# *Typical Flow Metering Equipment*

Prepared for

## *Giant Refining Company*

## *Gallup, New Mexico*

August 2006

Prepared by

HRC

HUBBELL, ROTH & CLARK, INC

Consulting Engineers

555 Hulet Drive • P.O. Box 824
Bloomfield Hills, MI 48303-0824
(248) 454-6300
www.hrc-engr.com

# Section I

# Typical Magnetic Flow Meter

(for closed-conduit flows)

# MagneW Two-Wire PLUS

YAMATAKE

## Versatile Two-Wire Magnetic Flowmeter Slashes Installation Costs

Measurement instrumentation has evolved from "end of the line" hardware to play an integral role in the overall control strategy. But improved operation efficiency can take a toll on the bottom line. Whether upgrading to improve existing two-wire flow instrument performance or designing a new control strategy, long four-wire cable runs significantly escalate installation and maintenance expenses.

The Yamatake MagneW Two-Wire PLUS (TWP) magnetic flowmeter series consistently delivers reliable, accurate performance at a fraction of traditional four-wire installation costs. Now you can cost-effectively replace alternate technology two-wire flow measurement instruments to improve performance and reduce maintenance.

Since the output loop provides the low voltage operating power, only one single pair of wires is needed – greatly reducing costly cable runs and simplifying overall installation and maintenance.

Although two-wire flowmeter installation cost is generally 4 to 5 times less than four-wire models, this is only one of the benefits of the MagneW TWP series. The series also features:

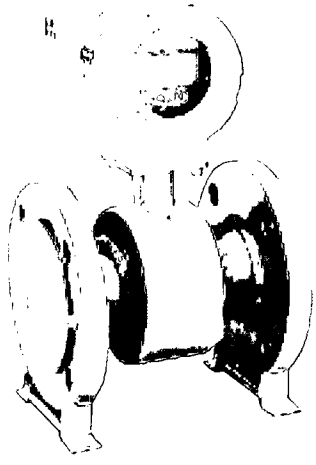
- **broad size range from 0.1 to 8 inch diameter (2.5 to 200mm)**
- **integral and remote mounting styles**
- **stable output - no external filters required**
- **reliable performance accuracy**
- **patented smooth lining finish for adhesive applications and long performance life**
- **unique electrode shape to reduce deposits**
- **DE and HART® communications capability**
- **flange or lower cost wafer process connections**
- **fully welded stainless steel detector body**
- **LCD converter display with data setting switches**
- **low power consumption**
- **FM Explosion Proof certification**

Backed by Yamatake Corporation's world-wide reputation for design innovation, high-quality products and precision manufacturing, the MagneW Two-Wire PLUS is well suited for processes in:

- **biochemistry**
- **chemical**
- **food and beverage**
- **metal and steel**
- **municipal utilities**
- **pharmaceutical**
- **pulp and paper**

The MagneW TWP can be effectively employed in most applications that measure flow rates for:

- **caustic or corrosive liquid**
- **chemical solutions**
- **cooling water**
- **medical fluids**
- **drainage and waste liquid**
- **industrial or sea water**



### Reliable, Repeatable Measurement

**Reference accuracy** – Dependable flow measurement is essential to product quality and productivity. The MagneW TWP series typically provides ± 0.5% of rate at normal flow rates.

**Noise susceptibility** causing inconsistent and erroneous output has been an issue with some two-wire flowmeters. The innovative, patented excitation method reduces noise susceptibility enabling the TWP series to deliver accurate, reliable data.

### Installation Flexibility

**Mounting** – MagneW Two-Wire PLUS flowmeters are available in integral or remote mounting styles. Remote mounting expands measurement capabilities in space constrained production areas simplifying installation and reducing costs. Remote mounting also simplifies maintenance and reduces equipment and plant personnel from exposure to hazardous environments.

**Pipe connection** – Flange or wafer units are both available in the series. If your application doesn't require a flange connection, the lower cost wafer and simplified installation are advantageous.

YAMATAKE AMERICA, INC. 9033 N. 24TH AVE. STE. 5 PHOENIX, ARIZONA 85021 TOLL FREE (888) 262-4639

## Easy Operation Converter

Four converter switches make data setting fast and easy. Communications is simple too, with both HART and DE communications available. The converter display shows three simultaneous values:

- **Percent flow rate (%)**
- **Actual flow rate (GPM)**
- **Totalized value**

## Durable, Long-life Detector Operation

**Lining and electrode** – The patented mirror finish PFA lining and the unique shaped electrodes resist fluid particle build up, making the MagneW TWP series an outstanding choice for chemical applications where adhesive properties of the process fluid can cause detector coating.

**Detector housing** – The detector body is fully welded stainless steel, much more impervious to corrosion and leakage than painted steel units. Manufactured to withstand corrosive chemical environments, the stainless detector body ensures virtually maintenance free operation.

### MagneW TWP Converter Specification Overview *

| | |
|---|---|
| Type | Integral/Remote |
| Loop Power | 15.6 to 42 VDC |
| Structure | IEC IP67, NEMA 4X |
| Output | 4-20 mA DC, Pulse, Contact, DE |
| Communication | DE/HART |
| Display | Backlit LED main display<br>7 segments 8 digits,<br>subdisplay 2 lines, 16 digits,<br>simultaneous displays % flow rate,<br>actual flow rate, totalized value |
| Data Setting | 4 key switches, communications |
| Housing | Aluminum alloy with baked acrylic or epoxy paint |
| Ambient Temp. | -4 to +140°F (-20 to +60°C) |
| Ambient Humidity | 10 to 90% RH |
| Mounting | Integral/Wall/2 in. (50mm) pipe |
| Elec. Conductivity | 10 µS/cm minimum |
| Functions | Data setting protection, low flow cutoff setting, dropout setting |
| Accuracy | ± 0.5% of rate |

*These MagneW TWP Converter and Detector specifications are a summary. Contact Yamatake America Inc. to request publication SS2-MTG200-0100 for complete specifications.

### MagneW TWP Detector Specification Overview *

| | |
|---|---|
| Diameter | 0.1, 0.2, 0.5, 1, 1.5, 2, 2.5, 3, 4, 6, 8 inch (2.5, 5, 10, 15, 25, 40, 50, 80, 100, 150, 200 mm) |
| Type | Integral/Remote |
| Structure | IEC IP67, NEMA 4X |
| Approvals | FM Explosion-proof** |
| Pipe Connections | Flange/Wafer ANSI 150/300, JIS 10/20/30K, DIN PN 10/16/25 |
| Electrodes | SS316L, Hastelloy C, Titanium, Zirconium, Tungsten carbide, Tantalum, Platinum/Iridium, others |
| Grounding Rings | SS316, Hastelloy C, Titanium, Zirconium, Tantalum, Platinum/Iridium, others |
| Lining | PFA |
| Housing | 304 Stainless Steel |
| Fluid Temp. | -4 to +266°F (-20 to +130°C) |
| Fluid Pressure | -14.2 to 426 PSI (-0.098 to 2.94 MPa) |
| Ambient Temp. | -4 to +140°F (-20 to +60°C) |
| Ambient Humidity | 10 to 90% RH |

**Pending at time of this printing.



## Broad Portfolio

In addition to the MagneW Two-Wire PLUS Yamatake also offers a broad range of quality four-wire electromagnetic flowmeters from 0.1 to 44 inch (2.5 to 1100mm) diameters. The high energy noise resistant (HENRI) models specifically address slurry and dense particle suspension applications requiring noise immunity.

# Section II

## Typical Open Channel Flow Meters

(area-velocity for insertion in pipes or bubblers for use with flumes)

# Open-Channel Flow Meters

## Innovative Technology for a Wide Range of Applications


HACH®

*Be Right™*

# Innovative Technology


Flow measurement accuracy requires flexible technology, tailored to your site conditions. That's why Hach flow meters give you four ways to measure flow; ultrasonic, submerged pressure sensors, bubbler, and area velocity. The flow meters covered in this brochure have been configured to provide you with a choice of state-of-the-art features and options. (See the table on page opposite.)

**Direct Average Velocity.** The Hach Doppler weighted-average method collects and averages the velocities of multiple points in the cross-sectional area of the channel. This eliminates the need for on-site velocity calibration, thereby reducing installation and maintenance requirements, and time in the manhole.

**1 Megahertz Doppler Velocity Technology.** The Hach Doppler sensors feature a high frequency, which provides higher data resolution by detecting smaller particles.

**Multiple-Level and Velocity Sensors.** Some flow meter models offer an optional second- and third-level measurement or velocity measurement sensor; this allows one flow meter to either monitor multiple channels or to take multiple measurements of the same channel.

**Low Profile Probe.** The standard Hach submerged AV probe is the smallest probe of its type currently available. A low profile means less turbulence, which results in more accurate velocity measurements, especially in low-flow situations. The Hach wafer velocity probe, which measures 0.44" H x 1.5" W x 2.7" L, used in combination with the In-pipe Ultrasonic sensor can measure flow in low-level, high-velocity applications.

**In-Pipe Ultrasonic Sensor.** Reduces the ultrasonic deadband, thereby providing a greater percentage of level capture. This permits the use of the more accurate ultrasonic technology in pipes or in situations that would normally require a submerged pressure transducer.


**Intrinsically Safe Options.** The model 911 and 940 flow meters can be used in hazardous or potentially hazardous environments.

**Water Quality Parameters.** The model 950 can monitor pH, conductivity, ORP, and DO. The model 980 can monitor pH. Other measurements include rainfall and temperature.

**Easy-to-Read Graphics Display.** Provides maximum amount of graphed or tabular data at a glance. In the field, the display allows for quick review of data.

**Patented Drawdown Correction.** Compensates for effects of velocity on submerged pressure level measurement.

Hach offers a versatile line of flow meters that allows you to choose the right meter for your application or site condition and to upgrade as your needs change.

## Open Channel Flow Meter Model Guide

| Features | 910 | 911 | 920 | 930 | 940 | 950 | 950AV | 950 OptiFlow | 950 OptiFlow AV | 980 | 980AV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Page | 4 | 5 | 6 | 8 | 7 | 9 | 10 | 9 | 9 | 12 | 13 |
| Portable/Field* | • | • | • | • | • | • | • | • | • | | |
| Permanent | | | • | • | | • | • | • | • | • | • |
| Interface via computer | • | • | • | • | • | • | • | • | • | • | • |
| User Interface: keypad + LCD | | | | | | • | • | • | • | • | • |
| Data Transfer Unit | • | | • | • | | • | • | • | • | • | • |
| Battery Life (in days) @ 15 minute intervals** | • (60) | • (65) | • (90) | • (365) | • (365) | • (150) | • (150) | (150) | (150) | | |
| AC Power Capability | | | • | | • | • | • | • | • | • | • |
| Level/Flow Measurement: | | | | | | | | | | | |
| 1 level only channel | | | | | | • | | • | | • | |
| 1 level and/or velocity channel | • | • | | | | | • | | • | | • |
| 2 level and/or velocity channels | | | • | | • | | | | | | |
| 3 level and/or velocity channels | | | | • | | | | | | | |
| Bubbler | | | | | | • | • | • | • | | |
| Submerged Pressure | • | • | • | • | • | • | • | • | • | | • |
| Ultra Sonic | | | • | • | • | • | • | • | • | • | • |
| Area Velocity | • | • | • | • | • | | • | | • | | • |
| Intrinsic Safety | | • | | | • | | | | | | |
| NEMA Rating 6P | • | • | • | • | • | | | | | | |
| 4X, 6 | | | | | | • | • | • | • | | |
| 4X (IP66) | | | | | | | | | | • | • |
| Optional Features pH/Temp Only | | | | | | • | • | • | • | • | • |
| pH/Temp/ORP | | | | | | • | • | • | • | | |
| DO/Conductivity | | | | | | • | • | • | • | | |
| Rain Gauge | | | • | • | | • | • | • | • | • | • |
| 4-20 mA Outputs | | | | | | • | • | • | • | • | • |
| Alarm Relays | | | | | | • | • | • | • | • | • |
| Analog Inputs | | | | | | • | • | • | • | • | • |
| RS-232 | • | • | • | • | • | • | • | • | • | • | • |
| Modem (USA, Canada only) | | | • | • | • | • | • | • | • | • | • |
| Sampler Pacing | | • | • | • | • | • | • | • | • | • | • |
| Mechanical Totalizer | | | | | | • | • | • | • | | |

** May be affected by site conditions.

## Rain Gauge or Rain Gauge with Rain Logger

Built to National Weather Service standards, the Rain Gauge accurately measures rainfall in 0.01" increments. The rain gauge can be connected to a Hach Flow Meter, or the Rain Logger can be used for stand-alone or long-term rainfall recording, as well as for portable use in storm water runoff monitoring.

## Portable Field or Permanent Models

Models include: "blind" flow meters (no keypad or display), and flow meters with graphic display: the 950 (shown upper right) has both AC and battery power making it suitable for use in the field or for permanent installation; the 980 (shown upper left) is for permanent installation.

* See page 11 for information on the hand-held Portable Flow Velocity Meter

# 910 Portable Area Velocity Flow Meter

*Hach's* **Sigma 910** *is our most popular meter for economical, short-term, single-channel collection system monitoring.*


## 910 Design Specifications

- **Dimensions:** 4.5" diameter X 17.625" L, (11.4 cm diameter x 44.8 cm L)
- **Weight:** 7.8 lbs. (3.54 kg) with battery
- **Enclosure Material:** PVC
- **Enclosure Rating:** NEMA 6P (IP67)
- **Operating Temperature Range:** 0 to 140°F (-18° to 60°C)
- **Storage Temperature Range:** -40° to 140°F (-40° to 60°C)
- **Power Source:** One (6V) Alkaline Lantern Battery
- **Battery Life:** 60 days typical with a 15-minute recording interval, 1 level and 1 velocity, data download once per week, at 50°F (10°C) (also affected by site conditions)
- **User Interface:** IBM-compatible PC
- **Monitoring Intervals:** 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, and 60-minutes
- **Program Memory:** Non-volatile programmable flash, can be updated via RS-232 port
- **Time-Based Accuracy:** ±1 second per day
- **Units of Measurement:**
  *Level:* in., m, cm, ft.
  *Flow:* GPS, GPM, GPH, LPS, LPM, LPH, MGD, AFD, CFS, CFM, CFH, CFD, M3S, M3M, M3H, M3D
  *Totalized Flow:* gal., ft.³, acre-ft., L, m³
- **Data Storage:**
  *Capacity:* 90 days of 1 level reading and 1 velocity reading at a 15-minute recording interval
  *Data Types:* Level and velocity
  *Storage Mode:* Wrap or slate
- **Communications:** Serial connection to IBM-compatible computer with Hach Data Management Software

**Submerged Depth/ Velocity Sensor Accuracy:**

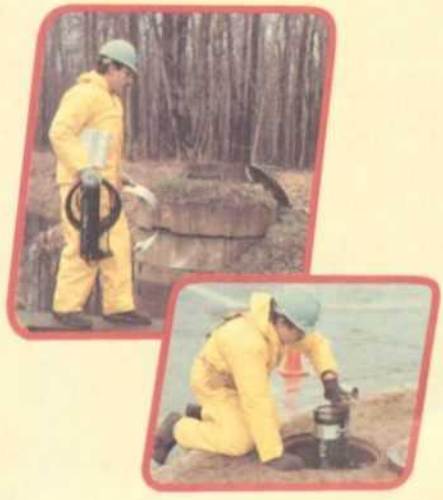
- **Level Measurement:**
  *(Non-linearity and Hysteresis):* Standard – .018' to 11.5' ±.023', (.005 to 3.5 m ± .007 m); Extended – .018' to 34.6' ± .07', (.005 to 10.5 m ± .021 m)
  *Maximum Allowable Level:* 3x over pressure
  *Operating Temperature Range:* 32° to 160°F, (0 to 71°C)
  *Compensated Temperature Range:* 32° to 86°F, (0 to 30°C)
  *Temperature Error:* 0.018' to 11.5' ±.004'/°F, (.005 to 3.5 m ± .0022 m/°C) .018' to 34.6' ±.012'/°F, (.018 to 10.5 m ±.006 m/°C) (maximum error within compensated temperature range – per degree of change)
  *Velocity-Induced Error on Depth (patent pending):* 0 to 10'/sec. (0 to 3.05 m/s) = .085% of reading
  *Air Intake:* Atmospheric pressure reference is desiccant protected
- **Velocity Measurement:**
  *Method:* Doppler ultrasonic
  *Transducer Type:* Twin 1 MHz piezoelectric crystals
  *Typical Minimum Depth for Velocity:* .8", (2 cm)
  *Range:* -5 to 20 fps, (-1.52 to 6.10 m/s)
  *Zero Stability:* <.05 fps, (.015 m/s)
  *Accuracy:* ±2% of reading
  *Operating Temperature:* 0 to 140°F, (-18° to 60°C)
- **General:**
  *Material:* Polymer body with stainless steel diaphragm
  *Cable:* Urethane sensor cable with air vent
  *Cable Length:* 25' (7.6 m) standard. 250' (76 m) maximum
  *Dimensions (combination sensor):* .8" H x 1.5" W x 5" L, (2 cm H x 3.8 cm W x 12.7 cm L)

The 910 measures average velocity directly, without the need for time consuming flow profiling, significantly reducing the cost of installation and operation. A compact 4 ½ x 18 in. design and a weight of less than 8 lbs (with battery) make the 910 one of your best options for remote environments. This meter will log level and velocity data for more than 60 days without changing a battery, and its sealed design provides superior system protection against surcharge conditions.

- Low-profile probe reduces maintenance and is detachable/interchangeable for ultimate flexibility.
- Easy installation with a small, 4 ½ in. diameter and no velocity calibration required.
- NEMA 6P sealed to withstand submergence and prolonged surcharge conditions.
- Advanced, ultrasonic one-MHz Doppler technology avoids signal dropouts and ensures, without the need for on-site calibration, high levels of accuracy in low-flow, full-pipe, or reversed-flow conditions.
- A higher level of accuracy, since the 910 automatically corrects the effects of temperature on level measurement.
- Patented Drawdown Correction feature corrects the effects of velocity on accurate level measurement.

Ideal for:

- Short Term Flow Studies
- Sanitary Sewer Evaluation Studies



# 911 Intrinsically Safe Portable Area Velocity Flow Meter

With quick installation and minimum maintenance, the 911 is ideal for short-term flow studies in hazardous or potentially hazardous environments. Hach's advanced Doppler technology is accurate, even in low-flow, full-pipe, and reversed-flow conditions. There is no need for profiling to establish accurate average velocity. The 911's accuracy is further enhanced by a proprietary technology that corrects for the effects of temperature and velocity on level measurement.

- CSA-NRTL/C certified for operation in Class I, Division I, Groups C & D hazardous locations. DEMKO listed.
- Low profile, non-fouling probe reduces your need for maintenance and is detachable/interchangeable for ultimate flexibility.
- Easy installation with a slender 6.5 in. diameter, no profiling required.
- NEMA 6P sealed to withstand submergence and prolonged surcharge conditions.
- Advanced, ultrasonic one-MHz Doppler technology avoids signal dropouts and ensures high levels of accuracy in low-flow, full-pipe or reversed-flow conditions, without the need for on-site calibration.
- A higher level of accuracy, since the 911 automatically corrects the effects of temperature on level measurement.
- Patented Drawdown Correction feature corrects the effects of velocity on accurate level measurement.

Ideal for:

- Short Term Flow Studies in Hazardous or Potentially Hazardous Areas
- Sanitary Sewer Evaluation Studies
- CSO Studies and Monitoring

*Are there hazardous gasses at your monitoring site?*
*Be sure you're safe with an affordable* **Sigma 911** *intrinsically safe flow meter.*


## 911 Design Specifications

- **Dimensions:** 6.5" diameter x 22.5" L (16.5 cm D x 57 cm L) with 12 Ah battery
- **Weight:** 17.5 lb. (8 kg) with 12 Ah battery
- **Enclosure Material:** PVC
- **Enclosure Rating:** NEMA 6P (IP67)
- **Certification:** CSA-NRTL/C-Class 1, Div. 1, Groups C & D; Intrinsically Safe. CENELEC approved, EEx ia IIB T3
- **Operating Temperature Range:** 0 to 140°F (-18° to 60°C)
- **Storage Temperature Range:** -40° to 140°F (-40° to 60°C)
- **Power Source:** One 12V, 12 Ah lead-acid rechargeable
- **Battery Life:** With 12 Ah battery, 240 days typical with a 15-minute recording interval. Assumes data download once per week, at 50°F/10°C, also affected by site conditions
- **User Interface:** Optically isolated IBM compatible PC
- **Monitoring Intervals:** 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, and 60-minutes
- **Program Memory:** Non-volatile, programmable flash, can be updated via RS-232 port
- **Time Based Accuracy:** ±1 second per day
- **Units of measurement**:
  *Level:* in., m, cm, ft.
  *Flow:* GPS, GPM, GPH, LPS, LPM, LPH, MGD, AFD, CFS, CFM, CFH, CFD, M3S, M3M, M3H, M3D
  *Totalized flow:* gal., ft³, acre-ft., L, m³
- **Optically Isolated Sampler Output:** 6-12 VDC pulse, 100 mA max, at 500 ms duration flow proportional
- **Data Storage:**
  *Capacity:* 90 days of 1 level reading and 1 velocity reading at a 15-minute recording interval
  *Data Types:* Level and velocity
  *Storage Mode:* Wrap or slate
- **Communications:** Serial connection via optically isolated interface to IBM compatible computer with Hach data analysis software

**Submerged Depth/ Velocity Sensor Accuracy:**

- **Level Measurement:**
  *(Non-linearity and Hysteresis):* .018' to 11.5' ±.023' (±.005 m to 3.5 m ±.007 m)
  *Maximum Allowable Pressure:* 3x over pressure
  *Operating Temperature Range:* 32° to 160°F, (0 to 71°C)
  *Compensated Temperature Range:* 32° to 86°F, (0 to 30°C)
  *Temperature Error:* .018' to 11.5' (±.004'/°F, (.005 m to 3.5 m ± .0022 m/°C) (maximum error within compensated temperature range – per degree of change)
  *Velocity Induced Error on Depth (patent pending):* 0 to 10'/sec., (0 to 3.05 m/s) = .085% of reading
  *Air Intake:* Atmospheric pressure reference is desiccant protected
- **Velocity Measurement:**
  *Method:* Doppler ultrasonic
  *Transducer Type:* Twin 1 MHz piezoelectric crystals
  *Typical minimum depth for velocity:* 0.8", (2 cm)
  *Zero Stability:* <.05 fps, (.015 m/s)
  *Range:* -5 to 20 fps, (-1.52 to 6.10 m/s)
  *Accuracy:* ±2% of reading
  *Operating Temperature:* 0 to 140°F, (-18° to 60°C)
- **General:**
  *Material:* Polymer body with stainless steel diaphragm
  *Cable:* Urethane sensor cable with air vent
  *Cable Length:* 25' (7.5 m) standard; 100' (30.5 m) maximum
  *Dimensions (combination sensor):* 0.8" H x 1.5" W x 5" L (2 cm H x 3.8 cm W x 12.7 cm L)

# 920 Area Velocity Flow Meter

The 920 meter can be used in portable or permanent applications and is available with up to two independent level/velocity channels. You can measure level and velocity in two channels or velocity in one and level in another. And, with Hach's pager communication, you can be alerted to overflows, bypasses, or a change in the flow pattern. Choose from submerged pressure transducer/velocity sensor or Hach's Sigma In-Pipe Ultrasonic Depth Sensor (patent pending) combined with a "wafer-thin" velocity sensor that provides greater accuracy in shallow flows.

- Multiple sensors for redundancy, averaging and multiple pipe monitoring.
- Easy installation with fast setup and no velocity calibration required.
- Sampler pacing capabilities, ideal for CSO and storm water.
- Optional rainfall logging feature records and characterizes rain events, a true innovation in water monitoring.
- Optional internal modem automates data retrieval, paging and reporting.
- NEMA 6P sealed to withstand submergence and prolonged surcharge conditions.
- Low power draw creates an extended 90-day battery life.
- Advanced, ultrasonic one-MHz Doppler technology avoids signal dropouts and ensures high levels of accuracy in low-flow, full-pipe or reversed-flow conditions, without the need for on-site calibration.
- A higher level of accuracy, since the 920 automatically corrects the effects of temperature on level measurement.
- Patented Drawdown Correction feature corrects the effects of velocity on accurate level measurement.

Ideal for:

- Short Term Flow Studies
- Sanitary Sewer Evaluation Studies
- CSO Studies and monitoring
- NPDES Stormwater Compliance


*Hach's* **Sigma 920** *allows two-channel monitoring, has a longer battery life, and increased data storage, and offers optional sampler, modem, and pager interfaces.*

## 920 Design Specifications

- **Dimensions:** 6.625" diameter x 17.625" L, (16.8 cm diameter x 44.7 cm L)
- **Weight:** 16.5 lbs. (7.5 kg) with batteries
- **Enclosure Material:** PVC
- **Enclosure Rating:** NEMA 6P (IP67)
- **Operating Temperature Range:** 0 to 140°F, (-18° to 60°C)
- **Storage Temperature Range:** -40° to 140°F, (-40° to 60°C)
- **Power Source:** Two (6V) Alkaline Lantern Batteries
- **Battery Life:** 90 days typical with a 15-minute recording interval, 1 level and 1 velocity, data download once per week, at 50°F, (10°C) (also affected by site conditions)
- **User Interface:** IBM-compatible PC
- **Monitoring Intervals:** 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, and 60-minutes
- **Program Memory:** Non-volatile, programmable flash, can be updated via RS-232 port
- **Time-Based Accuracy**: ±1 second per day
- **Units of Measurement:**
  *Level:* in., m, cm, ft.
  *Flow:* GPS, GPM, GPH, LPS, LPM, LPH, MGD, AFD, CFS, CFM, CFH, CFD, M3S, M3M, M3H, M3D
  *Totalized Flow:* gal., ft.³, acre-ft., L, m³
- **Data Storage Capacity (optional):**
  240 days of 2 level readings, 2 velocity readings and rain at a 15-minute recording interval
  *Data Types:* Level, velocity and rainfall
  *Storage Mode:* Wrap or slate
- **Sampler Output Conditions (optional):**
  Set point on level, velocity, rainfall, flow, or flow rate of change
- **Sampler Output (optional):** 6-12 VDC pulse, 100 mA max. at 500 ms duration flow proportional.
- **Communications:** RS-232 serial connection to IBM-compatible computer with Hach Data Management Software
  *Optional Modem:* Bell 212
  *Baud:* 14400
  *Transfer protocol:* Binary -OR- 14400, V.32 bis, V.42, MNP2-4 error correction. V.42 bis, MNP5 data compression. MNP10EC Cellular Protocol
  *Local Terminal:* RS-232 at 19.2k baud

### Submerged Depth/ Velocity Sensor Accuracy:

- **Level Measurement:**
  *(Non-linearity and Hysteresis):* Standard – .018" to 11.5' ±.023', (.005 to 3.5 m ± .007 m); Extended – .018" to 34.6' ±.07', (.005 to 10.5 m ± .021 m)
  *Maximum Allowable Level:* 3x over pressure
  *Operating Temperature Range:* 32° to 160°F, (0° to 71°C)
  *Compensated Temperature Range:* 32° to 86°F, (0° to 30°C)
  *Temperature Error:* .018" to 11.5' ±.004'/°F, (.005 to 3.5 m ±.0022 m/°C) .018" to 34.6' ±.012'/°F, (.018 to 10.5 m ±.006m/°C) (maximum error within compensated temperature range – per degree of change)
  *Velocity Induced Error on Depth (patent pending):* 0 to 10'/sec. (0 to 3.05 m/s) = .085% of reading
  *Air Intake:* Atmospheric pressure reference is desiccant protected
- **Velocity Measurement:**
  *Method:* Doppler ultrasonic
  *Transducer Type:* Twin 1 MHz piezoelectric crystals
  *Typical minimum depth for velocity:* .8", (2 cm)
  *Range:* -5 to 20 fps, (-1.52 to 6.10 m/s)
  *Zero Stability:* <.05 fps, (.015 m/s)
  *Accuracy:* ±2% of reading
  *Operating Temperature:* 0 to 140°F, (-18° to 60°C)
- **General:**
  *Material:* Polymer body with stainless steel diaphragm
  *Cable:* Urethane sensor cable with air vent
  *Cable Length:* 25' (7.6 m) standard 250' (76 m) maximum
  *Dimensions (combination sensor):* .8" H x 1.5" W x 5" L (2 cm H x 3.8 cm W x 12.7 cm L)

### Optional In-Pipe Ultrasonic Level and Velocity Sensor Accuracy:

- **Velocity Sensor:**
  *Dimensions:* .44" H x 1.5" W x 2.7" L, (1.12 cm H x 3.81 cm W x 6.86 cm L)
  *Nose Angle:* 20 degrees from horizontal
  *Cable Length:* Standard range probe 25' (7.6 m); custom cable lengths to 250' (76 m); cable diameter .225" (.57 cm)
  *Materials:* Sensor – polymer; cable – urethane; sensor-mounting hardware – stainless steel
- **Ultrasonic Level Sensor (In-pipe):**
  *Accuracy:* At 72°F (22°C) still air, 40-70% relative humidity from .125 to 15' ±.01', (.038 to 4.57 m ± .003 m)
  *Range:* Minimum distance from sensor to liquid 0" (0 cm). Maximum distance from sensor to liquid 15' (4.57 m)
  *Span:* .125' to 15', (.038 to 4.57 m)
  *Ambient Operating Temperature:* 0 to 140°F, (-18° to 60°C)
  *Temperature Error:* ±.0001'/°F, (±.00005 m/°C) (maximum error within compensated temperature range – per degree of change)
  *Resolution:* .0075", (.019 cm)
  *Material:* Stainless steel housing with PVC acoustic window
  *Cable:* 4 conductor
  *Cable Length:* 25' (7.6 m) standard, 1,000' (305 m) using RS-485 two-wire remote sensor option
  *Crystal Specification:* 75 KHz, 7° beam angle
  *Dimensions:* 1.5" diameter x 12" L, (3.81 cm diameter x 30 cm L)

# 940 Intrinsically Safe Area Velocity Flow Meter

*Hach's* **Sigma 940** *intrinsically-safe flow meter supports dual sensors, interfaces with samplers, has a long battery life, and offers increased data storage and optional modem capability.*


## 940 Design Specifications

- **Dimensions:** 8.625" diameter x 23.625" L, (21.9 cm diameter x 60 cm L)
- **Weight:** 17.52 lbs. (7.95 kg) with batteries
- **Enclosure Material:** PVC
- **Enclosure Rating:** NEMA 6P (IP67)
- **Certification:** CSA-NRTL/C-Class 1, Div. 1, Groups C & D Intrinsically Safe; CENELEC approved, EEx ia IIB T3
- **Operating Temperature Range:** 0 to 140°F, (-18° to 60°C)
- **Storage Temperature Range:** -40° to 140°F, (-40° to 60°C)
- **Power Source:** One (12V) 25Ah lithium battery pack or A/C power adapter
- **Battery Life:** 365 days typical with a 15-minute recording interval, 1 level and 1 velocity, data download once per week, at 50°F (10°C) (also affected by site conditions)
- **User Interface:** Optically isolated, IBM-compatible PC
- **Monitoring Intervals:** 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, and 60-minutes
- **Program Memory:** Non-volatile programmable flash, can be updated via RS-232 port, in non-hazardous area
- **Time-Based Accuracy:** ±1 second per day.
- **Units of Measurement:**
  *Level:* in., m, cm, ft.
  *Flow:* GPS, GPM, GPH, LPS, LPM, LPH, MGD, AFD, CFS, CFM, CFH, CFD, M3S, M3M, M3H, M3D
  *Totalized Flow:* gal., ft.³, acre-ft., L, m³
- **Data Storage:**
  *Capacity:* 306 days of 2 level readings, 2 velocity readings at a 15-minute recording interval
  *Data Types:* Level and velocity
  *Storage Mode:* Wrap or slate
- **Sampler Output Conditions (optional):** Set point on level, velocity, flow, or flow rate of change
- **Sampler Output (optional):** 6-12 VDC pulse, 100 mA max. at 500 ms duration with approved interface
- **Communications:** RS-232 serial connection via optically isolated interface to IBM-compatible computer with Hach data analysis software
  *Optional Modem:* External with fiber optic interface 14400, V.32 bis,V.42, MNP2-4 error correction. V.42 bis, MNP5 data compression. MNP10EC
  *Local Terminal:* RS-232 at 19.2k baud
  SCADA Modbus communication protocol via RS-232 or optional modem

**Submerged Depth/ Velocity Sensor Accuracy:**

- **Level Measurement:**
  *(Non-linearity and Hysteresis):* .018' to 11.5' ±.023', (.005 to 3.5 m ± .007 m)
  *Maximum Allowable Level:* 3x over pressure
  *Operating Temperature Range:* 32° to 160°F, (0 to 71°C)
  *Compensated Temperature Range:* 32 to 86°F, (0 to 30°C)
  *Temperature Error:* .018' to 11.5' ±.004'/°F, (.005 to 3.5 m ±.0022 m/°C) (maximum error within compensated temperature range – per degree of change)
  *Velocity Induced Error on Depth (patent pending):* 0 to 10'./sec., (0 to 3.05 m/s) = .085% of reading
  *Air Intake:* Atmospheric pressure reference is desiccant protected
- **Velocity Measurement:**
  *Method:* Doppler ultrasonic
  *Transducer Type:* Twin 1 MHz piezoelectric crystals
  *Typical Minimum Depth for Velocity:* .8", (2 cm)
  *Range:* -5 to 20 fps, (-1.52 to 6.10 m/s)
  *Zero Stability:* <.05 fps, (.015 m/s)
  *Accuracy:* ±2% of reading
  *Operating Temperature:* 0 to 140°F, (-18 to 60°C)
- **General:**
  *Material:* Polymer body with stainless steel diaphragm
  *Cable:* Urethane sensor cable with air vent.
  *Cable Length:* 25' (7.6 m) standard. 100' (30.5 m) maximum
  *Dimensions (combination sensor):* 0.8" H x 1.5" W x 5" L, (2 cm H x 3.8 cm W x 12.7 cm L)

**In-Pipe Ultrasonic Level and Velocity Sensor Accuracy:**

- **Velocity Sensor:**
  *Dimensions:* .44" H x 1.5" W x 2.7" L, (1.12 cm H x 3.81 cm W x 6.86 cm L)
  *Nose Angle:* 20 degrees from horizontal
  *Cable Length:* 25', (7.6 m) standard, 100' (30.5 m) maximum; cable diameter 0.23" (0.57 cm.)
  *Materials:* Sensor – polymer; Cable – urethane; Sensor-mounting hardware – stainless steel
- **Ultrasonic Level Sensor (In-pipe):**
  *Accuracy:* At 72°F (22°C) still air, 40 to 70% relative humidity from .125' to 15' ±.01', (.038 to 4.57 m ±.003 m)
  *Range:* Minimum distance from sensor to liquid 0", (0 cm). Maximum distance from sensor to liquid 7', (2.13 m)
  *Span:* .125' to 7', (.038 to 2.13 m)
  *Ambient Operating Temperature:* 0 to 140°F, (-18° to 60°C)
  *Temperature Error:* ±.0001'/°F, (±.00005 m/°C) (maximum error within compensated temperature range – per degree of change)
  *Resolution:* .0075", (.019 cm)
  *Material:* Stainless steel housing with PVC acoustic window
  *Cable:* 4 conductor
  *Cable Length:* 25', (7.6 m) standard
  *Crystal Specification:* 75 kHz, 7° beam angle
  *Dimensions:* 1.5" diameter X 12" L, (3.81 cm diameter x 30 cm L)

The 940 is the safest investment for your sewer and your budget. With the 940, remote monitoring becomes a way of life. Its rugged design, low-profile probes and long battery life significantly reduce site visits. Choose up to two area velocity sensors, or one area velocity and one level backup. Whether you're experiencing redundancy in a single pipe or level and velocity in separate pipes, you'll profit from new performance levels in a single meter.

Industry standard MODBUS ASCII protocol has been incorporated into Hach's Sigma 940 Flow Meter. The implementation of the MODBUS protocol will allow your MMI, SCADA or DCS system to directly communicate with the 940 Flow Meter without the use (or additional cost) of a PLC. Now you can have real-time, read-only access to all available data channels in the 940 Flow Meter.

- CSA-NRTL/C DEMKO listed and certified for operation in Class I, Division I, Groups C & D hazardous locations.
- Multiple sensors for redundancy, averaging and multiple pipe monitoring.
- Telephone and pager alarms for quick notification of system changes.
- Low power draw, with a long, one-year battery life.
- NEMA 6P sealed to withstand submergence and prolonged surcharge conditions.
- Sampler pacing capabilities, to document the extent of overflow problems.
- Advanced, ultrasonic one-MHz Doppler technology avoids signal dropouts and ensures high levels of accuracy in low-flow, full-pipe or reversed-flow conditions, without the need for on-site calibration.
- A higher level of accuracy, since the 940 automatically corrects the effects of temperature on level measurement.
- Patented Drawdown Correction feature corrects the effects of velocity on accurate level measurement.

Ideal for:

- Long Term Flow Monitoring in Hazardous or Potentially Hazardous Areas
- Sanitary Sewer Evaluation Studies
- CSO Studies and Monitoring

# 930 Long-Term Area Velocity Flow Meter

*The* **Sigma 930** *is Hach's most advanced flow meter–supports three interchangeable sensors, long battery life, increased data storage and offers optional interfaces with samplers, and modem capability.*


## 930 Design Specifications

- **Dimensions:** 8.625" diameter x 23.625" L, (21.9 cm diameter x 60 cm L)
- **Weight:** 35.7 lbs. (16.2 kg) with batteries
- **Enclosure Material:** PVC
- **Enclosure Rating:** NEMA 6P (IP67)
- **Operating Temperature Range:** 0 to 140°F, (-18° to 60°C)
- **Storage Temperature Range:** -40° to 140°F, (-40° to 60°C)
- **Power Source:** Six (6V) Alkaline Lantern Batteries
- **Battery Life:** 365 days typical with a 15-minute recording interval, 1 level and 1 velocity, data download once per week, at 50°F (10°C) (also affected by site conditions)
- **User Interface:** IBM-compatible PC
- **Monitoring Intervals:** 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, and 60-minutes
- **Program Memory:** Non-volatile, programmable flash, can be updated via RS-232 port
- **Time Based Accuracy:** ±1 second per day
- **Units of Measurement:**
  *Level:* in., m, cm, ft.
  *Flow:* GPS, GPM, GPH, LPS, LPM, LPH, MGD, AFD, CFS, CFM, CFH, CFD, M3S, M3M, M3H, M3D
  *Totalized Flow:* gal., ft.$^3$, acre-ft., L, m$^3$
- **Data Storage:**
  *Capacity:* 175 days of 3 level readings, 3 velocity readings and rain at a 15-minute recording interval
  *Data Types:* Level, velocity, rainfall
  *Storage Mode:* Wrap or slate
- **Output Conditions (optional):** Set point on level, velocity, rainfall, flow, or flow rate of change
- **Sampler Output (optional):** 6-12 VDC pulse, 100 mA max. at 500 ms duration
- **Communications:** RS-232 serial connection to IBM-compatible computer with Hach Data Management Software
  *Optional Modem:* Bell 212
  *Baud:* 14400
  *Transfer protocol:* Binary -OR- 14400, V.32 bis, V.42, MNP2-4 error correction. V.42 bis, MNP5 data compression. MNP10EC Cellular Protocol
  *Local Terminal:* RS-232 at 19.2k baud

### Submerged Depth/ Velocity Sensor Accuracy:

- **Level Measurement:**
  *(Non-linearity and Hysteresis):* Standard – .018' to 11.5' ±.023', (.005 to 3.5 m ±.007 m); Extended – .018' to 34.6' ±.07', (.005 to 10.5 m ±.021 m)
  *Maximum Allowable Level:* 3x over pressure
  Operating Temperature Range: 32° to 160°F, (0 to 71°C)
  *Compensated Temperature Range:* 32° to 86°F, (0 to 30°C)
  *Temperature Error:* .018' to 11.5' ±.004'/°F, (.005 to 3.5 m ±.0022 m/°C) .018' to 34.6' ±.012'/°F, (.018 to 10.5 m ±.006 m/°C) (maximum error within compensated temperature range – per degree of change)
  *Velocity Induced Error on Depth (patent pending):* 0 to 10'/sec. (0 to 3.05 m/s) = .085% of reading
  *Air Intake:* Atmospheric pressure reference is desiccant protected
- **Velocity Measurement:**
  *Method:* Doppler ultrasonic
  *Transducer Type:* Twin 1 MHz piezoelectric crystals
  *Typical minimum depth for velocity:* .8", (2 cm)
  *Range:* -5 to 20 fps., (-1.52 to 6.10 m/s)
  *Zero Stability:* <.05 fps., (.015 m/s)
  *Accuracy:* ±2% of reading
  *Operating Temperature:* 0 to 140°F, (-18° to 60°C)
- **General:**
  *Material:* Polymer body with stainless steel diaphragm
  *Cable:* Urethane sensor cable with air vent
  *Cable Length:* 25' (7.6 m) standard. 250' (76 m) maximum
  *Dimensions (combination sensor):* .8" H x 1.5" W x 5" L, (2 cm x 3.8 cm x 12.7 cm)

### In-Pipe Ultrasonic Level and Velocity Sensor Accuracy:

- **Velocity Sensor:**
  *Dimensions:* .44" H x 1.5" W x 2.7". L, (1.12 cm x 3.81 cm x 6.86 cm)
  *Nose Angle:* 20 degrees from horizontal
  *Cable Length:* Standard range probe 25' (7.6 m); custom cable lengths to 250' (76 m); cable diameter .225" (.57 cm)
  *Materials:* Sensor – polymer; cable – urethane; sensor mounting hardware – stainless steel
- **Ultrasonic Level Sensor (In-pipe):**
  *Accuracy:* At 72°F (22°C) still air, 40 to 70% relative humidity from .125' to 15' ±.01', (.038 to 4.57 m ±.003 m)
  *Range:* Minimum distance from sensor to liquid 0" (0 cm). Maximum distance from sensor to liquid 15' (4.57 m)
  *Span:* .125 to 15', (.038 to 4.57 m)
  *Ambient Operating Temperature:* 0 to 140°F, (-18° to 60°C)
  *Temperature Error:* ±.0001'/°F, (±.00005 m/°C) (maximum error within compensated temperature range – per degree of change)
  *Resolution:* .0075", (.019 cm)
  *Material:* Stainless steel housing with PVC acoustic window
  *Cable:* 4 conductor
  *Cable Length:* 25' (7.6 m) standard, 1,000' (305 m) using RS-485 two-wire remote sensor option
  *Crystal Specification:* 75 KHz, 7° beam angle
  *Dimensions:* 1.5" diameter x 12" L, (3.81 cm diameter x 30 cm L)

The Hach's Sigma 930 is designed for long-term/permanent flow studies with approximately 365-day battery life and a strong NEMA 6P PVC enclosure. Permanent collection system monitoring can now be done confidently, within an affordable budget.

- Multi-point and/or redundant monitoring with a single meter.
- Up to three level and velocity sensors.
- Low power draw creates an extended year-long battery life.
- Optional rainfall logging feature records and characterizes rain events, a true innovation in water monitoring.
- Optional internal modem automates data retrieval, paging and reporting.
- Optional sampler pacing capabilities, ideal for CSO and Stormwater.
- NEMA 6P sealed to withstand submergence and prolonged surcharge conditions.
- Advanced, ultrasonic one-MHz Doppler technology avoids signal dropouts and ensures high levels of accuracy in low-flow, full-pipe or reversed-flow conditions, without the need for on-site calibration.
- A higher level of accuracy, since the 930 automatically corrects the effects of temperature on level measurement.
- Patented drawdown correction feature corrects the effects of velocity on accurate level measurement.
- Multiple sensors for redundancy, averaging and multiple pipe monitoring.

Ideal for:

- Long-Term Flow Monitoring
- Sanitary Sewer Evaluation Studies
- CSO Studies and Monitoring
- NPDES Stormwater Compliance
- Permanent Collection System Monitoring

## 950 Design Specifications (Continued)

### 950 Bubbler:

> **Level Measurement Accuracy:**
*(linearity and hysteresis at 72°F, 22°C)* from .01 to 11.75' - ±0.011' (±0.003m)
*Range:* .01 to 11.75', (.003 - 3.6 m)
*Ambient Operating Temperature Range:* 0° to 145°F, (-18° to 63°C)
*Compensated Temperature Range:* 32° to 138°F ,(0° to 59°C)
*Temperature Error:* ±.0003'/°F (maximum error within compensated temperature range – per degree of change)
*Air Intakes:* Bubble source and reference port desiccant protected. Fittings provided for remote intakes
*Filters:* 10 micron on bubble source intake
*Line Purge:* Bubble line is high pressure purged at programmed intervals, or in manual mode on demand
*Line Size:* 1/8", (.32 cm) ID standard

### 950 Ultrasonic:

#### 50 kHz Ultrasonic Transducer:

> **Level Measurement Accuracy:**
*(at 72°F, 22°C, still air, 40 - 70% relative humidity)* from 1 to 10' ± .01' )(±.003 m)
*Range:* Minimum distance from sensor to liquid 15" (38.1 cm). Maximum distance from sensor to liquid 30' (9.1 m)
*Span:* 50kHz, 0 - 29'
*Ambient Operating Temperature Range:* 0° to 140°F, (-18° to 60°C)
*Temperature Error:* ±.000047'/F° (maximum error within compensated temperature range – per degree of change)
*Resolution:* .0011'
*Material:* PVC housing with Buna-N acoustic window
*Cable:* 4 conductor with integral stainless steel support cable
*Cable Length:* 25' (7.6 m) standard
*Crystal Specification:* 50 kHz, 11.5° included beam angle
*Dimensions:* 3.75" H x 2.75" D, (9.5 cm x 7 cm)
*Weight:* 1.5 lbs.

#### 75kHz Ultrasonic Transducer:

> **Level Measurement Accuracy:**
*(at 72°F, 22°C, still air, 40 - 70% relative humidity)* from 1 to 10'. ± .01' )(±.003 m)
*Range:* Minimum distance from sensor to liquid 14". (23 cm). Maximum distance from sensor to liquid 1' (3.3 m)
*Span:* 0 – 15'
*Ambient Operating Temperature Range:* 0° to 140°F, (-18° to 60°C)
*Temperature Error:* ±.000047'/F° (maximum error within compensated temperature range - per degree of change)
*Resolution:* .0011'
*Material:* PVC housing with Buna-N acoustic window
*Cable:* 4 conductor with integral stainless steel support cable
*Cable Length:* 25' (7.6 m) standard
*Crystal Specification:* 5° beam angle with horn
*Dimensions:* 75 kHz, 5.0" H x 2.25" D, (12.7 cm x 5.7 cm)
*Weight:* 1.5 lbs.

### In-Pipe Ultrasonic:

> **75 kHz Ultrasonic Level Sensor (In-Pipe):**
*Accuracy:* At 72°F (22°C), still air, 40-70% relative humidity from .125 to 15' - ±.01' (.038 to 4.57 m ±.003 m)
*Range:* 0" (0 cm) - 11' (3.35 m)
*Span:* .125 - 15', (.038 - 4.57 m)
*Ambient Operating Temperature:* 0 to 140°F, (-18 to 60°C)
*Temperature Error:* ±.0001'/°F (±.00005 m/°C) (maximum error within compensated temperature range – per degree of change)
*Resolution:* .0075" (.019 cm)
*Material:* Stainless steel housing with Buna-N acoustic window
*Cable:* 4 conductor
*Cable Length:* 25' (7.6 m) standard, 1000' (305 m) using RS-485 two wire remote sensor option
*Crystal Specification:* 75 kHz, 7° included beam angle
*Dimensions:* 2.0" diameter x 12" L (3.81 x 30 cm)

### 950 Submerged Pressure:

> **Level Measurement Accuracy:**
*(non-linearity and hysteresis)* ±0.1% full scale
*Transducer Type:* Differential piezo resistive with balanced bridge
*Transducer Orientation:* Inverted
*Maximum Range:*
*P/N 1379:* 2.5 psi .04 - 5.75', (.01 m - 1.75 m)
*P/N 2343:* 5.0 psi .04 - 11.75', (.01 m - 3.58 m)
*P/N 2333:* 10.0 psi .04 - 23', (.01 m - 7.0 m)
*Maximum Allowable Level:* 6x over pressure
*Operating Temperature Range:* 32° to 160°F, (0 to 71°C)
*Compensated Temperature Range:* 32° to 96°F, (0 to 36°C)
*Temperature Error:*
*P/N 1379:* .04 to 5.75' ±.006'/F°
*P/N 2343:* .04 to 11.75' ±.0012'/F°
*P/N 2333:* .04 to 23' ±.0024'/F°
(Maximum error within compensated temperature range – per degree of change)
*Air Intake:* Atmospheric pressure reference is desiccant protected
*Material:* 316 stainless steel body with titanium diaphragm
*Cable:* 4 conductor polyurethane sensor cable with air vent
*Cable Length:* 25' (7.6 m) standard. 250' (76 m) maximum
*Dimensions:* 1" D x 6.75" L, (2.54 cm x 17.2 cm)
*Probe Frontal Area:* 0.875 $in^2$
*Weight:* 1.5 lbs.

### 950 Area x Velocity:

#### Submerged Depth/Area Velocity Sensor:
***Method:* Doppler Principle/Pressure Transducer**

> **Level Measurement**
*(non-linearity and hysteresis):* Standard .018 to 11.5'. ±.023' (.005 m - 3.5 m ±.007 m)
*Extended:* .018 to 34.6' ± .07' (.005 - 10.5 m ± .021 m)
*Maximum Allowable Level:* 3x over pressure
*Operating Temperature Range:* 32 to 160°F, (0 to 71°C)
*Compensated Temperature Range:* 32 to 86°F, (0 to 30°C)
*Temperature Error:* .018 - 11.5'. ±.004'/°F (.005 m - 3.5 m ± .0022 m/°C). .018 - 34.6' ±.012'/°F (.018 - 10.5 m ±.006 m/°C) (maximum error within compensated temperature range – per degree of change)
*Velocity Induced Error on Depth (patent pending):* 0 to 10'/sec. (0 to 3.05 m/s) = .085% of reading.
*Air Intake:* Atmospheric pressure reference is desiccant protected

> **Velocity Measurement:**
*Method:* Doppler Ultrasonic
*Transducer Type:* Twin 1 MHz piezoelectric Crystals
*Typical minimum depth for velocity:* 0.8" (2 cm)
*Range:* -5 to +20 fps (-1.52 to 6.10 m/s)
*Zero stability:* <.05 fps (.015 m/s)
*Accuracy:* ±2% of reading
*Operating Temperature:* 0 to 140°F, (-18 to 60°C)

> **General:**
*Material:* Polymer body with stainless steel diaphragm
*Cable:* Urethane sensor cable with air vent.
*Cable Length:* 25' (7.6 m) standard. 250' (76 m) maximum
*Dimensions (combination sensor):* .8" H x 1.5" W x 5" L, (2 cm x 3.8 cm x 12.7 cm)

#### Bubbler Level/Area Velocity Sensor:
***Method:* Doppler Principle/Pressure Transducer**

> **Level Measurement**
*(linearity and hysteresis at 72°F, 22°C):* from .01 to 11.75' - ±0.011' (.033 m)
*Range:* .01 to 11.75' (.003 - 3.6 m)
*Ambient Operating Temperature Range:* 0 - 145°F, (-18 - 63°C)
*Compensated for changes in ambient Temperature Range:* 32 - 138°F (0 - 59°C)
*Temperature Error:* ±.0003'/°F (maximum error within compensated temperature range – per degree of change)
*Air Intakes:* Bubble source and reference port desiccant protected. Fittings provided for remote intakes
*Filters:* 10 micron on bubble source intake
*Line Purge:* Bubble line is high pressure purged at programmed intervals, or in manual mode on demand

> **Velocity Measurement:**
*Method:* Doppler Ultrasonic
*Transducer Type:* Twin 1 MHz piezoelectric Crystals
*Typical minimum depth for velocity:* 0.8" (2 cm)
*Range:* -5 to +20 fps (-1.52 to 6.10 m/s)
*Zero stability:* <.05 fps (.015 m/s)
*Accuracy:* ±2% of reading
*Operating Temperature:* 0 to 140°F, (-18 to 60°C)

> **General:**
*Cable Length:* 25' (7.6m) standard, 250' maximum
*Cable Diameter:* 0.4" (1cm)
*Dimensions (combination sensor):* 0.8" H x 1.5" W x 3.7" L, (2 cm x 3.8 cm x 9.7 cm)

#### Velocity Sensor
***Method:* Doppler Principle**

*Accuracy:* ±2% of reading; Zero Stability: ±0.05 fps (±1.52 cm)
*Dimensions:* .44" H x 1.5" W x 2.7" L, (1.12 cm x 3.81 cm x 6.86 cm)
*Nose Angle:* 20 deg from horizontal
*Cable Length:* Standard range probe - 25' (7.6 m); custom cable lengths to 250' (76 m); cable diameter - .225" (.57 cm)
*Materials:* Sensor - polymer; cable - urethane; sensor mounting hardware - stainless steel
*Dimensions:* 0.5"H x 1.5" W x 3.7"L (1.5 cm x 3.8 cm x 9.7 cm)

# 950 Series Flow & Water Quality Meter

For applications requiring more than flow, the 950 optionally monitors rainfall, pH, temperature, ORP, dissolved oxygen and/or conductivity. In addition, the 950 has analog inputs for datalogging from other instruments, for example, total suspended solids monitors. You can also control samplers, pumps, or other equipment based on flow or selected parameter(s) exceeding high/low set points with relay outputs.

Meters in the 950 Series are versatile to meet your needs - customize your meter to specific site conditions easily. The large LCD graphics display lets you quickly see the information you need quickly, on-site, in your choice of 10 languages, and without the inconvenience of outdated paper charts; you'll no longer need to replace pens, paper, or service mechanical recorders.

Industry standard SCADA MODBUS ASCII protocol is included in Hach's Sigma 950 Flow Meter Series. 4-20 mA outputs are also available: this allows flexible integration with a SCADA system. You can have real-time, read-only access to all available data channels in the 950 Flow Meter.

- Keypad and large graphics display makes using laptops in the field optional. A single keystroke provides an instantaneous flow summary and review of all program settings.
- Three level measurement technologies available: ultrasonic, submerged, or bubbler.
- Battery or AC powered.
- Water quality data helps identify upsets that may affect your plant.
- An OptiFlow model provides maximum flexibility with three different level technology choices plus velocity.
- Doppler area velocity flow measurement.
- Sampler pacing ability to document the extent of overflow problems.
- Optional rainfall logging to record and characterize rain events.
- Remote communications capability via modem or RS-232.
- Enough memory to log more than 18,000 data points—expandable to 116,000 data points or over one year of flow data at a 5-minute logging interval.
- Flash memory allows software enhancements without replacing e-proms or returning meter to factory.
- Optional four user-assignable alarm relays.
- Optional two user-assignable 4-20 mA outputs, allowing the meter to be part of a current loop able to drive recorders, samplers, metering pumps, chlorinators, and other devices or SCADA integration.

*The* **950** *and* **950 AV** *provide portable and/or permanent single-channel monitoring plus water quality testing, process control interface, and a digital display. The* **950** *and* **950 AV Optiflow** *models offer maximum flexibility for multiple applications. Up to three different level sensor technologies and velocity are available* **in one meter**.

- Rugged, environmentally sealed: the 950 is NEMA 4X-6 rated and can survive submersion and corrosive gases—even with the door open.
- Data can be downloaded in any of three ways: (1) palm-sized Data Transfer Unit (DTU); (2) built-in modem to transmit data over telephone lines; and (3) direct RS-232 link to a PC utilizing data analysis software.

Ideal for:

- Long Term or Permanent Flow Studies
- Sanitary Sewer Evaluation Studies
- CSO Studies and Monitoring
- NPDES Stormwater Compliance
- Industrial Compliance Monitoring
- Applications involving frequent moving of meter to different site conditions (Optiflow models)

## 950 Design Specifications

### General:

- **Dimensions:** 13.5" H x 10.0" W x 9.5" D, (34.3 cm x 25.4 cm x 24.1 cm)
- **Weight:** 15 lbs. (6.8 kg) including power source
- **Enclosure Material:** ABS, UV resistant, stable from -40° to 176°F (-40°C to 80°C)
- **Enclosure Rating:** NEMA 4X,6 with front cover open or closed
- **Operating Temperature Range:** +14° to 150°F, (-10°C to 65.5°C)
- **Storage Temperature Range:** -40° to 176°F, (-40°C to 80°C)
- **Power:** 12 VDC
- **Power Options:** 6 amp-hr. gel electrolyte rechargeable battery, 4 amp-hr. Ni-Cad rechargeable battery, lantern battery case with (2) 6-Volt lantern batteries, 115 VAC, 230 VAC or 100 VAC power converter w/battery charger
- **Graphics Display:** Back lit LCD, auto-off when not in use. 8 line x 40 character in ASCII mode, 60 dot x 240 dot in graphics mode. Dimensions 1.5" H x 5" W (3.8 cm x 12.7 cm); displays level vs. time, flow vs. time. Optionally, may display rainfall, pH, ORP, temperature, DO, conductivity vs. time, sampler events and alarm events
- **Keypad:** 21 position sealed membrane switch with blinking green LED to indicate power on; 4 "soft keys", functions defined by display
- **Totalizers:** 8-digit resettable and 8-digit non-resettable LCD software totalizer; 6-digit non-resettable mechanical totalizer optional
- **Time Based Accuracy:** ±1 second per day
- **Battery Life:** 150 days typical with a 15 minute recording interval, 1 level and 1 velocity, data download once per week, at 50°F (10°C) (also affected by site conditions)
- **Units of Measurement:**
  *Flow:* GPS, GPM, GPH, LPS, LPM, LPH, MGD, AFD, CFS, CFM, CFH, CFD, CMS, CMM, CMH, CMD
  *Totalized Flow:* gal., $ft.^3$, acre-ft., lit., $m^3$.
- **Primary Devices:**
  *Flumes:* Parshall, Palmer Bowlus, Leopold-Lagco, H, HL, HS, Trapezoidal
  *Weirs:* V-notch (15 - 120°) Contracted/Non-contracted rectangular, Thelmar, compound Cipolletti
  *Manning Equation:* Round, U and Rectangular Trapezoidal Channels
  *Flow Nozzles:* Kennison, Parabolic, California Pipe
  *Head vs. Flow:* Custom programmable curve of up to 99 points
- **Datalogging:**
  *Capacity:* Up to 512k bytes: 402 days of level, velocity and rainfall readings at 15 minute intervals plus 300 events
  *Monitoring Intervals:* 1, 2, 3, 5, 15, 30 or 60-minute intervals
- **Program Memory:** Non-volatile, programmable flash; can be updated via RS-232 port
- **Sampler Output:** 12-17 VDC pulse, 100 mA max at 500 ms duration
- **Communications:**
  *RS-232:* up to 19,200 baud
  SCADA Modbus communication protocol via RS-232 or optional modem
  *Modem (optional):* 14,400 baud
  *Cellular Communications (optional):* 14,400 bps, MNP 10-EC Cellular Protocol
  *Pager Alarms*

## 950 Design Specifications (Continued)

### Sigma 950 Factory Installed Options:

- **pH-Temperature/ORP Meter:**
  *Control/Logging:* Field selectable to log pH-Temperature or ORP independent of flow or in conjunction with flow; also controls sample collection in response to value exceeding low/high set points
  *Recording Intervals:* 1, 2, 3, 5, 6, 10, 12, 15, 30, and 60 minutes
  *Probe Pre-Amplifier/Junction Box:* NEMA 4X with labeled terminal strip
  *pH/Temperature Sensor:* Temperature compensated; impact resistant ABS plastic body; combination electrode with porous Teflon® junction
  *Measurement Range:* 2 to 12 pH within specifications, 0 to 14 pH maximum range
  *Operating Temperature Range:* 0 to 176°F, (-18°C to 80°C)
  *Dimensions:* 0.75" diameter x 6" long with .75" mpt cable end (1.9 cm x 15.2 cm long with1.9 cm mpt cable end)
- **Integral Dissolved Oxygen/ Temperature Meter:**
  *Control/Logging:* Field selectable to log dissolved oxygen independent of flow or in conjunction with flow; also controls sample collection in response to value exceeding low/high set points
  *Recording Intervals:* 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, and 60 minutes
  *Measurement Method:* Polargraphic
  *Sensor:* Temperature compensated; impact resistant polypropylene body
  *Range:* 0-20 mg/L
  *Resolution:* .01 mg/L
  *Accuracy:* ±0.2 mg/L
  *Operating Temperature Range:* 32 to 122°F, (0 to 50°C)
  *Dimensions:* 0.65" diameter x 5" long with .75" mpt cable end, (1.65 cm diameter x 12.7 cm long with 1.9 cm mpt cable end)
- **Integral Conductivity/ Temperature Meter:**
  *Control/Logging:* Field selectable to log conductivity independent of flow or in conjunction with flow, also controls sample collection in response to value exceeding low/high set points
  *Recording Intervals:* 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, and 60 minutes
  *Sensor:* Temperature compensated; impact resistant polypropylene body
  *Range:* 0-20 mS/cm
  *Resolution:* 0.01 mS/cm or 0.01 µS/cm (user selected)
  *Accuracy:* ±1% of reading +0.05 mS/cm
  *Operating Temperature Range:* 32 to 122°F, (0 to 50°C)
  *Dimensions:* 0.67" diameter x 5" long with .75" mpt cable end, (1.70 cm diameter x 12.7 cm long with 1.9 cm mpt cable end)
- **Rain Gauge Input:** For use with Hach Tipping Bucket Rain Gauge. Flow Meter records rainfall data in 0.01" increments. Flow measurement can be initiated based upon field selectable rate of rain.
- **Analog Input Data-logging Channels:** Up to seven additional data-logging channels record data from external sources; field assignable channel name(s) and units; - 4 to +4 VDC 0 – 20 mA, ±0.5% full scale voltage accuracy, ±0.2% full scale 4-20 mA accuracy with 200 ohm impedance
- **4 - 20 mA Outputs:** Up to 2 integral field assignable outputs, optically isolated, up to 600 ohm load, per output 0.1 % FS error.
- **Mechanical Totalizer:** 6-digit non-resettable mechanical totalizer; selectable units: gal., lit., ft.³, m³, acre-ft.
- **Alarm Relays:** Up to 4 integral alarm relays, 10 amp, Form C, user assignable to any internal or external data channel.
- **Modem:** 14,400 baud rate, CRC auto to check sum, FCC approved, cellular compatible.
- **Expanded Memory:** Increase memory from 18,432 data points to 116,736 data points.
- **AC Power Backup:** Provides power in the event of an AC power failure; internal trickle charger maintains 6 amp-hour battery.

*Teflon is a registered trademark of E.I. Dupont de Nemours Inc.*

# PVM Portable Flow Velocity Meter


*This lightweight (3 lb.), rugged field unit uses a Doppler velocity sensor to measure bi-directional velocity to ±10 feet/second.* **Hach's Sigma PVM** *also features true-time averaging for higher accuracy in turbulent flows.*

This rugged, easy-to-operate unit is ideal for checking and calibrating primary devices and flow meters, and for spot measurements in sewers, streams and irrigation channels. The PVM Meter quickly determines fluid point velocity or time averaging using a Doppler ultrasonic sensor. Velocity information is then processed for computing flow and controlling analog and display outputs.

- Doppler Technology for fluid point velocity or time average velocity.
- Digital circuitry samples velocity 15 times per second.
- Computes forward and reverse flow.
- 12-hour battery life.

## PVM Design Specifications

- **Included:** Portable velocity meter, velocity probe with 25' (7.6m) cable, nylon shoulder strap, battery charger, rechargeable nickel cadmium battery, swivel head probe holder, two extension rods, and carrying case.
- **Velocity Sensor:** Ultrasonic Doppler
- **Velocity Ranges:** 0.05' to ± 10'/sec. (0.015 to ±3 m/s); bi-directional measurement
- **Velocity Accuracy:** ±1% of full scale
- **Resolution:** .01'/sec, (.003 m/s)
- **Minimum Depth:** 1.0", (25mm)
- **Minimum Particulate Level:** 100 micron @ 100 PPM
- **Display:** 4 line x 20 character LCD with contrast adjustment
- **Recorder Output:** -2 to +2 VDC corresponding to -10' to +10'/sec. (-3 to +3 m/s) (optional)
- **Power Source:** Internal rechargeable 6-cell 1500 mA-H Ni-Cad pack (internal to PVM)
- **Recharge Time:** 10 hours
- **Charger Power Requirements:** 115 VAC for AC to 12 VDC converter, 10-15 VDC from automobile lighter socket
- **Operating Time:**
  *Normal use:* 4 weeks
  *Continuous use:* 12 hours
- **Operating Temperature:** 32°to 122°F, (0 to 50°C)
- **Sensor Cable Length:** 25' (7.6 m) standard
- **Dimensions:** 4.5" H x 7" W x 6" diameter, (11.4 cm x 17.8 cm x 15.2 cm)
- **Weight:** 3 lbs. (1.4 kg) without carrying case
- **Probe Dimensions:** 1.0" H x 1.5" W x 1.5" diameter, (25 mm x 38 mm x 38 mm)
- **Probe Materials:** Urethane and epoxy polymers; stainless steel
- **Extension Rod:** Telescopic from 1.5' to 6', (0.5 to 1.8 m)

# 980 Open-Channel Permanent Flow Meter

The 980 Flow Meter provides the versatility needed to handle a wide range of applications and site conditions. It has been designed to use three different sensing technologies so that you can choose the most appropriate one for your specific flow situation. In addition, you can also monitor rainfall and several water quality parameters.

The unique backlit display allows you to easily review either a graph of any logged channel for any time period up to one day or to review minimum, maximum, and total flow values of any logged channel in hourly, daily, or other intervals of your choice.

- **Three Different Level/Flow Sensing Technologies:** Non-contacting ultrasonic; submerged pressure; Doppler velocity.
- **Advanced Monitoring:** Measures flow, level, pH, temperature, rainfall, and more.
- **Large, Easy-to-Read Graphics Display:** Provides maximum amount of graphed or tabular data at a glance.
- **Flexible Power Supply:** Automatically regulates input voltage (100 to 230 VAC, 50/60 Hz).
- **Data Logging:** Minimum of 396 days of three channels of user-selected readings at 15-minute intervals. Up to 300 events.
- **Numeric Keypad:** Sealed-membrane switch keypad. Audio signal confirms keystroke has registered.
- **Built-in Flow Equations:** Simply select the primary device. Or use the Manning Equation. For custom applications, enter up to 99 head-versus-flow data points. You select the level and flow units.
- **Seven External Analog Inputs:** Consolidate 4-20 outputs from other monitoring equipment into a standard format.
- **Simple Documentation:** Generate charts, graphs, and reports with Hach's software package.
- **Alarm Relays:** Four user-assignable, set-point and trouble alarms.
- **Pacing:** Will pace samplers or other equipment in proportion to flow.
- **Water-Resistant Enclosure:** Environmentally sealed NEMA 4X case for longer life and minimal service.
- **Modbus® SCADA Communications:** The 980 incorporates MODBUS Protocol for use in SCADA (Supervisory Control and Data Acquisition) systems.

(MODBUS is a trademark of Scheider Automation, Inc.)

*The **980** is a permanent, A/C powered, wall-mounted meter with three different level/flow sensing technologies and easy-to-read graphic display.*

Ideal for:

- Surcharge flows or reversed flow conditions
- Weirs and flumes
- Small-to-large channels

## 980 Design Specifications

- **Dimensions:** 14.62" H x 11.88" W x 8.26" D (37.13 cm x 30.18 cm x 20.98 cm)
- **Weight:** 16.80 lbs (7.62 kg)
- **Enclosure:** NEMA 4X, IP66 with front cover closed, UV resistant, -40 to 176°F, (-40 to 80°C)
- **Mounting:** Wall, Rail / Pole mount
- **Graphics Display:** Backlit liquid crystal display (LCD). 8-line x 40-character in text mode, 64 x 240 pixels in graphics mode. Displays level vs. time, flow vs. time, rainfall vs. time, pH and temperature.
- **Keypad:** 19-position, sealed-membrane switch including four "soft keys," functions defined by display.
- **Totalizers:** 8-digit resettable and 8-digit non-resettable software. *Units:* ft.³, gal, m³, liter, acre-ft.
- **Measurement Modes:**
  *Flumes:* Parshall, Palmer Bowlus, Leopold-Lagco, H, HL, HS, Trapezoidal
  *Weirs:* V-notch, Contracted/Non-contracted rectangular, Thel-Mar, Compound Cipolletti, Compound V-notch
  *Manning Equation:* Round, U, Rectangular, and Trapezoidal Channels
  *Head vs. Flow:* Two independent user-entered, look-up tables of up to 100 points each.
  *Level Only:* Inches, feet, centimeters, meters
  *Area Velocity:* Level-area table, circular pipe, U-shaped channel, trapezoidal channel, rectangular channel.
  *Power Equation:* $Q = K_1H^{n_1} \pm K_2H^{n_2}$
- **Data Logging:**
  *Capacity:* Up to 456k bytes, 396 days of three channels of user-selected readings at 15 minute intervals. Plus 300 events.
  *Memory Mode:* Wrap-around
  *Data Points:* 116,000 data points
  *Daily Statistics:* Available for up to 32 days
  *Recording Intervals:* 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, or 60-minutes
  *Time Base Accuracy:* ± 6 seconds (0.007%) per day
- **Electrical:**
  *Power Specifications:* 0.25 amp maximum
  *Power Requirements:* 100-230 VAC, 50/60 Hz, single phase, 15 W max (0.25 amp max)
  *Installation Category:* II
  *Electrical Connection:* Seven 0.5" hubs, one 1.0" hub.
  *Relay Contact Ratings:* 5 amps (30- 230 AC)
  *Sampler Output:* 15 VDC, 100 mA at 500 ms duration
- **Environmental:**
  *Temperature Ranges:*
  *Storage:* -4°F to 158°F, (-20°C to 70°C)
  *Operating:* -4°F to 122°F, (-20°C to 50°C)
  *Humidity:* 0-90%, non-condensing

# 980 Design Specifications (continued)

### Ultrasonic Transducer:
*Operating Frequency:* 75 kHz
*Beam Angle:* ±12° (-10 dB)
*Range:* 11.5 in. minimum to 10.7 ft. maximum, @ 20°C., still air, ideal target, 50 ft. cable.
*Accuracy:* ±0.03 ft. over 2-ft. change in head, @ 20°C still air, ideal target, 50-ft. cable.
Operating Temperature Range: -4°F to 122°F, (-20°C to 50°C)
*Material:* PVC housing with acoustic window
*Cable:* Low-loss cable, coax cable RG 62/U
*Cable Length:* 25 ft. (7.6 m) standard, custom lengths to 500 ft. (contact manufacturer for performance information at custom lengths)
*Mounting:* Permanent and adjustable mounting brackets
*Dimensions (transducer only):* 5.0" H x 2.25" D, (12.7 cm x 5.7 cm)
*Weight:* 1.5 lbs.
*Connection:* Bare wire lead connection via terminal blocks

### Velocity Sensor:
*Method:* Doppler Principle
*Accuracy:* ±2% of reading; Zero Stability: ±1.52 cms (± 0.05 fps)
*Range:* -5 to +20 fps (-1.52 to 6.1 m/s)
*Resolution:* 0.01 fps (0.3 cm/s)
*Response Time:* 4.8 seconds
*Profile Time:* 4.8 seconds
*Length:* 2.7" (6.9 cm)
*Width:* 1.5" (3.81 cm)
*Height:* 0.44" (1.1 cm)
*Cable:* Urethane sensor cable, shielded
*Cable Length:* 25 ft. (7.6 m), custom cable lengths up to 100 ft.
*Mounting:* Dedicated mounting rings (mounting clips recommended for pipe diameters 8" or under), Mounting Plate (for permanent mounting-drills to pipe wall), Adjustable Mounting Band Kit
*Connection:* Sensor connector to quick-connect hub or bare leads connection via terminal block

### In-Pipe Ultrasonic Sensor:
*Operating Frequency:* 75 kHz
*Beam Angle:* 5° (-10 dB)
*Accuracy:* ±0.014 ft. for sensor-to-liquid distance between 2.86 inches and 13.5 ft ± 1 ft change in head from calibration point, 20°C still air, ideal target, 50 ft cable.
*Range:* Distance from liquid sensor: 0.64 inches (minimum) to 13.5 feet (maximum), @ 20°C still air, ideal target, 50 ft cable.
*Operating Temperature Range:* -4°F to 140°F, (-20°C to 60°C)
*Material:* StatCon A-E ABS plastic
*Cable:* Low-loss cable, coax cable RG 62/U
*Cable Length:* 25 ft. (7.6 m) standard, custom lengths up to 500 ft. (contact manufacturer for performance information at custom lengths)
*Dimensions (transducer only):* 1.75" (4.44 cm), maximum diameter x 12.375" (31.435 cm) long.
*Mounting:* Dedicated Mounting Rings, Permanent Mounting Bracket (installs directly to pipe wall), Adjustable Mounting Band Kit
*Connection:* Bare lead connection via terminal blocks

### Submerged Area Velocity Sensor:
*Method:* Doppler Principle / Pressure Transducer
*Material:* Polyurethane body, 316 series stainless steel diaphragm
*Cable:* Urethane sensor cable with air vent, shielded
*Cable Length:* 25 ft. (7.6 m) standard, custom cable lengths up to 100 ft.
*Length:* 5" (12.7 cm)
*Width:* 1.5" (3.81 cm
*Height:* 0.8" (2.03 cm)
*Mounting:* Dedicated mounting rings (mounting clips recommended for pipe diameters 8" or under), Mounting Plate (for permanent mounting screws to pipe wall), Adjustable Mounting Band Kit
*Connection:* Sensor connector to quick-connect hub, bare lead connection via terminal block or bare lead connection to junction box with bare lead junction box via terminal block

**Velocity:**
*Velocity Accuracy:* ± 2% of reading; Zero Stability: <0.05 fps (<0.015 m/s)
*Response time:* 4.8 sec.
*Profile Time:* 4.8 sec.
*Range:* -5 to +20 fps, (-1.52 to 6.1 m/s)
*Resolution:* 0.01 fps, (0.0028 m/s)
*Operating temperature:* 0° to 140°F, (-18° to 60°C)

**Depth:**
*Depth Accuracy:* ±2% of reading at 10 in. of depth.
*Maximum Allowable Level:* 3X over pressure
*Operating Temperature Range:* 32° to 160°F, (0° to 71°C)
*Compensated Temperature Range:* 32° to 86°F, (0 to 30°C)
*Temperature Error:*
0.018 to 11.5 ft. ±0.004 ft./°F (0.005 to 3.5 m ±0.0022 m/°C)
0.018 to 34.6 ft. ±0.012 ft./°F (0.005 to 10.5 m ±0.006 m/°C)
(maximum error within compensated temperature range - per degree of change)
*Draw down connection*:* 0 to 10 fps (0 to 3.05 m/s) = 0.085% of reading
*Air Intake:* Atmospheric pressure reference is desiccant protected

### Integral pH Meter:
*Control/Logging:* Field selectable to log pH independent of flow or in conjunction with flow; also controls sample collection in response to value of low/high stipends
*pH Sensor:* Temperature compensated; impact resistant ABS plastic body. Combination electrode with porous Teflon junction.
*Measurement Range:* 2 to 12 pH
*Operating Temperature Range:* 0 to 176°F, (-18 to 80°C)
*Dimensions:* 0.75" diameter x 6" long (19.5 mm x 15.24 cm) with 0.75" (19.5 mm) mpt cable end

### Rain Gauge Input:
*General Information:* For use with Hach Tipping Bucket Rain Gauge. Flow measurement can be initiated upon field selectable rate of rain. Flow meter records rainfall data. Shielded cable, 100' length maximum. Each tip = 0.01" (0.25 mm) of rain.

### Analog Input Channels:
*General Information:* Up to seven additional data logging channels record data from external source(s). Four channels with -4.5 to 4.5 VDC input with 1 meg ohm input impedance on each channel and three channels with 4-20 mA input.

### 4-20 mA Output:
*General Information:* Two isolated output signals available. User assignable
*Maximum Resistive Load:* 600 ohms
*Output Voltage:* 24 VDC – no load

### Alarm Relays:
*General Information:* Four integral alarm relays; form C (common, normally open, normally closed), 5 amp. Connection to instrument through terminal blocks.
Relay Contact Ratings: 5 amps, (30-230 VAC)

### Communications:
*General Information:*
*RS-232:* up to 19,200 baud
*Modem:* 14400 bps., V.32 bis, V.42, MNP2-4 error correction. V.42 bis MNP5 data compression. MNP 10-EC Cellular Protocol; Pager; SCADA-Modbus® communication protocol (standard) via RS-232 or optional modem

# Hach Applications Knowledge

Hach offers more than 20 years experience in matching the right product for your specific application. The guide below is intended to make some of that experience available to our customers. Since field and application conditions can vary from site to site, to optimize performance of a system under unique site conditions we suggest contacting a Hach Technical or Sales representative for their recommendations and the latest specifications.

## Open-Channel Flow Measurement Technology Guide†††

| | Submerged Pressure Area Velocity | Keppler Submerged Pressure Area Velocity | Wafer Velocity (with ultrasonic Sensor*) | Standard Ultrasonic | In-Pipe Ultrasonic | Submerged Pressure Depth Only | Bubbler | Area Velocity Bubbler |
|---|---|---|---|---|---|---|---|---|
| **Applications** | | | | | | | | |
| Weirs and flumes | NR† | NR | NR | Excellent | NR | Excellent | Excellent | NR |
| Pipes/Channels < 6 in. (150 mm) | Contact Factory | | | | | | | |
| Pipes/Channels 6 to 8 in. (150 to 200 mm) | Good | Good | Very Good | NR | NR | Excellent | Excellent | Good |
| Pipes/Channels 10 to 15 in. (250 to 375 mm) | Excellent | Excellent | Excellent | NR | Good††† | Excellent | Excellent | Excellent |
| Pipes/Channels 15 to 96 in. (375 to 2500 mm) | Excellent | Excellent | Excellent | Very Good††† | Excellent††† | Excellent | Excellent | Excellent |
| Overflow Channels (normally dry) | NR | NR | Very Good | Excellent | Excellent | NR | Very Good | Very Good |
| **Site Conditions** | | | | | | | | |
| Backwater flow | Excellent | Excellent | Excellent††† | Excellent* | Excellent* | Excellent* | Excellent* | Excellent* |
| Full pipe, surcharged flow | Excellent | Excellent | Excellent | NR | NR | Excellent* | Excellent* | Excellent* |
| Reverse flow | Excellent | Excellent | Excellent | Excellent* | Excellent* | Excellent* | Excellent* | Excellent* |
| Low depth, < 2 in. (50 mm) | NR | NR | Good | Excellent | Excellent | Good | Very Good | NR |
| Low Velocity, 0.2 to 0.8 fps (0.06 to 0.24 m/s) | Good | Very Good | Good | Excellent | Excellent | Excellent | Excellent | Good |
| Highly Erosive Conditions (high velocity with abrasive content present) | Very Good | NR | Good | Excellent | Excellent | Excellent | Excellent | Good |
| Low suspended solids, 50 to 100 ppm | Good | Very Good | Good | Excellent | Excellent | Excellent | Excellent | Good |
| Low suspended solids, < 50 ppm | NR | NR | NR | Excellent | Excellent | Excellent | Excellent | NR |
| Air temperature fluctuations | Excellent | Excellent | Excellent | Good | Good | Excellent | Very Good | Very Good |
| Liquid temperature fluctuations | Very Good | Very Good | Very Good | Excellent | Excellent | Very Good | Excellent | Excellent |
| Water Temp 100-140°F | Good | Good | Excellent | Good††† | Good††† | Good | Excellent | Good |
| Silt** | NR | NR | NR | Excellent | Excellent | Very Good | Very Good | NR |
| Suspended solids | Excellent | Excellent | Excellent | Excellent | Excellent | Excellent | Excellent | Excellent |
| Suspended grease** | Good | Good | Good | Excellent | Excellent | Good | Good | Good |
| Floating oil, grease, or debris | Excellent | Excellent | Excellent | Excellent | Excellent | Excellent | Excellent | Excellent |
| Surface turbulence | Excellent | Excellent | Excellent | NR | NR | Excellent | Excellent | Excellent |
| Boiling turbulence | NR | NR | NR | NR | NR | Very Good | Excellent | NR |
| Foam on liquid | Excellent | Excellent | Excellent | NR | NR | Excellent | Excellent | Excellent |
| Steam above liquid | Excellent | Excellent | Excellent | NR | NR | Excellent | Excellent | Excellent |
| Strong wind | Excellent | Excellent | Excellent | NR | NR | Excellent | Excellent | Excellent |

† Not Recommended *When used with Wafer Velocity ** For optimum results, velocity sensor must be unobstructed. ††† Application may depend on local site conditions. Contact factory for application advice.

# New

### *An Introduction to Open-Channel Flow Measurement Technology*

To further assist you in determining the right equipment for your specific site conditions, Hach has prepared a handbook on the basics of flow measurement. It provides information regarding types of open-channel flow measurement, technologies currently employed, applications, and general guidelines for successful flow measurement. A detailed "Technology Guide" to help users choose the right instrumentation for their application is included.

- > Municipal treatment
- > Pretreatment
- > Combined sewer overflow (CSO)
- > Sanitary sewer overflow (SSO)
- > Municipal stormwater
- > Nonpoint source runoff
- > Industrial discharge
- > Stormwater
- > Hazardous and difficult locations

# Area Velocity (Doppler) Applications

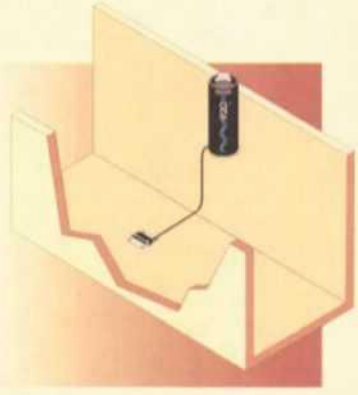
The unsurpassed flexibility of Hach's Sigma Flow Meters makes it possible to configure a meter for virtually any application. This versatility is illustrated by Hach's Sigma Doppler Applications.

### Redundant measurements.

Frequently, critical applications such as custody transfer or inter-agency billing demand redundant measurement. At this site, one 920 is providing ultrasonic measurement in a parshall flume while also measuring flow upstream using the Continuity Equation, Q=AxV. This assures no lost data in a submerged flow condition.

### Measure flow in two pipes with one meter.

When CSO outfall is conducive to accurate flow measurement, the 920 can measure depth and velocity in the primary channel, as well as overflow.



### Allows setup in dry pipe.

Hach area velocity flow meters do not require on-site manual velocity calibration to establish average velocity, allowing setup in a dry pipe. Rapid signal processing and temperature compensation accurately record the change from dry to wet conditions.

## Data Management and Analysis Software

Hach's analysis software lets you quickly and easily program your Hach data logger, download data, and turn it into useful information.

- Easy-to-use graphical Windows-like screen.
- Pull-down menus and a quick-click toolbar allows even inexperienced users to quickly learn the program.
- View current data at the monitoring site and download all files in an instant.
- Automates remote data collection by scheduling multiple loggers for unattended retrieval via modem.
- Site files can be viewed as text or graphs, and reported on screen and printed. Graphs can be exported to a spreadsheet.
- Data editing enables you to correct for site or equipment anomalies.
- Data is stored in dual files to assure data integrity. The data is stored in individual site files from each download–as well as in a common database file which merges all data from a single site. The result is simpler, more efficient analysis.

**Feature Summary:**

- Real time view of logger status.
- Multiple sensor support.
- Remote programming.
- Modem scheduling.
- Alarms.

For detailed information on Hach software, please visit www.hach.com.

## All Hach Area Velocity Flow Meters Use
## Advanced 1 Megahertz Doppler Technology

- > Direct Average Velocity
- > Active Probe Electronics
- > Stronger Signal Frequency
- > Faster Signal Processing
- > Quicker Response Time
- > Low Profile Probe
- > Reverse Flow Measurement
- > Drawdown correction: Compensates for effects of velocity on level measurement.

## Technical Training Programs

Training is vital to the success of your monitoring program. Hach offers workshops in general analytical theory and procedure, and in the specific application of samplers and flow meters, to help organizations support a strong testing program, and to help individuals build a sound foundation for professional development.

We provide training at our facilities in Loveland, Colorado, USA, at scheduled regional training sessions held around the country, and in customized sessions designed to meet your specific needs and schedule. All our workshops are self-contained and have no prerequisite requirements. Continuing Education Units are available.

The flow and sampling two-day workshop covers theory, practical applications, and hands-on experience, including:

- > Flow meter programming
- > Sampler programming
- > Doppler velocity measurement
- > Submerged pressure transducers
- > Ultrasonic transducers
- > Peristaltic pumps
- > Data analysis
- > Site selection
- > Routine maintenance

For details (including schedule, registration, cost), call 1-800-227-4224, or visit http://www.hach.com and click on 'Technical Training'.

Your Representative/Distributor is:

**For current price information, technical support, and ordering assistance, contact the Hach office or distributor serving your area.**


*In the United States, contact:*
HACH COMPANY World Headquarters
P.O. Box 389
Loveland, Colorado 80539-0389 U.S.A.
Telephone: 800-227-4224
Fax: 970-669-2932
E-mail: orders@hach.com
***www.hach.com***

*U.S. exporters and customers in Canada, Latin America, sub-Saharan Africa, Asia, and Australia/New Zealand, contact:*
HACH COMPANY World Headquarters
P.O. Box 389
Loveland, Colorado 80539-0389 U.S.A.
Telephone: 970-669-3050
Fax: 970-461-3939
E-mail: intl@hach.com
***www.hach.com***

*In Europe, the Middle East, and Mediterranean Africa, contact:*
HACH + LANGE GmbH
Willstätterstraße 11
D-40549 Düsseldorf GERMANY
Tel: +49 (0) 211 5288-0
Fax: +49 (0) 211 5288-143
E-mail: info@hach-lange.de
***www.hach-lange.com***


HACH®

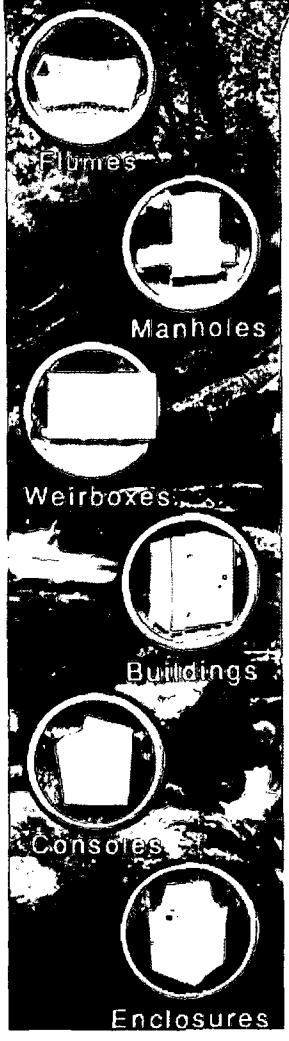
*Be Right™*

Lit. No. 3440
J51.5 Printed in U.S.A.

# Section III

## Typical Flumes

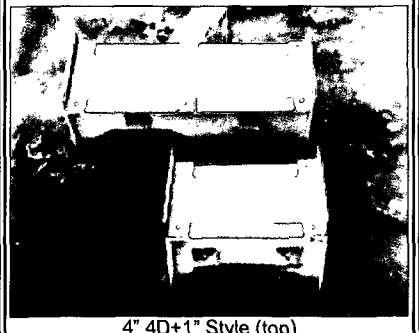
(used with flowmeters to sense level of water in flume and convert to flow)


## Palmer-Bowlus

The Palmer-Bowlus flume takes its name from its inventors, Harold Palmer and Fred Bowlus. The flume was developed for the Los Angeles County Sanitation Department in the mid-1930's. The flume was specifically designed to be a simple and effective wastewater flow-measuring device. The flume is essentially a restriction in the channel and is sized according to the width of the flume (typically, but not always, the width of the pipe it is connected to).

Palmer-Bowlus flumes are available from TRACOM in three different styles:

| | | |
|---|---|---|
| **4D+1"** | **Permanent Style**<br>• 2" top and end flanges<br>• Integral approach section<br>• Point of measurement inside of flume<br>• Available with inlet and outlet end bulkheads to connect to existing pipe |  <br>6" 4D+1" Style with Stainless Steel Ultrasonic Mounting Bracket |
| **2D+1"** | **Portable Style**<br>• 2" top and end flanges<br>• Shorter lay length than 4D+1" style<br>• Point of measurement upstream (outside) of flume<br>  ○ Cannot be provided with bubble or sample tubes, submerged probe or Drexelbrook cavities, or staff gauges<br>• Available with outlet bulkhead to connect to existing pipe |  <br>4" 4D+1" Style (top)<br>4" 2D+1" Style (bottom) Comparison |
| | **Insert Style**<br>• 2D+1" length | |

| | | |
|---|---|---|
| **Insert** | • No top or end flanges<br>• No support ribs<br>• Intended to install into the lower half of an existing pipe<br>• Reduced discharge capacity due to limited sidewall height O.D. of flume is I.D. of existing pipe<br>• Point of measurement upstream (outside) of flume<br>  ○ Cannot be provided with bubble or sample tubes, submerged probe or Drexelbrook cavities, or staff gauges<br>• Not available with inlet or outlet bulkheads |  <br>6", 8", and 10" Insert Flumes |

For new construction the 4D+1" style is preferable due to the integral approach section. The 2D+1" style is more common in retrofit constructions where space is a concern, although problems can occur in that the head measurement is made upstream from the flume itself. TRACOM does not recommend the use of the 2D+1" style, unless there is a space concern, considering the marginal cost difference between it and the 4D+1" style and the additional labor that will be required to form the upstream channel properly so that an accurate level measurement can be taken.

Unlike the 4D+1" and 2D+1" styles, the Insert style does not have inlet or outlet flanges and is intended to fit into existing pipe. The overall geometry is similar to the 2D+1" style, but, unlike the 2D+1", the *O.D.* of the flume is the *I.D.* of the pipe.

**Options and Accessories**

- Ultrasonic mounting brackets
- Bubble tubes
- Sample tubes
- Submerged probe cavities
- Stilling wells (attached and detached)
- Staff gauges
- Removable probe holders
- Inlet and outlet bulkheads
- Pipe stubs
- Flanged end connections
- FRP grating
- Riser boxes
- Transition entrances
- Nesting

- Multi-piece construction
- Chemically resistant gel coat

Listed below are various Palmer-Bowlus flume sizes and their recommended flow ranges.

| Size | Recommended Flow Rates |
|---|---|
| 4" | 5-55 GPM |
| 6" | 15-148 GPM |
| 8" | 31-300 GPM |
| 10" | 56-521 GPM |
| 12" | 89-817 GPM |
| 15" | 148-1450 GPM |
| 18" | 239-2271 GPM |
| 21" | 358-3322 GPM |
| 24" | 356-3322 GPM |
| *For sizes above 24" consult the factory* | |

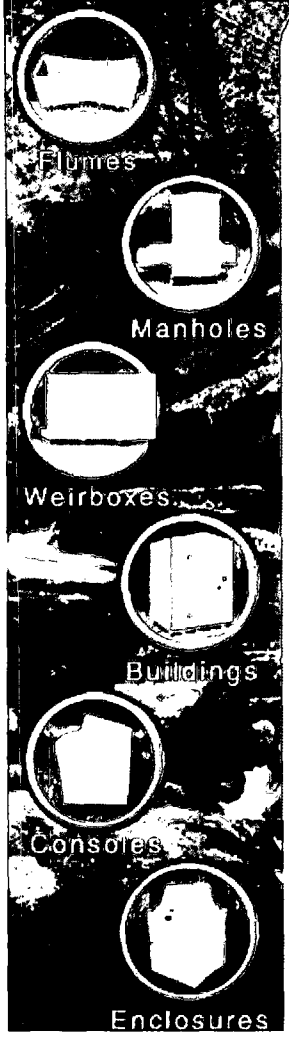
Specifications - Installation Instructions - Typical Drawing

If you would like additional information, pricing, or assistance in sizing and specifying a flume, please fill out and submit our flume application form.

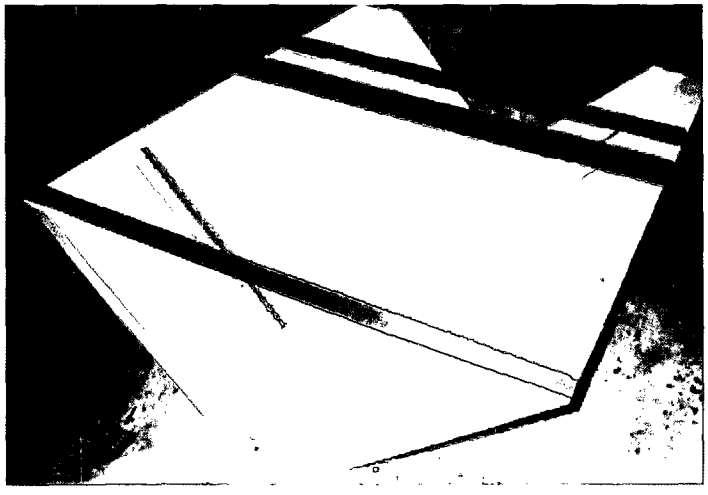
**Note:** If you are unable to view those materials on your machine, please download Adobe Acrobat® 5.0 Reader.



Toll-Free: 1.877.4FLUMES (1.877.435.8637)
Phone: 1.770.664.6513 · Fax: 1.770.664.6565
sales@tracomfrp.com
6575-A Industrial Way
Alpharetta, Georgia 30004 USA


## Trapezoidal



12" 45 Degree (#1) Trapezoidal Flume with Staff Gauge

Originally developed by the U.S. Soil Conservation Service to measure flows in irrigation channels, the Trapezoidal flume is now used in growing number of sanitary and industrial sewer applications with very low rates.

**Primary advantages include:**

- The straight through bottom (for silt and debris passage)
- Ability to operate under higher degrees of submergence than Parshall flumes
- Trapezoidal cross-section (conforms to natural channels and conveys large flows while providing accuracy for low flows)

Trapezoidal flumes are generally sized by throat width and geometry. A number of styles are commercially available. The most commonly used types are listed in the chart below. While not as common, several other types of Trapezoidal flumes that may be encountered including those defined by Robinson and Chamberlain.

**Options and Accessories**

- Ultrasonic mounting brackets
- Bubble tubes
- Sample tubes
- Submerged probe cavities
- Stilling wells (detached)
- Staff gauges
- Removable probe holders

**Listed below are standard Trapezoidal flumes and their recommended flow ranges.**

| Size | Recommended Flow Rates |
|---|---|
| Small | |

- Inlet and outlet end adapters
- Pipe stubs
- Flanged end connections
- FRP grating
- Riser boxes
- Multi-piece construction
- Chemically resistant gel coat

| | |
|---|---|
| 60 Degree V | 1-43 GPM |
| Large 60 Degree V | 1-156 GPM |
| Extra Large 60 Degree V | 1-663 GPM |
| 8" 60 Degree | 101-7955 GPM |
| 3' 60 Degree | 2-6,200 GPM |
| 2" 45 Degree WSC | 1-1,161 GPM |
| 12" 45 Degree SRCRC | 74-3,177 GPM |
| 2' SRCRC | 320-23,780 GPM |
| ***Consult the factory for sizes not listed above*** | |

Specifications - Installation Instructions - Typical Drawing

If you would like additional information, pricing, or assistance in sizing and specifying a flume, please fill out and submit our flume application form.

**Note:** If you are unable to view those materials on your machine, please download Adobe Acrobat® 5.0 Reader.



Toll-Free: 1.877.4FLUMES (1.877.435.8637)
Phone: 1.770.664.6513 · Fax: 1.770.664.6565
sales@tracomfrp.com
6575-A Industrial Way
Alpharetta, Georgia 30004 USA