consists of measuring both the cross-sectional area of the flow stream at a certain point, and the average velocity of the flow at the same point. Multiplying the area by its average velocity yields the flow rate. This is often referred to as the continuity equation ($Q = A \times V$).

This method has several advantages over weirs and flumes, and the Manning formula. A key advantage is that, in addition to measuring flow under free flow conditions, it can also be used to measure flow under submerged, full pipe, surcharges, and reverse flow conditions.

Area velocity flow conversion works best when the channel shape is uniform. If not entirely uniform, a survey of the channel should be conducted to calculate level-to-cross-sectional-area data tables.

When installing an area velocity sensor in the stream, be sure to position it in an area that best represents the average velocity. Never install the sensor where eddy currents can disrupt the velocity reading accuracy.

In large streams the velocity profile is very dynamic and one sensor cannot read all the way across. In this case, install multiple sensors to more accurately measure the velocity profile. During later analysis, average the velocities to calculate the most accurate flow rate.

Figure 21 – Isco 2150 Area Velocity Module on site

Figure 22 – AV sensor and strainer mounted to a plate at the bottom of a storm channel

Here are answers to some questions that commonly arise when considering surface water monitoring projects. Of course, we can't anticipate every one, so feel free to contact our Customer Service Department for insights and advice regarding your specific needs.

"Where should a rain gauge be located?"

The rain gauge should be installed where its collector (top) has unobstructed access to rainfall. Its location should be away from trees, buildings or other objects. If vegetation serves as a windbreak, keep in mind that unchecked growth can greatly change the conditions of the site with the passage of time. See Figure A.

A general rule is:
The height of the surrounding objects should not exceed twice their distance from the rain gauge.

Figure A

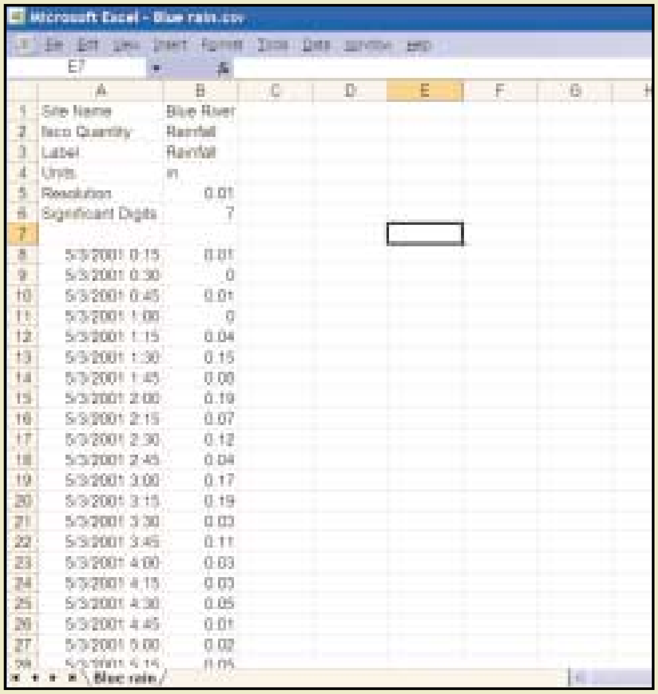
"Our sampler and flow meter are inside a manhole, making it impractical to connect the rain gauge to the flow meter. Is there an alternate way to store rainfall data?"

Isco's 676 Logging Rain Gauge is perfect for such situations. It includes a flow logger that records rainfall data. Data can be retrieved to a notebook computer, phone line and modem, or digital cell phone modem.

"The fire stations in our city already have rain gauges. Will we be able to combine their data with the data from our sampler and flowmeter?"

Yes. Isco's Flowlink®4 Software can import rainfall data (stored in ASCII format) from a spreadsheet file. Once imported, Flowlink allows you to analyze the data along with flow, multi-parameter, and sample data collected by your Isco Sampler and/or Flow Meter.

This advanced flow data management software can also import and analyze data from several other sources. See Figure B.



	A	B
1	Site Name	Blue River
2	Isco Quantity	Rainfall
3	Label	Rainfall
4	Units	in
5	Resolution	0.01
6	Significant Digits	7
7		
8	5/3/2001 0:15	0.01
9	5/3/2001 0:30	0
10	5/3/2001 0:45	0.01
11	5/3/2001 1:00	0
12	5/3/2001 1:15	0.04
13	5/3/2001 1:30	0.15
14	5/3/2001 1:45	0.08
15	5/3/2001 2:00	0.19
16	5/3/2001 2:15	0.07
17	5/3/2001 2:30	0.12
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21	5/3/2001 3:30	0.03
22	5/3/2001 3:45	0.11
23	5/3/2001 4:00	0.03
24	5/3/2001 4:15	0.03
25	5/3/2001 4:30	0.05
26	5/3/2001 4:45	0.01
27	5/3/2001 5:00	0.02
28	5/3/2001 5:15	0.05

Figure B

"Some industrial facilities must collect a "first flush" sample during the first 30 minutes of a storm, as well as a flow-weighted composite sample for the entire storm event (or the first three hours of the run-off, whichever occurs first). Can a single sampler collect both of these samples?"

Isco's 6712 Sampler has special programming that allows for both types of samples to be taken. The sampler's bottles can be divided into two groups. The first group can be programmed to take the "first flush" sample. The second group can be programmed to take flow-weighted samples.

Isco's 6712 Sampler offers four 1-gallon glass bottle to accommodate this type of sampling. Bottle #1 can be assigned to the first bottle group and the remaining three bottles can be assigned to take hourly composites. See Figure C.

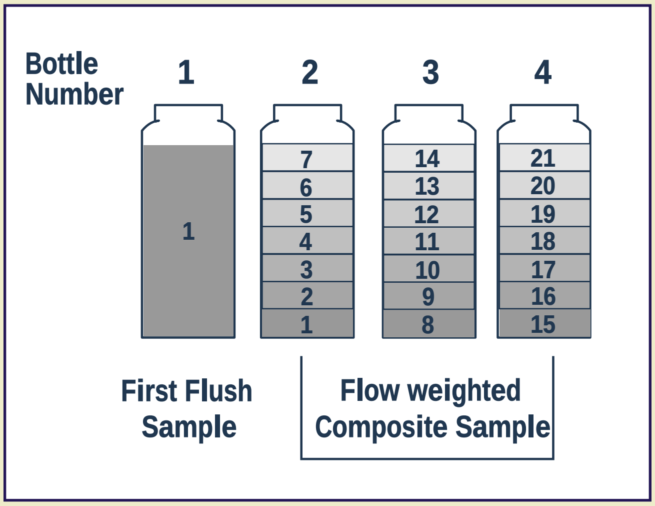

Figure C

"It's difficult to estimate the amount of run-off prior to a storm event. If we underestimate, all the bottles fill too soon. If we overestimate, we don't collect enough sample for complete analysis. Is there a way to solve this problem?"

An Isco sampler with twelve 1-quart glass bottles is the answer. The first-flush sample is stored in the first three bottles. Individual samples are collected into the nine remaining bottles at 20-minute intervals. After the storm, sub-samples from each of these nine bottles can be poured into one container, resulting in a flow-weighted composite sample.

The volume of each sub-sample is proportional to the flow at the time of sampling – as measured by the flow meter – eliminating the need to predict run-off volume before a storm event. See Figure D.

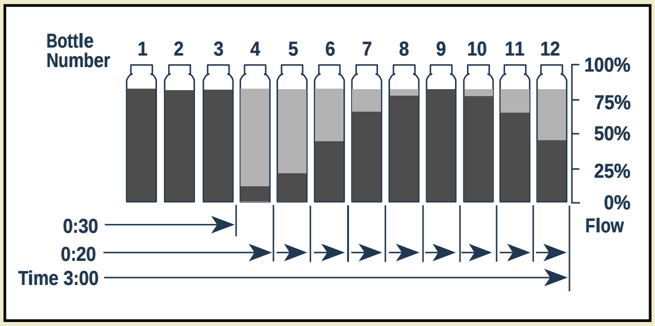

Figure D

"We are required to collect samples, but don't need to measure flow and rainfall. Is there a way to activate the sampler when run-off occurs – without a using a flow meter?"

You bet. Use Isco's 1640 Liquid Level Actuator. It has a probe located in the flow stream. When the water level rises and touches the probe, the Liquid Level Actuator signals the sampler to begin collecting.

"How do we preserve samples at 4 degrees C?"

Isco's portable samplers feature insulated bases for holding ice to cool samples during short-duration sampling activities (usually less than 12 hours). For long-term use, ice must be added just prior to a storm event. This can be difficult to manage and can expose persons to hazardous weather conditions. See Figure E.

Isco is unique in offering a transportable refrigerated sampler, the Avalanche®. It uses a deep-cycle marine battery, or AC power but stays powered-down until the first sample is taken. Then, on-board refrigeration cools samples and keeps them at 4°C until retrieval is convenient (typically in 48-72 hours).

Figure E

"What about collecting samples of volatile organic compounds (VOCs)?"

Standard samplers aren't suitable for VOC sampling because the pumps strip VOCs from the liquid. In addition, their bottles aren't sealed after sample collection.

Isco's 6100 VOC Sampler automatically collects and seals representative samples according to EPA protocols. Our flow meters can activate both the 6100 and a standard sampler at the same time. See Figure F.

Keep in mind; unlike standard samples, VOC samples must be collected from a tranquil section of the flow stream.

Figure F

"What's the best way to power a stormwater monitoring system?"

Where portable equipment is used, Isco recommends lead-acid batteries, as they hold a charge longer than other types. Automotive or deep-cycle marine batteries have a very high capacity and relatively low cost. Isco offers a 45 amp/hour lead-acid battery with integral cable.

Where line power is available, an AC power pack can be used to convert 120 or 240 volts AC to the required 12 volts DC.

For long-term applications, or where access is difficult, solar panels may be most suitable. A solar charger maintains a lead-acid battery in a fully charged condition, virtually eliminating the need to visit the site for periodic battery replacement. See Figure G.

Figure G

"What are the options for checking the status of a site without actually going there?"

With a telephone modem, a site can be called to view the current parameter readings, and to check the state of the automatic sampler.

At a permanent location, a phone line can be routed directly to a sampler with an internal modem. For temporary use, or where routing a telephone line would be cost prohibitive, an Isco Model 6712 sampler can be fitted with a digital cellular modem.

A phone modem and simple terminal emulation program (Windows HyperTerminal, for example), will give you remote access to the site information and allow changes to sampler programming.

"I'd like to leave my monitoring equipment in the field for long periods of time and eliminate unnecessary trips to the site. What do I need?

The alarm dial-out feature is what you're looking for. With an internal modem, an Isco sampler will call up to five phone numbers to notify you of an alarm condition. With a digital cellular modem, the sampler can send text messages to your cell phone or pager. Both modems let you program an Isco Model 6712 sampler to dial-out when the selected conditions occur; i.e., program is complete, the sampler has been activated, the sampler has malfunctioned during its program, etc.

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A well-thought plan that incorporates the right equipment and software is the key to successful surface water monitoring. Use the following checklist as a guide to help plan the overall strategy for the site or sites you'll be monitoring.

Parameters Monitored

__ Rainfall Amount
__ Flow Rate
__ Flow Depth
__ Temperature
__ DO
__ Turbidity
__ pH

Sampling Method

__ Time-paced
__ Event-paced
__ Flow-paced

Samples Required

__ Periodic
__ First-flush
__ Flow-weighted Composite

Site Conditions

__ Easily Accessible
__ Remote
__ AC Power Available
__ Secure __Vulnerable

Channel Type and Condition

__ Round Pipe
__ Lined (concrete, etc.)
__ Natural (earthen ditch)
__ Smooth __ Rough __Irregular
__ Surcharge Possible
__ Reverse Flow Possible
__ Submerged Flow Possible
__ Debris Likely
Channel Length ___________ ft.

Equipment Needed

__ Rain Gauge
__Standard __Logging
__ Flow Meter
__Ultrasonic __Submerged Probe
__Bubbler __A.V. __Other
__ Sampler
__Portable ___Stationary
__1 Bottle __4 Bottles
__ 12 Bottles __Other
__ Weir __Flume
__ System Enclosure
__ Refrigeration

Data Retrieval/Communications

__ Laptop PC
__ Field Transfer (RTD)
__ Telephone Modem/Land Line
__ Alarm Dial-out
__ Cellular Phone
__ Wireless (2102 Module)
__ Radio
__ Text Message Alarms

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