STEVENS WATER MONITORING SYSTEMS, INC.

User Manual

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1. Introduction

The Steelhead data acquisition platform / logger delivers two-way link and control between sensor measurements and user's data management program(s). The Steelhead can be a primary data logger only and/or a gateway link between sensor(s) and data management programs via HTTPS and/or FTP using integrated cellular or coming soon, Wi-Fi and Iridium satellite communications. The Steelhead's all-in-one design includes integrated battery power in an IP-68 enclosure and waterproof M12 connectors. The ease of configuration and two-way connectivity creates an efficient and scalable true cloud-computing data acquisition & management experience.

Unique Features

- Direct HTTPS to Stevens Connect or user's cloud server
- FTP (File Transfer Protocol) for direct communications with legacy servers
- Dual communications via HTTPS and FTP
- Automatic alarm configuration that can change logging and reporting intervals
- Up to 3 years of operation on a 28Ah internal non-rechargeable battery. Other power management options available
- IP-68 enclosure
- High and low frequency pulse, SDI-12, and Modbus over RS-485 sensor inputs
- Advanced power surge and lighting protection
- Integrated solar input regulator to charge internal rechargeable batteries
- Built in GPS and barometric sensor
- Over-the-air software updates
- Configuration and data download via cloud-based program or via Bluetooth

2. Specifications

2.1 Technical Specifications

Sensor Data	**Logging Interval**	Configurable from 1 minute to 24 hours
	Reporting Interval	Configurable from 5 minutes to 24 hours
	Data records / storage	400,000 records typical. (Example: 5 min logging of 30 parameters per logging interval for 4 years equals approximately 400,000 records.) Memory size is 64 MB and stored on a FIFO basis
Data Memory	**Flash memory**	Non-volatile flash memory, complete data retention if loss of power
Sensor Interface	**Supported sensor types**	SDI-12
		Modbus over RS-485
		Pulse: 2 inputs, individually configurable as low frequency (< 100Hz) or high frequency (KHz), 20V max input voltage, 0.9V low voltage threshold, 1.8V high voltage threshold
	Sensor Connectors	3 x M12 A connectors. Connect more sensors using split cables or break-out box
	Power Output for Sensors	12V DC with max current source 200mA
	Sensor Power Supply	Switched
	Parameters	30 sensor parameters in total
	Number of Sensors	Up to 30 sensors, subject to current consumption and number of parameters
	Internal Barometric Sensor	Range 300 to 1250 hPa | 12-month long-term stability: ±0.33 hPa Absolute accuracy pressure (typ.): +/- 0.5 hPa; P=900 ...1100 hPa (T=25° to 40°C) Relative accuracy pressure (typ.): ±0.08 hPa, P=900…1100 hPa (T=25° to 40°C)
Communications	**Cellular**	4G LTE Cat-1 (International) or 4G LTE Cat-M (US Market)
	Antenna	Internal antenna: 698-875 MHz (1.9 gain) or 1710 – 2500 MHz (3.7 gain) Options: SMA connector for external antenna
	Mobile App Communication	BLE 5.0 Bluetooth low energy protocol
	GPS	GPS, GLONASS, BeiDou/Compass, Galileo and QZSS
Mechanical / Environmental	**Dimensions**	240 mm x 170 mm x 60mm (9.44 in x 6.7 in x 2.3 in)
	Enclosure Material	UV-resistant polymer
	Ingress Protection	IP-68 (dust proof and waterproof up to 1 meter immersion for 30 minutes)
	Operating Temperature	-40°C ~ +80°C (-40°F ~ +176°F)
	Lightning and Power Protection	Dedicated grounding lug Each input, output, and sensor power line has isolated gas discharge tubes, series current limiters, transient voltage suppressors (TVS), electrostatic discharge, electrical fast transient and lighting surge protection

2.2 Power Specifications

Steelhead Version	Input Power	Battery Capacity	Battery Life[3]
Battery Only	NA	28 Ah non-rechargeable[1]	3 years
Stevens Solar Panel	6V, 12W solar panel	2 batteries -10.5 Ah rechargeable[2] -28 Ah non-rechargeable[1,5]	6 months[4] 3 years[4]
DC Wall Adaptor or External Battery Power with Solar Panel	7V to 16V DC / 2A min	10.5 Ah rechargeable[2]	6 months[4]

[1] Lithium metal (Operating temperature range -40°C ~ +80°C [-40°F ~ +176°F])
[2] Lithium Ion (Operating temperature range -20°C ~ +55°C [-4°F ~ +131°F])
[3] Assumes 1 hour logging, 12 hour reporting, 3 sensors
[4] Battery life assuming solar panel or DC Wall adaptor not providing a charge
[5] Used if solar panel is not providing a charge or during extreme temperatures

2.3 Part Numbers

Part number ordering logic: 80065X -YYY-Z-S

X: Power Option

Power Supply Options (see explanation below)	X Option
Steelhead with battery only	B
Steelhead with 12-watt solar panel and internal regulator to charge internal battery	S
Steelhead with external power options (AC/DC adapter or external battery)	E

YYY: Communication Module Option

Cell Communication Module	YYY Option
US Market	USA
International	INT

Z: Cell Antenna Option

Antenna Option	Z Option
Internal antenna	I
External antenna on Steelhead (comes with antenna)	E
External antenna with extension cable (antenna purchased separately)	X

S: SIM Card Option

SIM Card Option	S Option
Citykinect SIM Card	C

Power supply options explained:

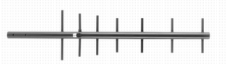
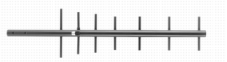
Battery Only (B)
One (1) non-rechargeable 28 Ah battery is included. Provides three (3) years of power if using up to three (3) typical low power SDI-12 sensors with 1 hour logging and 12 hour reporting.

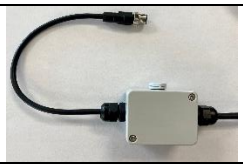
Solar Panel (S)
Two (2) internal batteries (a 28Ah non-rechargeable lithium metal and a 10.5 Ah rechargeable lithium ion) and a 6 V, 12W solar panel is included. The Steelhead has a built-in solar power regulator to keep the 10.5 Ah battery charged. The non-rechargeable battery provides backup power to the system during extreme temperature swings and in the rare case the rechargeable battery is low. Seasonal conditions can reduce the solar energy available which may not be enough to fully charge the battery without a higher-powered solar panel.

External Power (E)

External power works with an AC to DC (7V to 16V / 2A min) wall adaptor OR an external battery with an optional higher wattage solar panel. If using an external battery and higher wattage solar panel, the panel will keep the external rechargeable battery charged which will then provide power to the Steelhead through a regulator. A solar regulator and enclosure for the external battery is required. The Steelhead includes an internal 10.5 Ah rechargeable lithium-ion battery that will provide stable power during any external power interruptions.

Accessories

	Part Number	
Optional Power		
AC to DC Adapter （9V 2Amp)	80065-444	
6V 12-Watt Solar Panel with mounting bracket	80065-503	
40-Watt Solar Panel (with mounting bracket and regulator)	91064	
Solar Panel Regulator (to recharge external batteries)	70232	
External Battery (18AH)	92982	
External Antennas		
Antenna, ruggedized, 900Mhz, 3DB, whip with N Female	93777-10	
Antenna, 900 Mhz, 9DB, Yagi with N Connector	93772	
Antenna, Wide-Band Yagi, 9dB, with N Connector	93950-108	

External Antenna Cables		
Cable assembly, cell modem to bulkhead, N to SMA, 2 ft.	92824-001	
LMR400, N-to-N, antenna cable length per 10 feet	92845-010	
Sensor Connections		
1 to 2 Splitter	80065-321	
1 to 4 Splitter	80065-322	
5 Pin M12 Male Connector PG7 (3 provided with each Steelhead)	80065-407	
5 Pin M12 Male Connector PG9	80065-439	
2 Pin M12 Male Connector (provided with solar panel or external battery options)	80065-428	
Venting apparatus for vented pressure sensor applications	80065-338	
Physical Installation		
T-post mounting bracket	80065-314	

2.4 Steelhead Data Logger

2.4A Steelhead Physical Features

- IP-68 enclosure - dust and waterproof
- Cell modem
- GPS (Global Positioning System)
- NFC (wireless Near-Field Communication)
- Internal solar regulator
- Internal batteries (see section 2.3)
- Bluetooth for configuration, data viewing, data download, and diagnostics
- Physical power switch. There is no external light that indicates if the Steelhead is on. This can be determined by:
    - the mobile app, and/or
    - visually seeing the integrated switch is in the “on” position, and/or
    - seeing the Bluetooth connection on a phone or computer (see section 2.7)

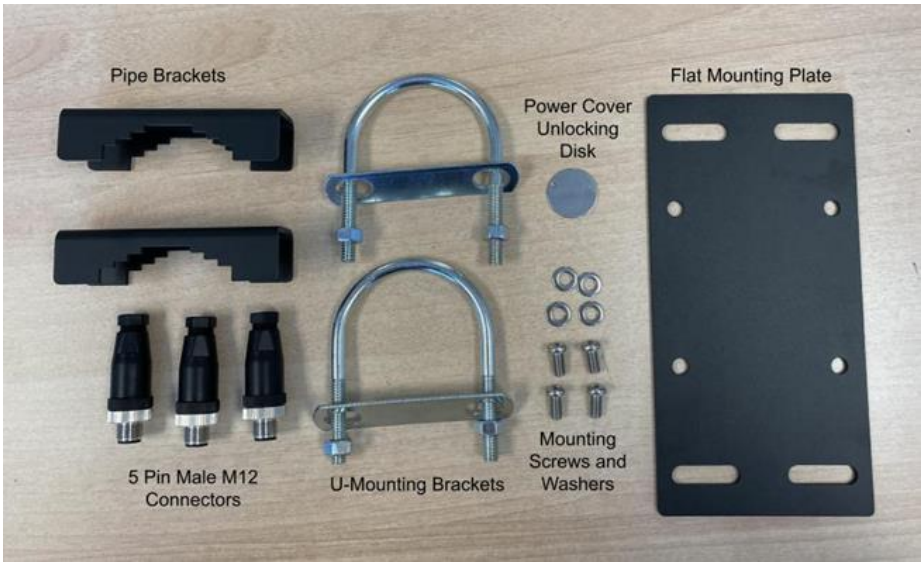
2.4B Steelhead Performance Features

- Security
    - Password protected Bluetooth connection ensures secure access and tamper prevention
    - Securely transmitted data using HTTPS encryption, preventing unauthorized interception
    - End-to-end data transport assurance prevents lost sample data due to cellular failures.
- Internal diagnostics
- Both US Standard and Metric Units available

2.4C Included with Each Steelhead Shipment

- Steelhead
- U mounting brackets (B and S versions) (2)
- Power cover unlocking disk (1)
- Flat mounting plate (1)
- Mounting screw and washer (4)
- Pipe bracket (2)
- 5-pin male M12 A connector (3)**

**For external power options a 2-pin M12A connector will be provided as well



2.5 Cell Module

An integrated cellular module is provided with 4G LTE Cat-1 (International) or 4G LTE Cat-M (US Market). See Section 2.2 for cell module and antenna options. The internal antenna is 698-875 MHz (1.9 gain) 1710 – 2500 MHz (3.7 gain). A dynamic IP is used which enhances security, improves configuration, and increases flexibility in connecting to a network. The Steelhead is setup to allow 2-way communication between the device and the cloud.

Steven's cellular service uses multiple networks and works in hundreds of countries to provide the most service to Steelhead customers. When the Steelhead powers on, it scans available networks and uses the strongest network to transmit data.

It is strongly recommended (but not required) to use the Stevens provided cell plan. Please contact Stevens if you would like to use your own cellular service data plan and SIM Card. The integrated cellular module uses a micro-SIM card.

2.6 Sensor Parameters

The Steelhead can support up to 30 parameters from all connected sensors. During configuration the parameters are selected from each sensor. For example, connecting a HydraProbe soil sensor via SDI-12 or Modbus may include soil moisture (%), soil temperature (C), soil conductivity (dS/m),

and pore water EC (dS/m), which will be four (4) parameters of the 30 parameters available. A rain gauge with a pulse output would be one (1) parameter. See section 4 for addition information on sensor measurements and section 8.2 to configure sensors.

2.7 Events / Alarm Conditions

The Steelhead allows up to five (5) separate events to be triggered on one or more sensor parameter(s) which enables automatic action. Parameter(s), respective event triggering condition (high / low threshold), the desired action, and the clear condition can all be set. Actions include:

- Increase logging
- Increase reporting times
- Immediate reporting

Contact Stevens if reporting to third party data management server to get the event data packet format.

Stevens-Connect also provides Alarms which allow for immediate notification via SMS and/or email. See Section 9 for details on how to set up events and alarms.

2.8 Bluetooth Connectivity

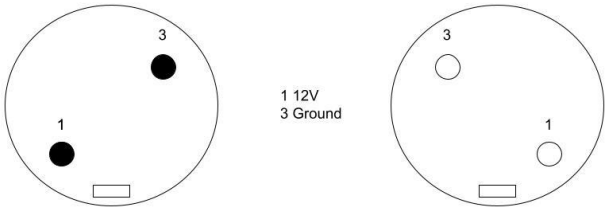
Bluetooth is included for device configuration, viewing data, downloading data, diagnostics, and troubleshooting. It can also be used to verify the Steelhead is powered on. The Bluetooth advertising name is user programmable (up to 64 characters per Bluetooth protocol) and initially defaults to the Steelhead's SUI number. The name will appear under available Bluetooth devices on your phone or computer.

3. Physical Wiring Connections

3.1 Power Connection (Power Input)

The Steelhead has one input for power that is universal for use with the Stevens solar panel or with external power options (see Section 2.2 Part Numbers). The solar panel or external power (battery or DC power) is connected with a M12 2-pin male connector. **This M12 2-pin male connector is different from the 5-pin sensor connector**.

Pin Number	Power
1	12 V nominal (typically red wire)
3	GND (typically black wire)



Steelhead has reverse polarity protection and accidental reverse connections will not cause damage to the unit. The Steelhead will not operate with reverse power connections.

All programming, configuration, diagnostics, and sensor measurements are saved in flash memory and will not be lost with low or no power supply.

Part Number	Steelhead Version	Description
80065B-YYY-Z	Battery Only	28 Ah / 3.7V, non-rechargeable internal battery that will operate until the battery voltage is below 3V.
80065S-YYY-Z	Stevens solar panel direct connection to power input	The internal rechargeable battery is used until battery voltage is below 3 V. In conditions of low solar energy during seasonal conditions or extreme cold (below -20 C), an additional integrated non-rechargeable battery (operates to -35C) inside the Steelhead is recommended. With two internal batteries, the Steelhead will automatically switch to the non-rechargeable battery when needed and then back to the rechargeable battery when not needed with a 0.4V hysteresis.
80065E-YYY-Z	External power supply	The Steelhead will automatically switch to the internal rechargeable battery power supply when external power drops below 6.7 V. If power is restored above 7V, the Steelhead will automatically switch back to the external power supply.

Solar Input Regulator and Battery Charger

The Steelhead has a highly efficient battery charge controller with integrated Maximum Power Point Tracking (MPPT) capability and can take input voltages up to 16V from a solar panel or a DC voltage source (e.g. wall adapter). AC to DC adapter should be 7 to 16V output, minimum of 2 amps (3 amps recommended). The input connector is protected against transient voltages.

The Steelhead has a battery charging protection circuit that protects against overvoltage, overcurrent, and high and low temperatures to ensure safety and longer battery life. The internal lithium battery pack temperature level is constantly monitored by the system and charging and discharging cut offs are applied at pre-defined temperature levels. The Steelhead internal rechargeable battery can charge in the temperature range of 0°C ~ 45°C and can discharge in the temperature range of -20°C ~ +60°C. The Steelhead has a cut off below -20°C and above +60°C, to ensure battery safety and longer life. In Steelhead variants with both rechargeable and non-rechargeable batteries, non-rechargeable battery sources can power the Steelhead outside these temperature ranges and thus ensures continuous and reliable operation at extreme temperatures.

3.2 Lightning / TVS Protection / Grounding

Properly grounding the system helps protect sensors and the Steelhead from nearby transient voltages and voltage surges caused by lightning. The Steelhead must be grounded to minimize the risk of damage due to transient voltage power surges (TVS).

> Primary lighting strikes are direct strikes or nearby strikes. One phenomenon which may be a source of hazardous potentials is a direct strike or nearby strike that may produce a dielectric breakdown (ionization) of the air resulting in an arc between the strike area and the system.
>
> Secondary lightning strikes are transient high current electrical discharge that induce a

voltage through the ground and in power lines or sensor wires. The earth at the point of lightning strike will undergo a significant rate of change in voltage which radiates outward in a radial direction from the strike point. If the magnitude of the ground potential rise is sufficient, dielectric breakdown of the any nearby cable (wire) sheath material may result and the cable will become part of the conductive discharge path. Such energy can follow in a sensor(s) or into the logger from connected cables (wires).

Lightning is highly variable and random. No system can be 100% protected against lightning strikes. Some areas / regions experience greater than average lightning and have different soil resistivity conditions. Accordingly, a local expert can provide specific lightning protection guidelines.

The Steelhead has advanced TVS Protection to protect against primary and secondary strikes. However, damage due to lightning is not covered under the warranty.

a. Ground the system to divert power surges to the ground. Some areas may install a lightning rod or fuse ball to help discharge primary strikes to the ground. As mentioned above, consulting a local expert in lightning protection is recommend. The Steelhead has a robust grounding connector lug that will help protect from damage by providing a low resistance path around the system to a point of low potential. All Steelhead components (sensors connectors, external power supply, mounts, housing) are referenced to this one common earth ground lug.

Earth ground lug is located next to the power input

i. Stevens recommends the Steelhead be earth grounded. This can be done by driving a 6-to-8-foot copper grounding rod into the earth and connecting this rod to the Steelhead grounding lug via at a 10 to 12 AWG wire. Avoid bends or kinks in this grounding wire.

Some soil types and location may need more than one grounding rod. More than one ground wire can be connected to the Steelhead ground lug if needed.

b. Soil types in regard to secondary strikes. The electrical resistivity of the earth (resistance of the earth to the flow of current) is almost as important as the intensity and frequency of lightning strikes in determining the probability of lightning damage. The unit of earth resistivity is defined as the resistance, in ohms, between opposite faces of earth (soil) one cubic meter in volume. If earth (soil) resistivity is high, the voltage which a given strike develops across dielectric, and the distance that lightning currents travel along a conductor before attenuating to harmless values are greater than if the earth (soil) resistivity is low. The result is that the probability of lightning damage is greater in some areas with high earth resistivity and only moderate incidence of storms than it is in areas with low resistivity and greater storm incidence. Earth resistivity varies over a considerable range in the world from a few ohm meters to 10,000 ohm meters or more in upland or mountainous country. Table 3.1 gives ranges of earth resistivity values to be expected for various types of soils.

Table 3.1 Resistivity of Various Soils

Soil Type	Resistivity (Ohm per Cubic Meter)
Loam	5 to 50
Clay	4 to 100
Sand/Gravel	50 to 1000
Sandstone	20 to 2000
Granite	1000 to 2000
Slates	600 to 5000
Limestone	5 to 10000
Shale	5 to 10000

Source: https://www.rd.usda.gov/files/UTP_Bulletins_1751F-801.pdf

c. Steelhead protections. The Steelhead power input and each sensor port has isolated Gas Discharge Tubes, Series Current Limiters, Transient Voltage Suppressors (TVS), Electrostatic Discharge (ESD), Electrical Fast Transient (EFT) and Lighting Surge protection. All protection circuits are connected to the grounding lug for proper earth connection.

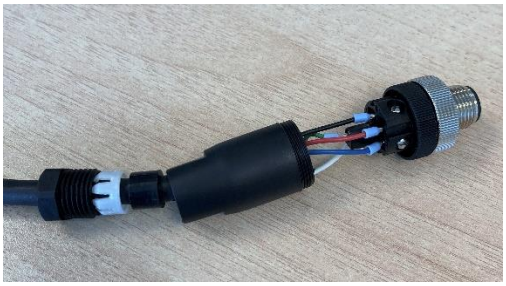
3.3 Sensor Connection

The Steelhead has three inputs for sensors. Sensors are connected with a M12A 5-pin male connector. Three connectors (PN: 80065-407) are included. The M12 connector is a IP67 waterproof circular connector with a 12-mm locking thread that is designed for washdown and corrosive environments.

SDI-12 sensors can be connected to any of the three inputs. Pulse and Modbus are only available on their respective inputs which are labeled on the Steelhead. SDI-12 and Modbus sensors may be chained together to allow multiple sensors on one connector (see section 3.4). Splitters can be ordered separately (1 connector to 2 connectors (1 to 2) PN: 80065-321 and 1 connector to 4 connectors (1 to 4) PN: 80065-322).

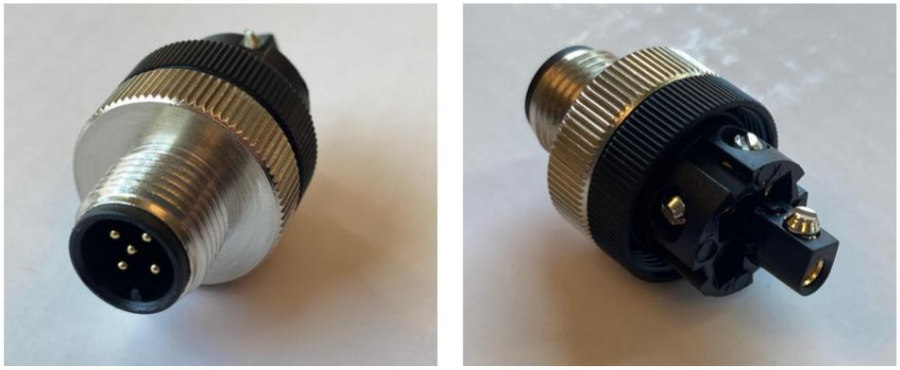
5 pin	SDI-12	SDI-12 PULSE 1, 2	SDI-12 MODBUS
1	GND	GND	GND
2	12 V	12 V	12 V
3	SDI-12	SDI-12	SDI-12
4	NO CONNECT	PULSE 1	A
5	NO CONNECT	PULSE 2	B

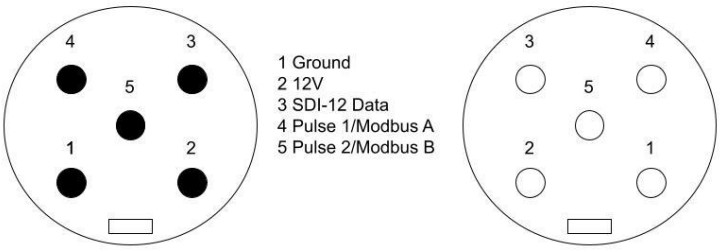
Female connectors on the Steelhead



Male connector shown with wires connected

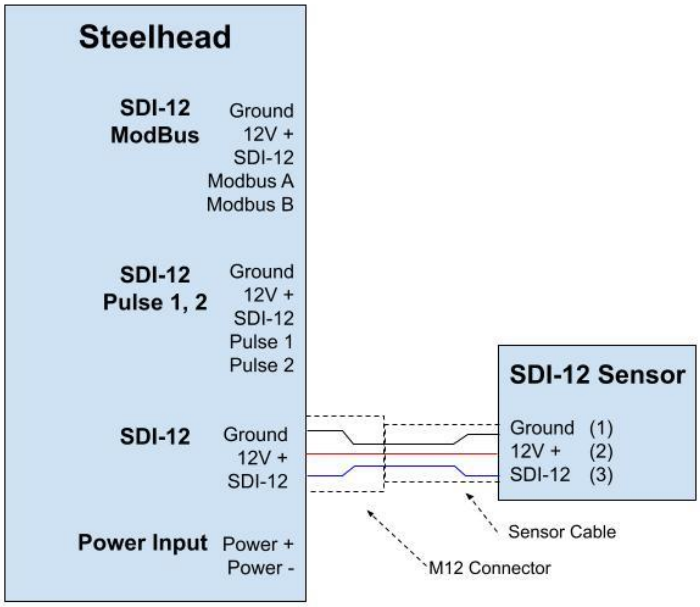
Note: numbers are embossed on the connector



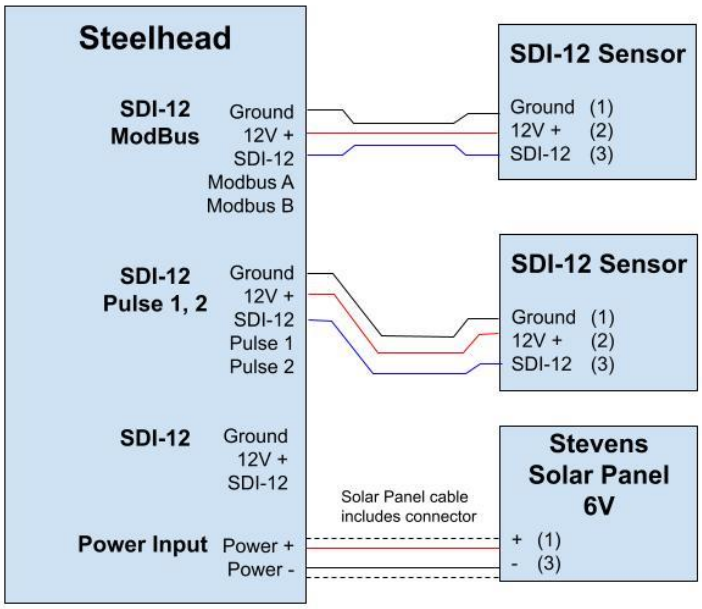


3.4 Sample Sensor Connections

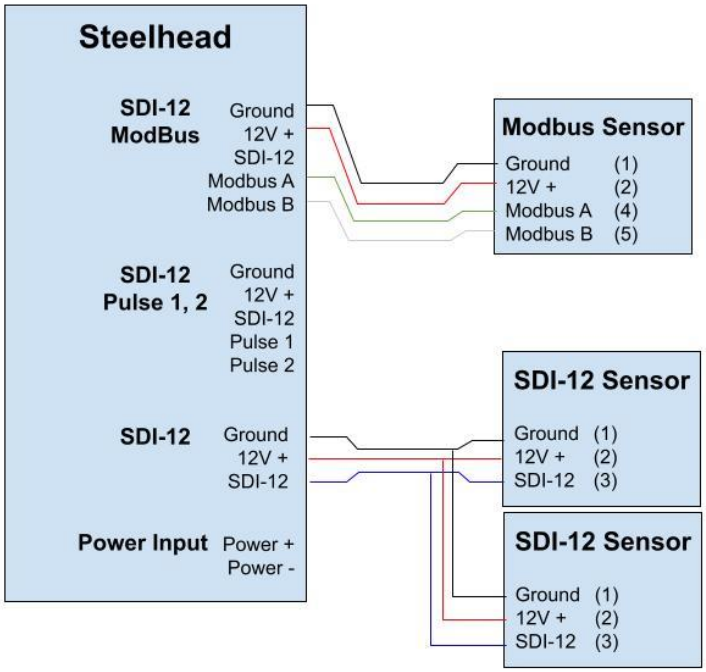
SDI-12 Sensor



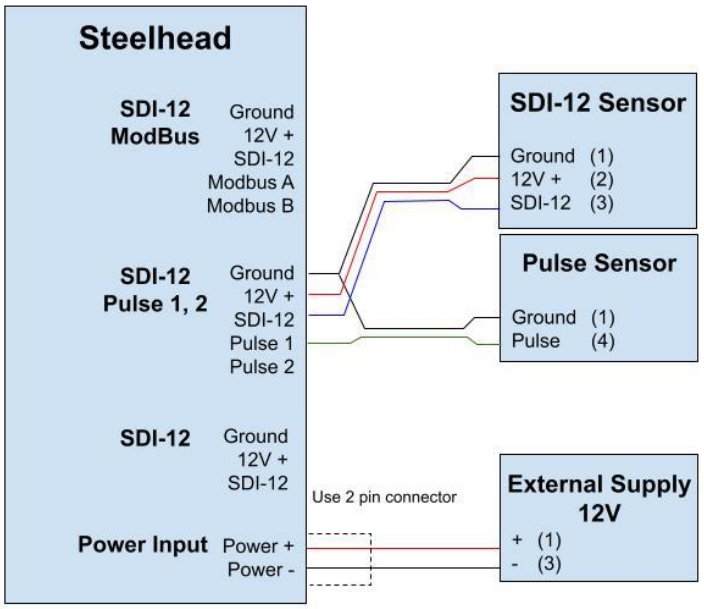
SDI-12 Sensors & Solar Panel



SDI-12 Sensors Same Connector & Modbus Sensor



Pulse Sensor & SDI-12 Sensor



4. Supported Sensor Measurement Input Types

4.1 SDI-12

Steelhead supports D/M commands on SDI-12 (Serial Digital Interface at 1200 baud). Each sensor input can have up to 30 single parameter SDI-12 sensors. The Steelhead's overall maximum number of parameters is 30.

For general information on SDI-12 and basic commands visit

- https://support.stevens-connect.com/getting-started/sdi12-quick-start.
- See SDI-12 specifications here http://www.sdi-12.org/current_specification/SDI-12_version-1_4-Jan-10-2019.pdf

4.2 Modbus

Steelhead supports read holding registers over Modbus RTU (Remote Terminal Unit) RS 485.

Supported RS 485 Settings:

- Baud Rates: 1200, 2400, 4800, 9600, 14400, 19200, 28800, 31250, 38400, 56000, 57600, 76800, 115200
- Parity: No Parity or Even Parity
- Zero indexed register addressing

Supported Parameter Settings:

- Data Types: Bit, INT16, UINT16, FLOAT32, INT32, UINT32
- Word Order: Big Endian, Little Endian, Big Swap, Little Swap

		Source Bytes	Target Bytes
Big Endian	The most significant byte always precedes the least significant byte	[a b] [c d]	[d c] [b a]
Little Endian	The least significant byte always precedes the most significant byte	[a b] [c d]	[a b] [c d]
Big Swap	The most significant halfword always precedes the least significant halfword	[a b] [c d]	[c d] [a b]
Little Swap	The least significant halfword always precedes the most significant halfword with the most significant byte of the halfword being first	[a b] [c d]	[b a] [d c]

4.3 Pulse

Steelhead supports switch closure pulse sensors. Two pulse channels can individually configurable as low frequency (<100Hz) or high frequency (KHz) [square wave], switch closure, or low-level A/C signals.

Connect two pulse sensors the Steelhead using a cable splitter (purchased separately) to the one pulse sensor input port on the Steelhead.

Pulse configuration options

Filter	**Fast**	For sensors with high frequency output (>100Hz) e.g., flow meters, wind speed sensors
	Slow	For sensors with low frequency output (<100Hz) e.g., tipping bucket rain gauge
Mode	**Count**	Value measured in each logging interval
	Accumulation	Output value accumulated over time

4.4 Internal Ambient (Barometric) Pressure Sensor

- Internal pressure sensor rated to 300-1250 hPa
- Absolute accuracy pressure (typ.): +/- 0.5 hPa; P=900 ...1100 hPa (T=25° to 40°C)
- Relative accuracy pressure (typ.): ±0.08 hPa, P=900…1100 hPa (T=25° to 40°C)
- 12-month long-term stability: ±0.33 hPa
- Using barometric pressure as a sensor can be turned on or off. When reported as a sensor, it uses 1 of the 30 available parameters.
- This barometric pressure sensor can be used as a pressure reference in depth reporting scenarios when using an absolute pressure sensor. This water level calculation using an absolution pressure sensor and internal barometric pressure sensor is post processed and not performed by the Steelhead.

5. Physical Installation

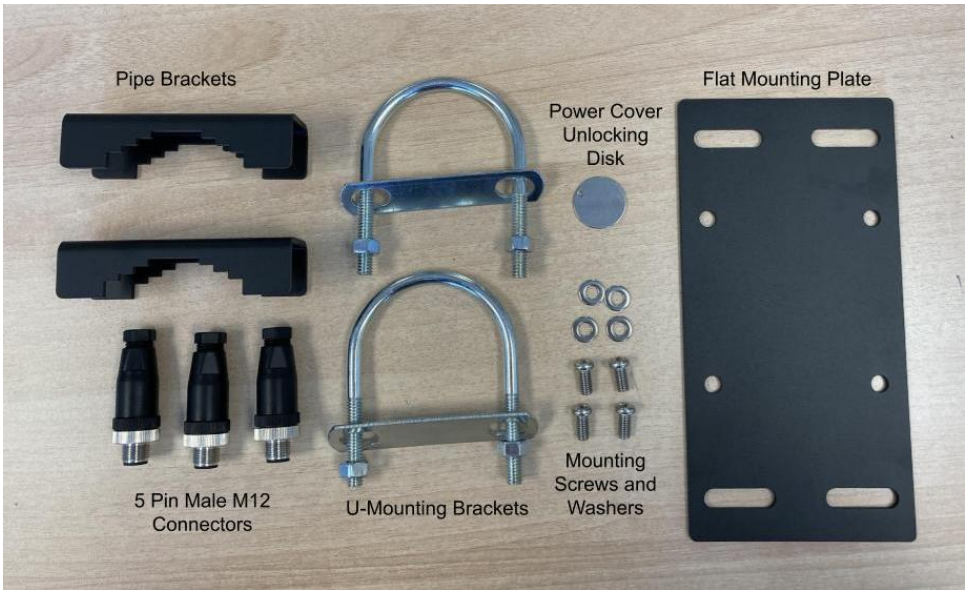
Tools/Equipment needed

- Steelhead and included parts
- Phillips head screwdriver
- Wrench
- Mounting surface
    - Equipment provided for mounting to a round pole 1.5 - 2” in diameter
    - If using a T-Pole, there is an optional T-Post mounting bracket (PN: 80065-314) that can be ordered separately
    - If mounting to a flat surface, additional tools and equipment may be needed depending on your configuration
- Optional: Solar panel assembly (PN: 80065-503)

The following are included parts with each Steelhead package:

- Steelhead
- U mounting brackets (B and S versions) (2)
- Power cover unlocking disk (1)
- Flat mounting plate (1)
- Mounting screw and washer (4)
- Pipe bracket (2)
- 5-pin male M12 A connector (3)**

**For external power options a 2-pin M12A connector will be provided as well



5.1 Turning on the Steelhead

1. The Steelhead is shipped with battery power off
2. Unlock the power cover using the provided power cover unlocking disk
3. Flip the switch toward the ON position
4. Replace the power cover to seal the Steelhead enclosure.

5. Note: there is no external light indicating power is on. Power on can be verified by:
    - the mobile app, and/or
    - visually seeing the integrated switch is in the “on” position, and/or
    - seeing the Bluetooth connection on a phone or computer (see section 2.7)

5.2 Mount to Flat Surface

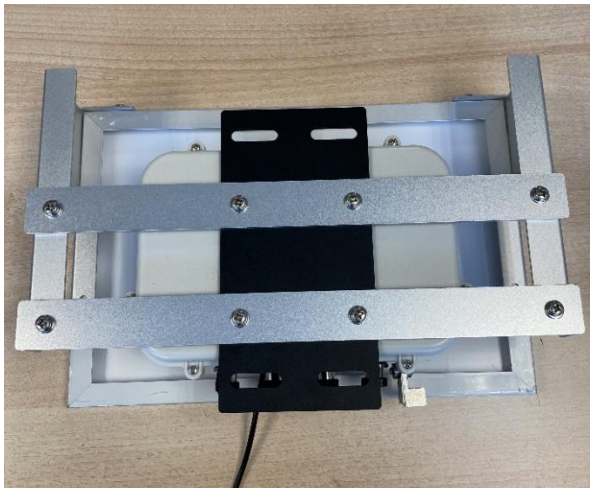
- Attach Flat Mounting Plate to the back of the steelhead
- Orient the longer side up so the sliding mounting holes are not obstructed

Important! Make sure the Steelhead internal power has been turned on before this step as the access panel cannot be reached after installing the mounting plate

5.3 Mounting Steelhead to Solar Panel

- Attach the Steelhead and Flat Mounting Plate to the inside of the solar panel chassis
- Orient the longer side of the Flat Mounting Plate up so the sliding mounting holes are not obstructed

Important! Make sure the Steelhead internal power has been turned on before this step as the access panel cannot be reached after installing the mounting plate



- Angle of the solar panel can be adjusted

5.4 Mount to Round Pole / Pipe

- Can be mounted with or without the solar panel
- Attach using the Pipe Brackets and U-mounting brackets
- Use a pole 1.5 - 2” in diameter

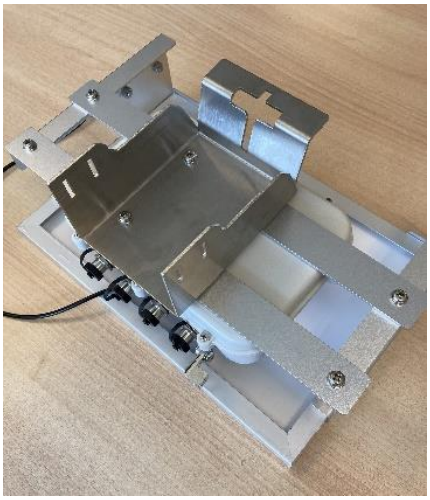
Important! Make sure the Steelhead internal power has been turned on before this step as the access panel cannot be reached after installing the mounting bracket

Helpful Hints: Extend the solar panel to the highest angle before mounting to allow easier access to hardware

5.5 Mount to T-Post

- Attach the Steelhead to the T-Post mounting bracket (PN: 80065-314) (ordered separately)
- Can be mounted with or without the solar panel

Important! Make sure the Steelhead internal power has been turned on before this step as the access panel cannot be reached after installing the mounting bracket



5.6 Make Connections

- Connect Earth Ground to the Steelhead grounding lug (optional but highly recommended – see Section 3.2 Lightning, ESD Protection, Grounding)
- Wire sensors to the M12 connector and connect M12 to the Steelhead.
- Wire power cable to the M12 connector and connect M12 to Steelhead Power Input if using solar panel or DC power

Helpful Hints: When tightening M12 connections, make sure to tighten only the metal ring and not loosen the plastic connector cover

6. Steelhead Configuration Overview

All configuration (logging and reporting intervals, sensor measurements, events, and more) is done online using the Steelhead configuration features of Stevens-Connect.com or using the Steelhead mobile app via Bluetooth wireless connection to the Steelhead. After any configuration changes are saved on Stevens-Connect.com, the Steelhead will automatically update upon the next scheduled transmission or on start-up. If changes are made directly to the Steelhead via the mobile app, Stevens-Connect will be updated on the next reporting interval. The most recent change is what is saved in the Steelhead and Stevens-Connect.

Each time the Steelhead is powered on (and each time it performs a scheduled transmission) the Steelhead compares its internal configuration to the one online. Any updates to the online configuration that has been saved under the Stevens-Connect website will be automatically updated on the Steelhead. The user does not need to be logged into Stevens-Connect for the Steelhead to retrieve this configuration file.

Logging interval defines the scheduled measurement time interval from connected sensors. It is user configurable between 1 minute to once every 24 hours for all sensors connected. Individual sensors cannot be logged at different intervals. Data is stored on the Steelhead's internal non-volatile flash memory. Data can be downloaded directly using the Stevens Steelhead mobile app

Reporting interval defines how often the Steelhead will transmit and report sensor data, diagnostics, and system status. The reporting interval is a selectable time between every 5 minutes to once every 24 hours. Reporting time begins at the top of the hour from midnight.

Logging and reporting intervals are independent. That is, the reporting time will not interfere with the logging time, although if logging occurs at the same time as reporting, such logged measurements will be reported at the next reporting interval.

At each reporting interval, the Steelhead first checks for configuration changes remotely made by the authorized user and then:

- Syncs Steelhead time with server time
- Checks for over-the-air (OTA) firmware updates (see section 11.10)
- Reports data to server
- Sends at each reporting interval (not logging interval) the following diagnostic data to server. These are not separate parameters for the Steelhead.
  - Battery percentage and voltage
  - Modem RSSI
  - Internal temperature
  - Internal humidity
  - Internal barometric pressure (this will be a separate parameter if the user wants this reported as a measurement - See section 4.4 on barometric pressure sensor)
  - Advanced diagnostic parameters (see Appendix B)

If the cell network or server is busy, the Steelhead will attempt connection three (3) times before going back to sleep. The data will be buffered and sent on the next successful connection to the cell network / server. Data will continue to buffer if connection is unsuccessful and will not be lost even after repeated failed connections.

If Stevens-Connect is not being used for data management, Steelhead configuration can be done with the mobile app. See section 7 for more information.

7. Configuration via Steelhead Mobile App

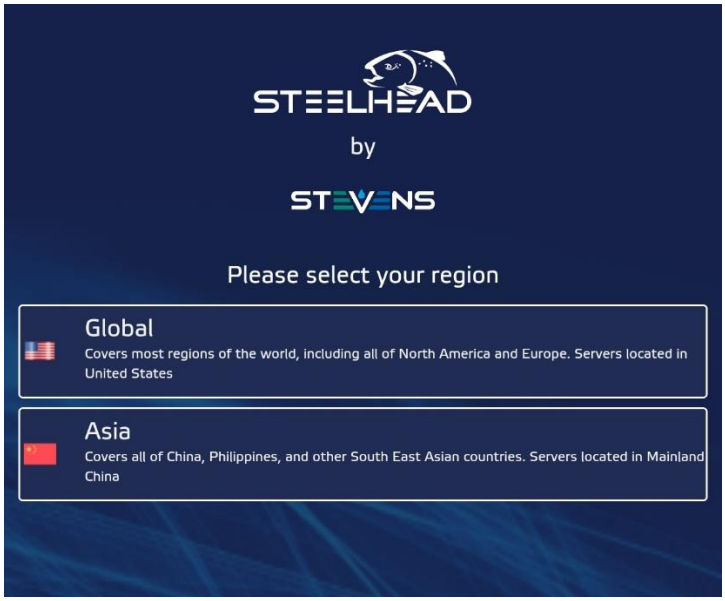
The mobile app can be used to configure the Steelhead, set up and modify sensors, download data, get current readings, use SDI-12 transparent mode, and much more.

7.1 Download the app

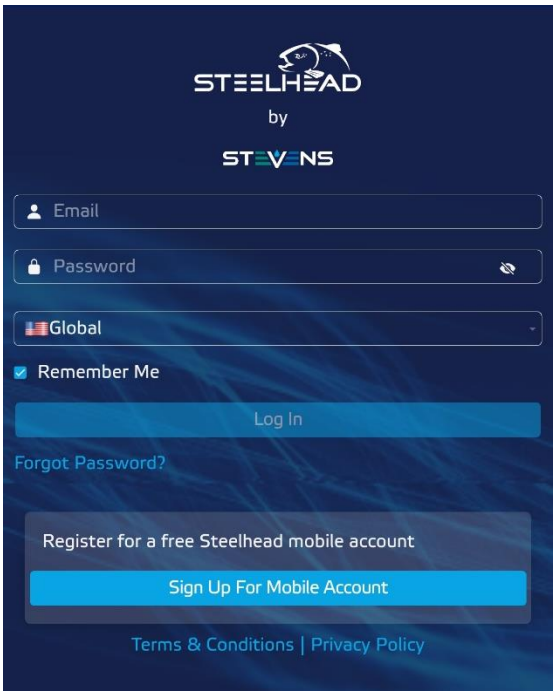
The mobile app can be found in the Google Play Store or Apple App Store by searching for “Steelhead”. You can also place a device capable of reading NFC tags near the NFC icon on the Steelhead. This will take you to the appropriate app store for your device to download the app or open the app if it is already downloaded.

7.2 Log in or register for a new account

When you first open the app, you will be prompted to enter your geographical region. “Global” is the default and is the right option for most users. If you are in Asia and using Stevens-Connect.cn, select “Asia” instead.

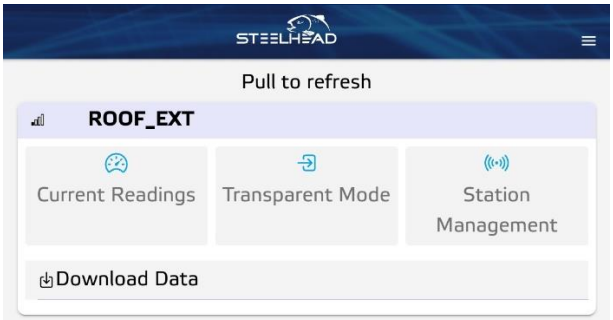


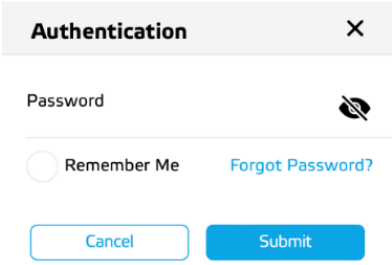
If you have a Stevens-Connect paid subscription, log in with your email address and password. If you don’t plan to use Stevens-Connect, register for a free Steelhead account. (Note: if a free account is used to set up the Steelhead, it will not be able to report to Stevens-Connect)



7.3 Find and connect to your Steelhead

- Tap on the device name (default is the SUI) to go to a station summary or select a specific action
- The password will be the individual Bluetooth (BLE) password for the Steelhead. The default password is “password”
- The password can be changed under Station Management -> Advanced -> Steelhead Password
- If you forget the password, a temporary one will be sent to the registered email account.



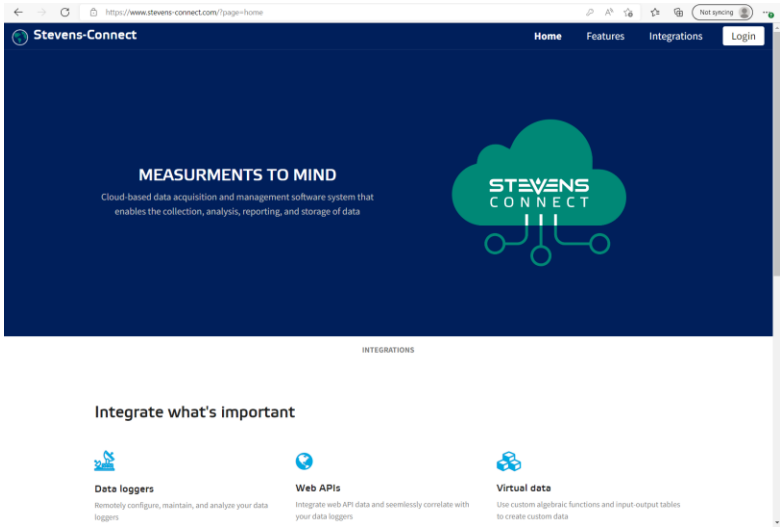


8. Configuration via Stevens-Connect

Stevens-Connect, www.stevens-connect.com or www.stevens-connect.cn (if using the China server), can be used to set up your Steelhead. Note that Stevens-Connect is advancing with new features and functionality all the time. Accordingly, screen shots presented in this manual may have changed.

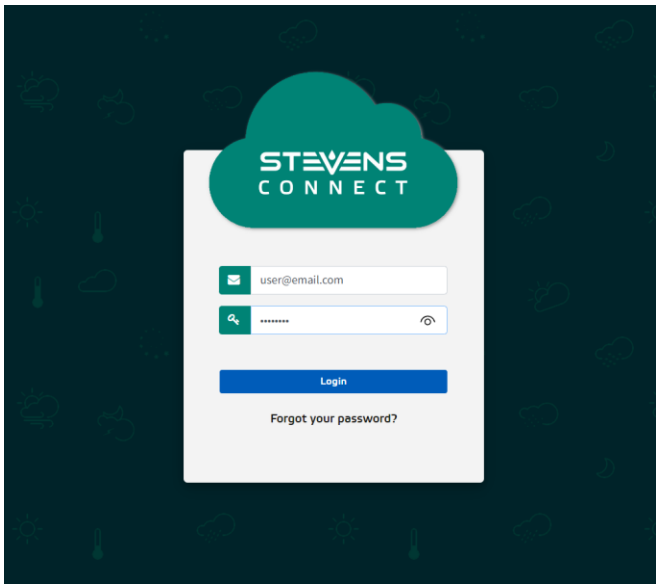
This manual is designed for the interaction between Steelhead and Stevens-Connect. Stevens-Connect is an advanced Software as a Service (SaaS) data management and analytic platform with several standard and unique features. Not all Stevens-Connect features are presented in this Steelhead manual. Please see https://stevenswater.com/products/stevens-connect/ for more information on Stevens-Connect.

The Steelhead does not need to be turned on to make changes to the configuration using Stevens-Connect. The configuration will automatically be downloaded to the Steelhead once the Steelhead is powered-on and connects to the server.



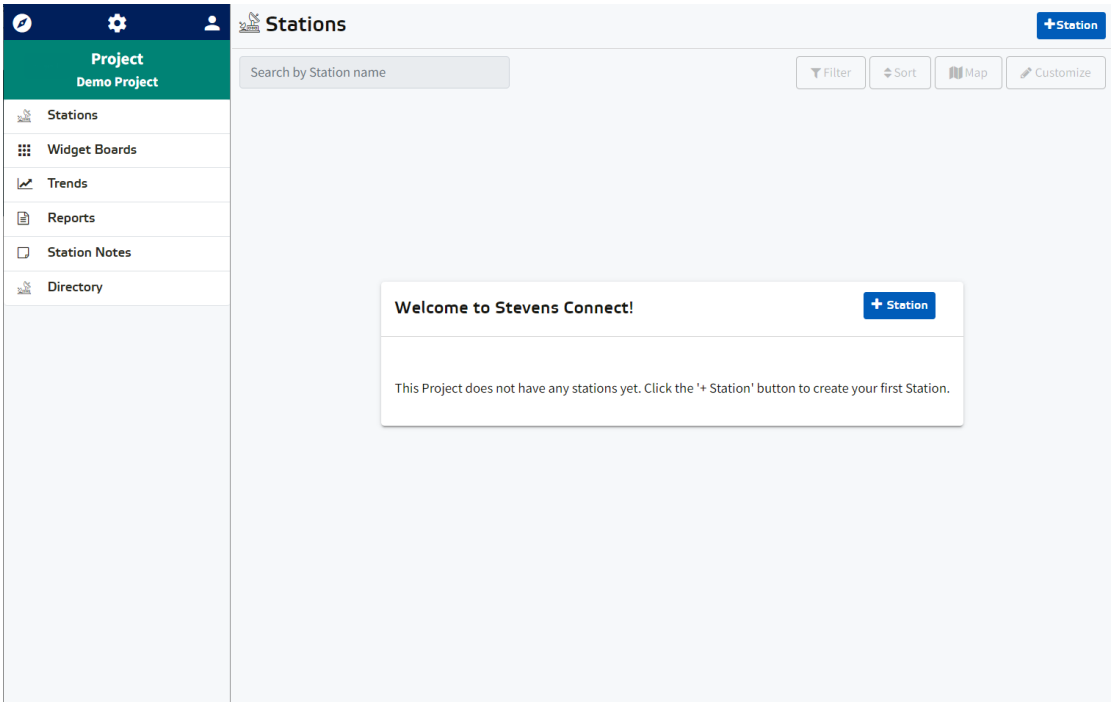
8.1 Log in to Stevens-Connect.com/Stevens-Connect.cn

Log in using your custom login information (email address and password) received from Stevens or Stevens' distributor. Contact Stevens directly if you need this information to be resent. Select "Login".

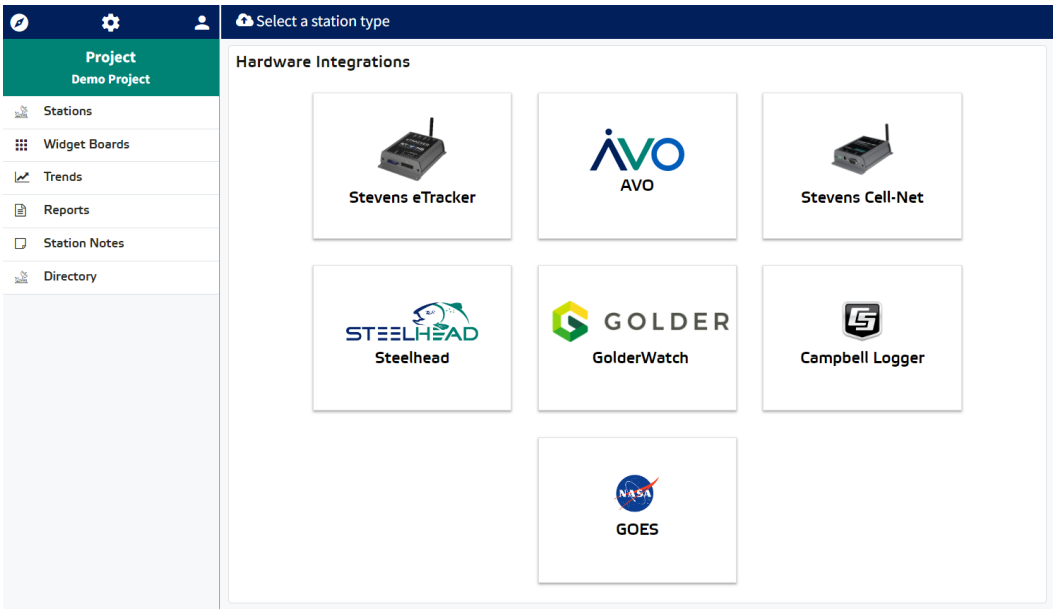


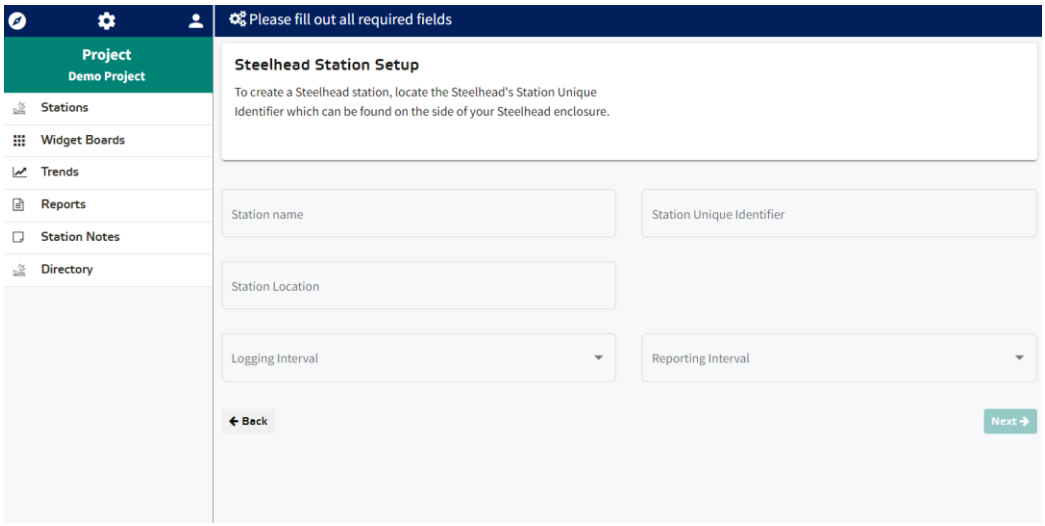
8.2 Setting up a New Station

Select “+ Station” in the upper right corner to get started.



After selecting “+ Station”, choose Steelhead





Fill in the information on this Station page:

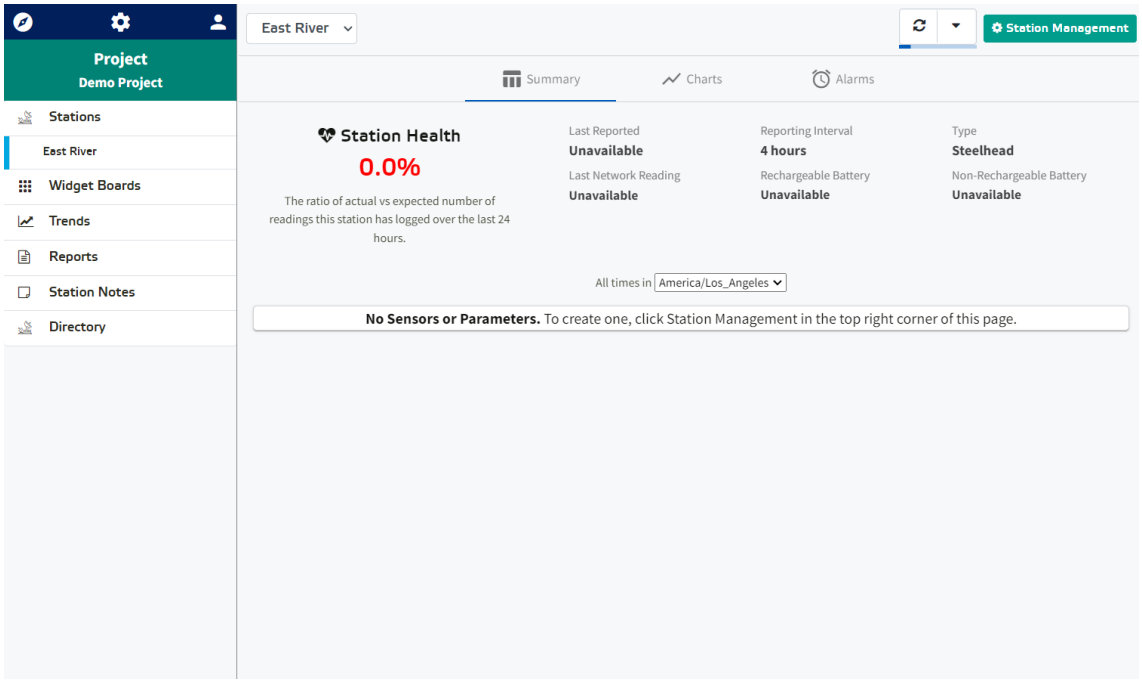
Station Name can be any descriptive identifier you choose for that station. It can be up to 64 characters, although no more than 20 characters is recommended because this name is used in reporting information from this station in charts, graphs, and tables. The Station Name is saved on the Steelhead and is also the Bluetooth advertising name.

Station Unique Identifier (SUI) is located on the label of your Steelhead unit. **It is a required field because it establishes the link between Steelhead and Stevens-Connect.** The data passed to and from the Steelhead over the cellular network is dependent upon this SUI. The SUI is not changeable and will be used for online configuration using the Stevens-Connect for each Steelhead. You can have multiple Steelheads under the same project, but each Steelhead has its own SUI number. The SUI can also be found by reading the NFC tag if the label has been removed or is unreadable (see section 11.9)

Station Location can be any descriptive identifier you choose to assign to the GPS coordinates Latitude and Longitude. This name is not required. This location name is for reference and currently only used on the Stevens-Connect Info page.

Logging Interval defines how often the Steelhead will log sensor data. **This interval applies to all connected sensors**. The logging interval is a pull-down selectable time between every 1 minutes to once every 24 hours. NOTE: the Steelhead is not designed for high frequency logging (faster than 1-minute intervals). Also, confirm with the sensor(s) manual that the logging interval is acceptable as some sensors have a warm-up time before data is ready.

Reporting Interval defines how often the Steelhead will transmit and report sensor data, diagnostics, and system status. The reporting interval is a pull-down selectable time between every 5 minutes to once every 24 hours. Reporting time begins at the top of the hour from midnight. The Logging Interval should be at least as often as the station's Reporting Interval. For example, if the Reporting Interval is every hour, the logging interval should be equal to or more frequent than one hour.



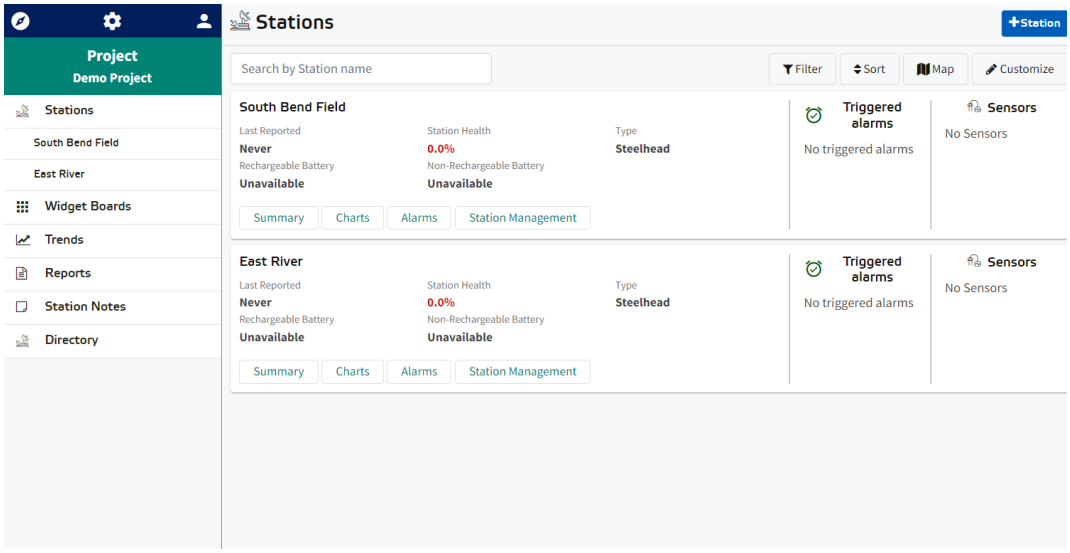
After the initial **Setting up a New Station** is completed, the Steelhead will save the station information in its non-volatile memory when it is powered and begins communication to the server over the cellular network.

8.3 Setting up Sensor Configurations

Now you are ready to connect your sensors to the Steelhead. (See Section 3 Physical Wire Connections for wiring instructions).

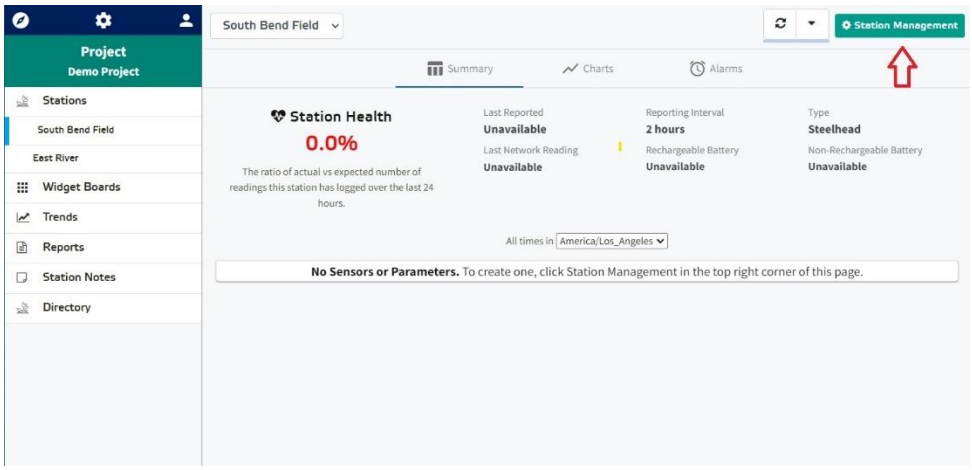
> **Note:** The sensors do not need to be physically connected to the Steelhead at the time of the station and sensor configuration.

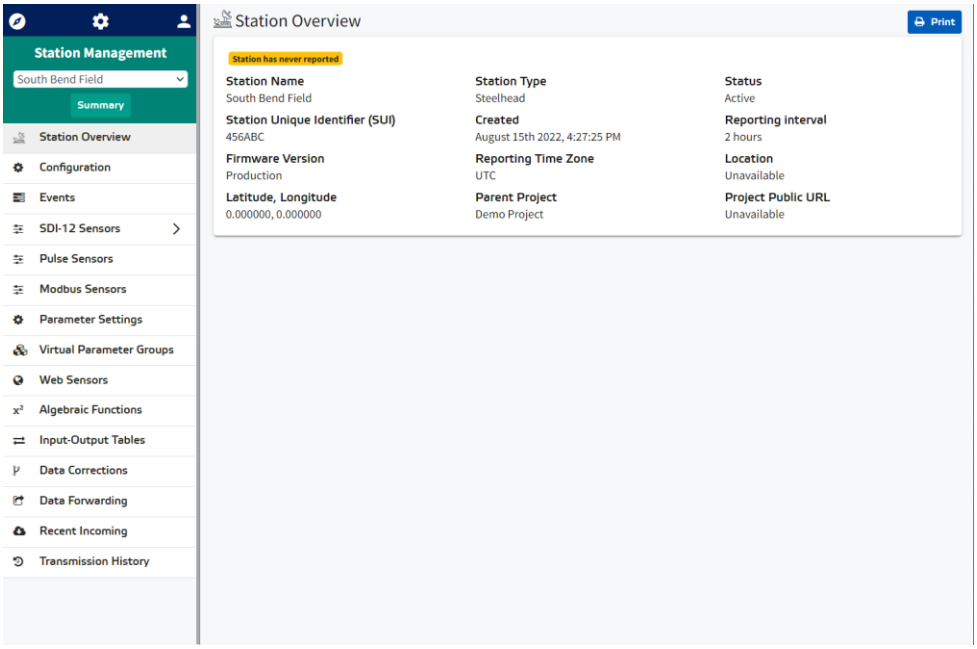
Log into Steven-Connect (See beginning of this Section 8.1). After logging on you will see the project information page with all stations in the project



From this screen you can select Summary for a particular station to view the dashboard or directly go to Station Management to add sensors.

To get to Station Management from the Summary page, select “Station Management” in the top right corner.





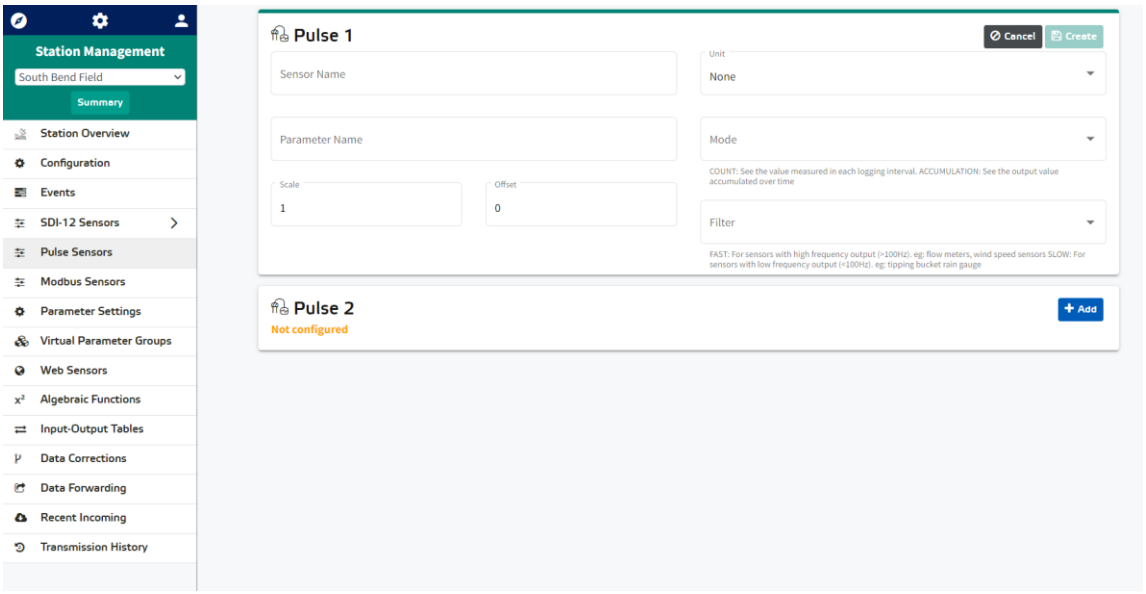
The left-hand menu has options for each sensor protocol as well as other Stevens-Connect features. Advanced Stevens-Connect features are described in Appendix A.

8.2A Analog Sensors

The Steelhead currently does not directly interface with analog sensors. Stevens can provide / recommend analog converters or other solutions to fit your needs. Please contact Stevens for options if you have an existing analog sensor.

8.2B Pulse Sensors

Select **Pulse Sensors** to configure up to two (2) pulse sensors. Pulse sensors need to be connected to the "SDI-12 / Pulse 1,2" port on the Steelhead. Two (2) pulse sensors inputs can be configured with Steelhead. A splitter (see section 2.3) will need to be purchased if two or more sensors are using the same port.



Sensor Name will be the reference for all measurements reported by that sensor. The sensor name can be alpha / numeric. An example of a sensor name could be the manufacturer model number or type like a Rain Gage. The maximum number of characters for the sensor name is 100, however, no more than 20 characters is recommended because this name is used in reporting the sensor's data in tables, graphs, charts, and other visual insights.

Parameter Name is the measurement parameter of that sensor. For example, if you are setting up a Met One Tipping Bucket, the parameter would be denoted as "Rain Fall".

Unit, if applicable, is the sensors output units of measure. If not applicable, say "None". For example, tipping buckets would use depth units such as "in" for inches or "mm" for millimeters. This is for displaying units of measure terminology on charts and graphs. There is no mathematical adjustment to the sensor value in selecting the units of measurement. If a desired unit is not listed, contact Stevens to get it added.

Mode determines how the pulse sensor measurements can be logged. Measurements can be logged as **Count** or **Accumulation**. Count is the number of pulses received during the logging interval. Accumulation is the number of pulses received over time. The accumulation value will continue to increase unless the start value is reset.

Count example: for a 10 Hz maximum pulse sensor, the maximum count is 10 times per second. If the logging interval is 15 minutes, the count value over that logging interval would be a maximum of 9,000 counts [10 counts per second maximum x 60 seconds x 15 minutes].

If the pulse sensor can output two measurements (like some rain gauges), the Steelhead assumes two pulse channels and each one would need to be configured as a separate pulse sensor.

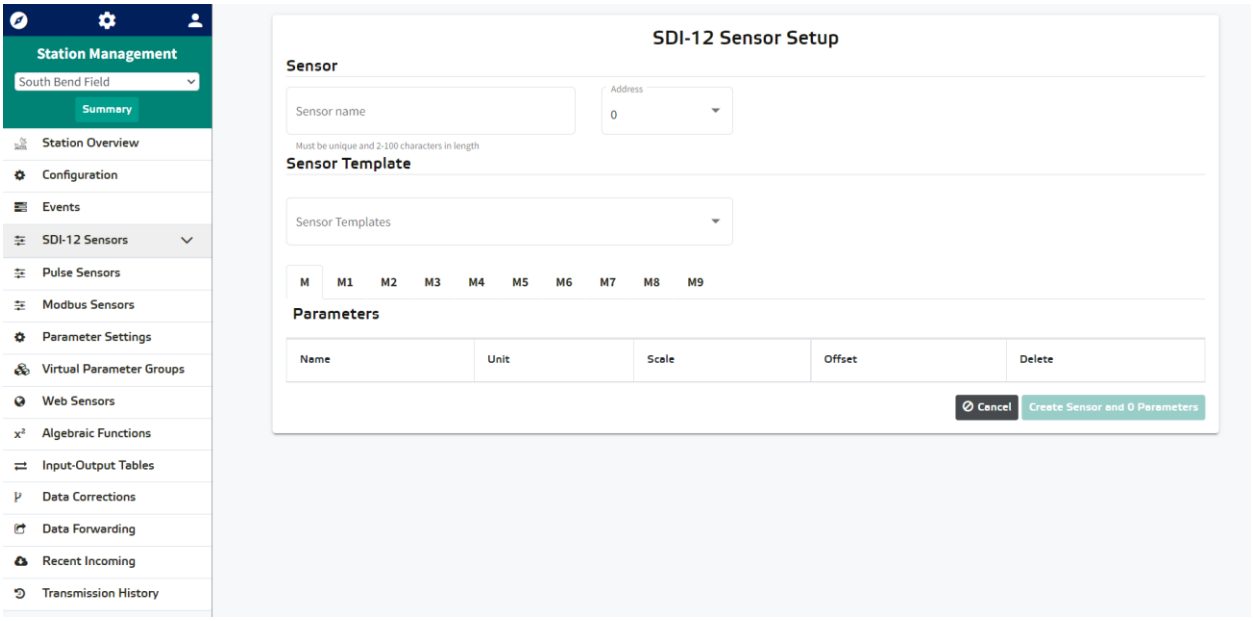
Filter is determined by the sensor frequency output. **Fast** is for sensors with high frequency outputs (>100Hz). E.g. Flow meters, wind speed sensors. **Slow** is for sensors with low frequency

outputs (<100Hz). E.g. Tipping bucket rain gage. If set to slow, the Steelhead will filter out debounce noise (false triggers) from mechanical switch sensors.

Scale is a multiple or a fraction of the sensors measurement to be logged and reported. This multiplication function is performed on the logging interval's Count value and the resulting calculated value is what is logged or added to the previous Accumulated value before logging.

Offset is an addition or subtraction of the sensors measurement to be logged and reported. This addition / subtraction function is performed on the logging interval's Count value and the resulting calculated value is what is logged or added to the previous Accumulated value before logging.

8.3C SDI-12 Sensors



Select **SDI-12 Sensors**. On this page you can view all configured SDI-12 sensors. Select "**+ Sensor**" to add a new SDI-12 sensor.

To modify an existing sensor, select it the left-hand drop-down menu and select "**Edit**".

The Steelhead allows up to 30 parameters (including Pulse, Modbus, and Internal Barometer sensors). Selecting the number of sensors may be limited to the number of parameter measurements from each sensor. For example, the Stevens HydraProbe soil sensor has 22 parameter measurement options. Most application use four (4) of these parameters from one HydraProbe sensor. In this example, the maximum number of HydraProbes connected to one Steelhead would be seven (7) [30 parameters divided by 4 parameters per HydraProbe]. Any SDI-12 Steelhead input port can be used. You may require a splitter for multiple SDI-12 sensors.

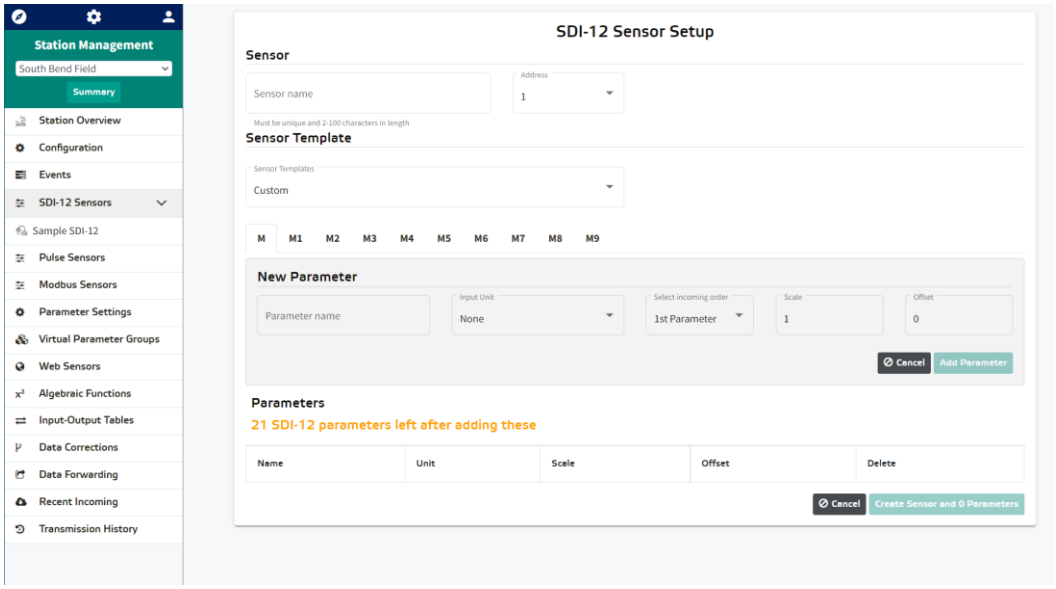
Sensor Name will be the reference for all measurements reported by that sensor. The sensor name can be alpha / numeric. An example of a sensor name could be the manufacturer model number or type like Stevens HydraProbe. The maximum number of characters for the sensor name is 100, however, no more than 20 characters is recommended because this name is used

in reporting the sensor's data in tables, graphs, charts, and other visual insights.

Address is the selectable SDI-12 address (alpha/numeric characters). The SDI-12 sensor address needs to be pre-programmed on the sensor. Each SDI-12 sensor connected to the Steelhead needs to have a separate address. See the SDI-12 sensor manual for instructions on changing the address and other SDI-12 commands.

The Steelhead mobile app has an **SDI-12 Transparent Mode** (see section 7) to discover and set the SDI-12 address per the SDI-12 manual's instructions.

Sensor Template provides several pre-configured templates for Stevens sensors. If you are connecting a sensor not listed, select "**Custom**" to input each parameter individually.



SDI-12 Parameters. Each SDI-12 parameter that will be logged needs to be configured. The Steelhead allows up to 30 parameters total between all sensors.

M Command can be selected with labeled tabs. Multiple parameters can be added under each M command.

Parameter Name will the reference for each SDI-12 sensor's parameter measurement that is to be report for that sensor. The parameter name can be alpha / numeric. The maximum number of characters in the sensor name is 100, however, no more than 20 characters is recommended because this name is used in reporting the sensor's data in tables, graphs, charts, and other visual insights.

Input Unit, if applicable, is the sensors output unit of measure. If not applicable, say "None". This is for displaying such units of measure terminology on charts and graphs. There is no mathematical adjustment to the sensor values in selecting the units of measurement. If a desired unit is not listed, contact Stevens to get it added.

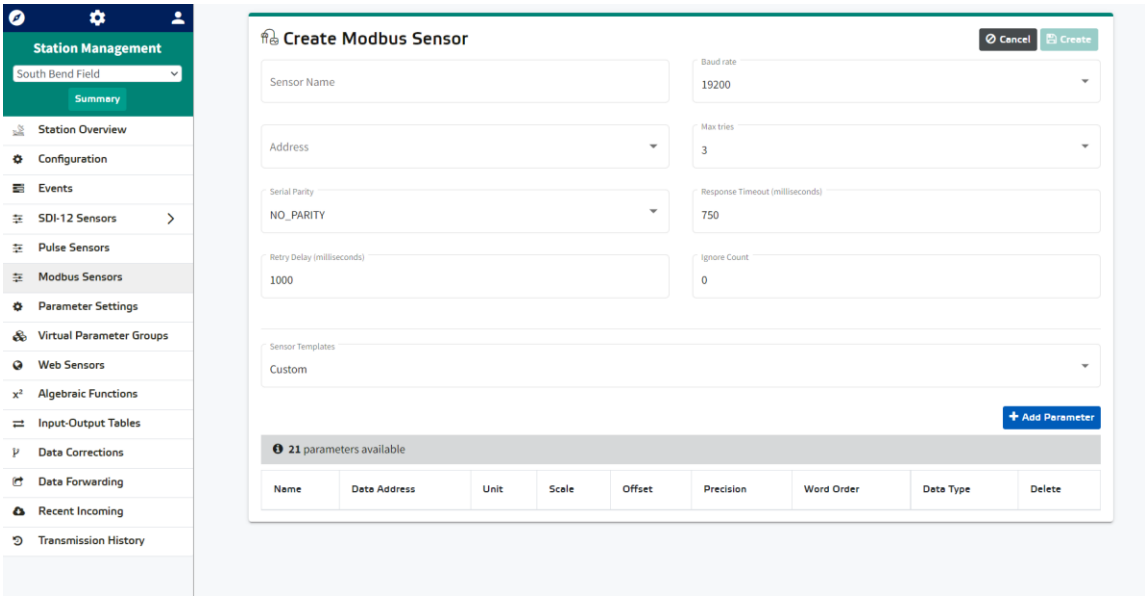
Incoming Order is the position of the desired parameter for the selected M command.

Most SDI-12 sensors output multiple parameters for each M command, and they are in a designated order. Refer to the specific SDI-12 sensor manual for information on specific M command parameter order.

Scale is a multiple or a fraction of the sensors measurement to be logged and reported. The resulting calculated value is what is logged. Enter '1' if no scale calculation is to be performed which multiplies the sensor measurement by 1.

Offset is an addition or subtraction of the sensors measurement to be logged and reported. The resulting calculated value is what is logged.

8.3D Modbus Input



Select **Modbus Sensors**. On this page you can view all configured Modbus sensors. Select "**+ Add**" to add a new Modbus sensor. Make sure to select "**Create**" in the top right corner after inputting all the sensor information to save.

To modify an existing sensor, select it the left-hand drop-down menu and select "**Edit**".

The Steelhead allows up to 30 parameters (including Pulse, Modbus, and Internal Barometer sensors). Selecting the number of sensors may be limited to the number of parameter measurements from each sensor. For example, the Stevens HydraProbe soil sensor has 22 parameter measurement options. Most application use four (4) of these parameters from one HydraProbe sensor. In this example, the maximum number of HydraProbes connected to one Steelhead would be seven (7) [30 parameters divided by 4 parameters per HydraProbe].

Sensor Name will be the reference for all measurements reported by that sensor. The sensor name can be alpha / numeric. An example of a sensor name could be the manufacturer model number or type like Stevens Smart PT. The maximum number of characters for the sensor name is 100, however, no more than 20 characters is recommended because this name is used in

reporting the sensor's data in tables, graphs, charts, and other visual insights.

Address is the selectable Modbus address (numeric characters). The Modbus sensor address needs to be pre-programmed on the sensor. Each Modbus sensor connected to the Steelhead needs to have a separate address. See the Modbus sensor manual for instructions on changing the address and other Modbus commands.

Baud rate is the rate at which information is transferred in a communication channel. Typical Modbus baud rates are 9600 or 19200. See the Modbus sensor manual for the baud rate value.

Max tries is the number of times the Steelhead attempts communication with the Modbus sensor if the sensor fails to respond to a command.

Serial Parity is used in serial communication to verify the data being transmitted is correctly received. See the Modbus sensor manual for the parity used in the sensor.

Response Timeout is the amount of time in milliseconds the Steelhead waits for a response from the Modbus sensor.

Retry Delay is the amount of time in milliseconds the Steelhead waits after a failed communication attempt before it transmits data to the sensor again.

Ignore Count is the number of readings from the sensor that will be discarded before the reading is stored. Example: if ignore count is set to 2, the Steelhead will request readings from the sensor two times before storing the third response as the result.

Sensor Template provides several pre-configured templates for Stevens sensors. If you are connecting a sensor not listed, select "**Custom**" to input each parameter individually.

Modbus Parameter. Each Modbus parameter that will be logged needs to be configured. The Steelhead allows up to 30 parameters total between all sensors.

> **Parameter Name** will the reference for each Modbus sensor's parameter measurement that is to be reported for that sensor. The parameter name can be alpha / numeric. The maximum number of characters in the sensor name is 100, however, no more than 20 characters is recommended because this name is used in reporting the sensor's data in tables, graphs, charts, and other visual insights.
>
> **Data Address** is the register address for the desired parameter.
>
> **Unit**, if applicable, is the sensor's output unit of measure. If not applicable, say "None". This is for displaying such units of measure terminology on charts and graphs. There is no mathematical adjustment to the sensor values in selecting the units of measurement. If a desired unit is not listed, contact Stevens to get it added.
>
> **Scale** is a multiple or a fraction of the sensors measurement to be logged and reported. The resulting calculated value is what is logged. Enter '1' if no scale calculation is to be performed which multiplies the sensor measurement by 1.

Offset is an addition or subtraction of the sensors measurement to be logged and reported. The resulting calculated value is what is logged.

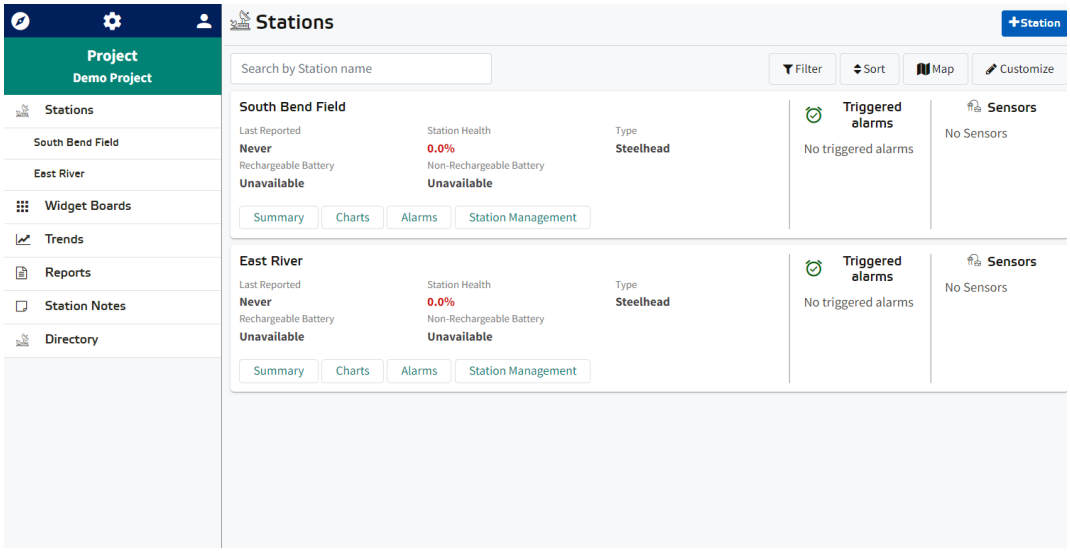
Precision is how many digits after the decimal point should be displayed.

Word Order is the order of the individual bytes. There is no defined word order in the Modbus specification. See the Modbus sensor manual for the word order used in the sensor.

Data Type is how the information is defined. Possible options are BIT, INT16, UINT16, FLOAT32, INT32 and UINT32. See the Modbus sensor manual for the data type used in the sensor.

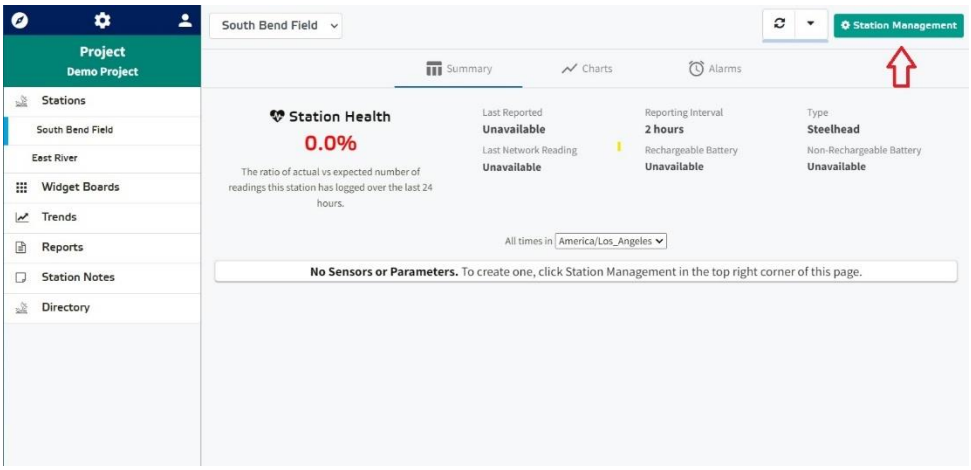
8.4 Station Configuration

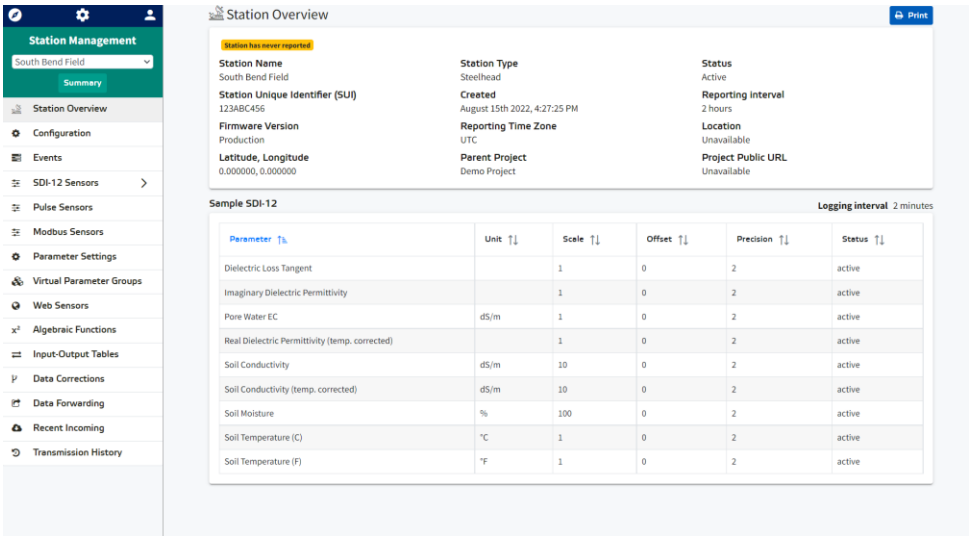
Log into Steven-Connect (see beginning of this Section 8.1). After logging on you will see the project information page with all stations in the project



From this screen you can select Summary for a particular station to view the dashboard or directly go to Station Management to view and modify sensors, change station configuration, and other advanced features.

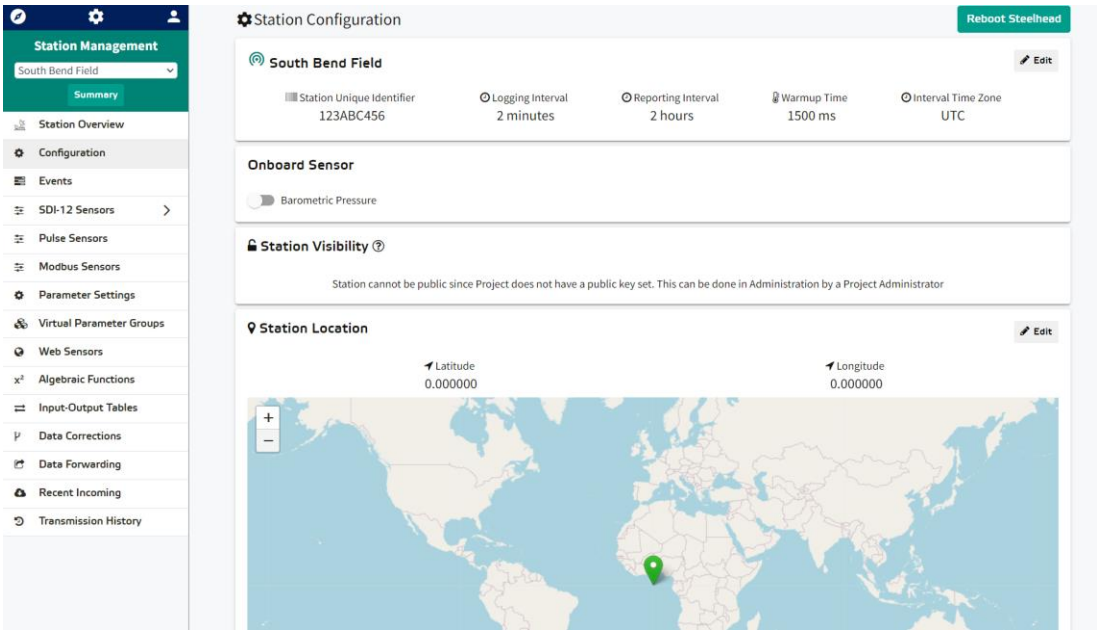
To get to Station Management from the Summary page, select “Station Management” in the top right corner.





The left-hand menu has station configuration options as well as other Stevens-Connect features. Advanced Stevens-Connect features are described in Appendix A.

Select **"Configuration"** to view the Steelhead configuration information, enable the onboard barometric sensor, power cycle the Steelhead, see station location, and reset the BLE password.



Select "**Edit**" to make Steelhead configuration changes. Before you leave the Configuration section, make sure to select "**Save**" to ensure all changes have been saved to Stevens-Connect. When the Steelhead reports next, it will check for configuration changes and save them to the memory

Reboot Steelhead is provided to power cycle the Steelhead. When the Steelhead reports next it will receive the command and cycle power. This feature allows the user to remotely fix errors that can be corrected with a restart.

9. Events / Alarm Configurations

Events / Alarms allow for automatic action and immediate alerts when readings reach user defined values. Events are handled by the Steelhead and Alarms are handled by Stevens-Connect.

Events are automatic actions programmed in the Steelhead that will trigger when user defined measurement conditions are detected.

Alarms provide notification via email and/or text (SMS). Alarms can be created to alert when parameters go out of range, when battery levels are low, and/or when the Steelhead fails to communicate.

9.1 Events

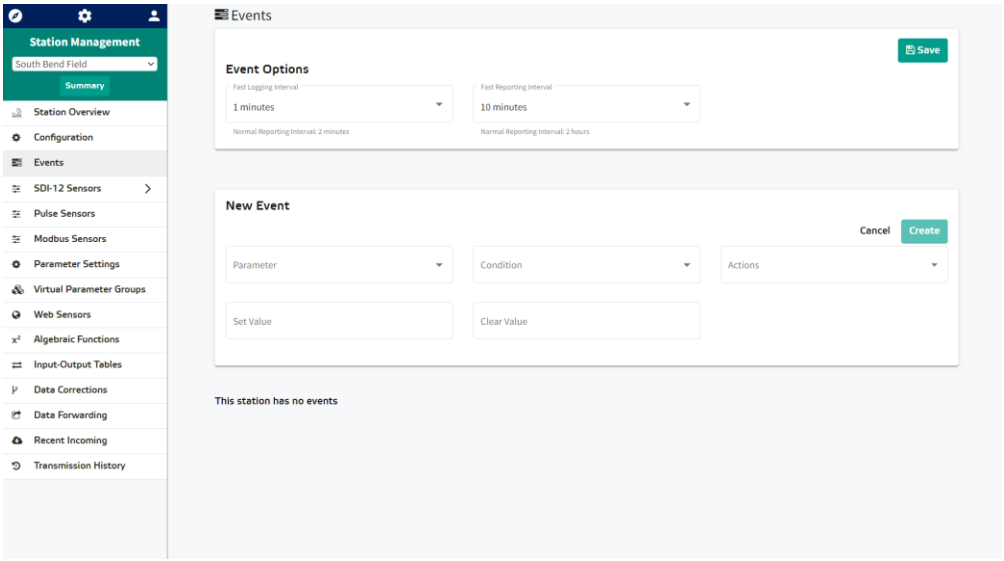
The Steelhead allows up to 5 (five) events to be triggered on sensor parameters to enable quick notification and response (that is immediate reporting or logging outside the scheduled intervals). You can select the desired parameter(s) and the condition the event should be triggered on and then the desired action to be taken: report now, start faster reporting, and/or log faster. You can also include a clear value to stop the event(s). When an event happens, the measurement will first be saved and then the user programmed action(s) will be performed.

Condition	**Greater than or equal to Set Value**	When the Set Value meets the condition, the event will start
	Greater than Set Value	
	Less than or equal to Set Value	
	Less than Set Value	
Actions	**Report Fast**	Start reporting at a higher time interval. Time interval can be adjusted
	Report Now	Report to the server immediately upon condition being met. Will report on each logging interval if condition is met.
	Log Fast	Start logging at a higher interval. Time interval can be adjusted
Set Value		Numeric value to start the event
Clear Value		Numeric value to end the event

Table 9.1 Steelhead event parameters

Event example: A user sets an event for water level on their Stevens Smart PT sensor that will be triggered when the value is less than or equal to 1 meter and to clear when the value is 1.5 meters. They would like to gather more data while in this event condition, so they set the actions to both report faster and log faster with the fast logging interval at 5 minutes and fast reporting interval at 10 minutes. Now when the water level is at 1 meter or falls below, the event is triggered and will continue the faster logging and reporting until the water level rises to 1.5 meters. At this point, the Steelhead will return to the previous logging and reporting intervals.

9.2 Configuring Events



Events can be found under Station Management in the left menu. The event Logging and Reporting Intervals can be edited here. Only values less than the normal logging and reporting intervals can be selected.

Parameter is a drop-down menu listing all parameters set up on the Steelhead.

Condition is a drop-down menu with four (4) options: Greater than or equal to Set Value, Greater than Set Value, Less than or equal to Set Value, and Less than Set Value. When the Set Value meets the condition, the event will start

Actions is a drop-down menu with three (3) options: Report Fast, Report Now, Log Fast. You may select multiple options. When the event starts, the action(s) will be performed.

Set Value Numeric value to start the event

Clear Value Numeric value to stop the event

9.3 Alarms

Alarms allow users to be alerted with an email or text (SMS) message when user defined conditions are met. Stevens-Connect has two categories for alarms: Station Communication and Parameter.

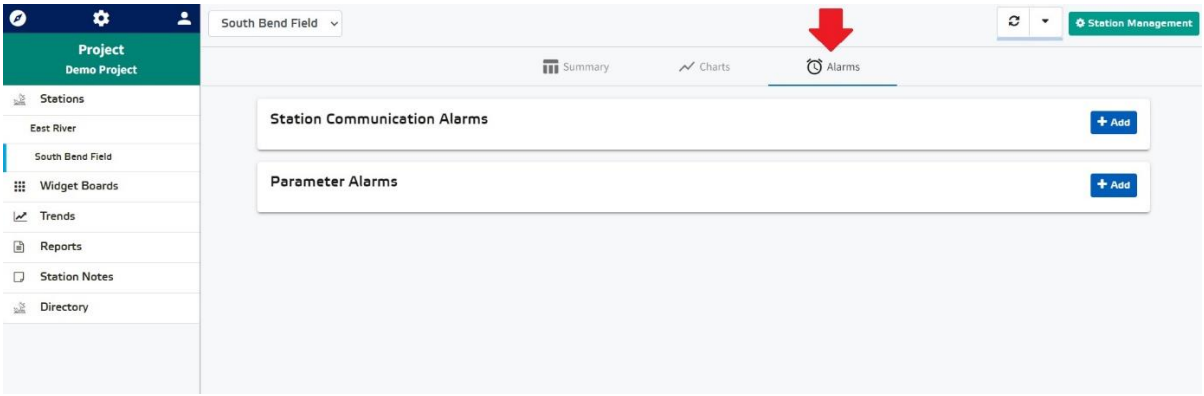
- Station Communication alarms can be set to notify users a Steelhead has not communicated to the server in a set number of hours.
- Parameter alarms are similar to Steelhead events as they are triggered on sensor and/or Steelhead parameters. There are three types of parameter alarms: value triggered, rate of change triggered, and totalization triggered. Parameter alarms are triggered on reporting intervals when the Steelhead communicates with the server.

When value triggered or rate of change alarms are cleared, an additional message will be sent to the user to indicate the end of the alarm condition. Totalization alarms only send a message when initially triggered.

Alarm example: A user has a Steelhead configured with a solar panel. They want to be alerted in case the solar panel gets obstructed or damaged. Normally the rechargeable battery percentage drops from 100 to 95% during the night and gets fully charged during the day. The user set a value triggered alarm on the Steelhead's internal rechargeable battery to trigger when the battery is less than or equal to 80. The user configures the alarm to send an email to both them and the technician to alert them both to a possible solar panel obstruction ensuring they are able to resolve the issue quickly.

Alarms are a Stevens-Connect feature and if Stevens-Connect is not used for data management, alarm conditions will not be possible. The user will need to reference the alarm features of the other data management programs used.

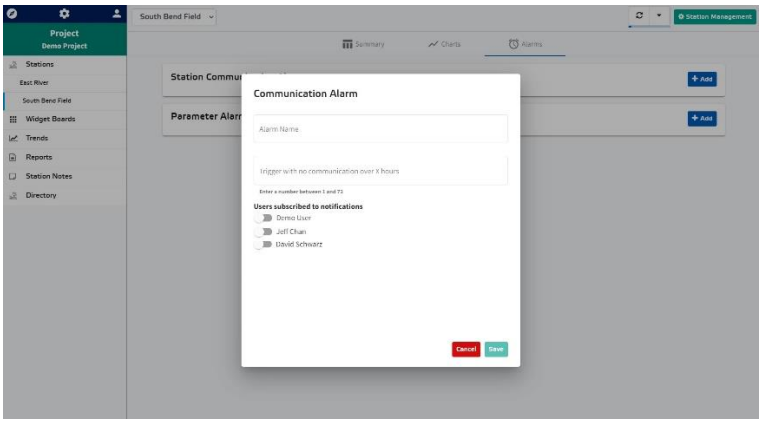
9.4 Configuring Alarms



Alarms can be found on the station dashboard. Select "**+ Add**" to add an alarm.

Station Communication Alarms

Used to notify users a Steelhead has not communicated to the server in a set number of hours.



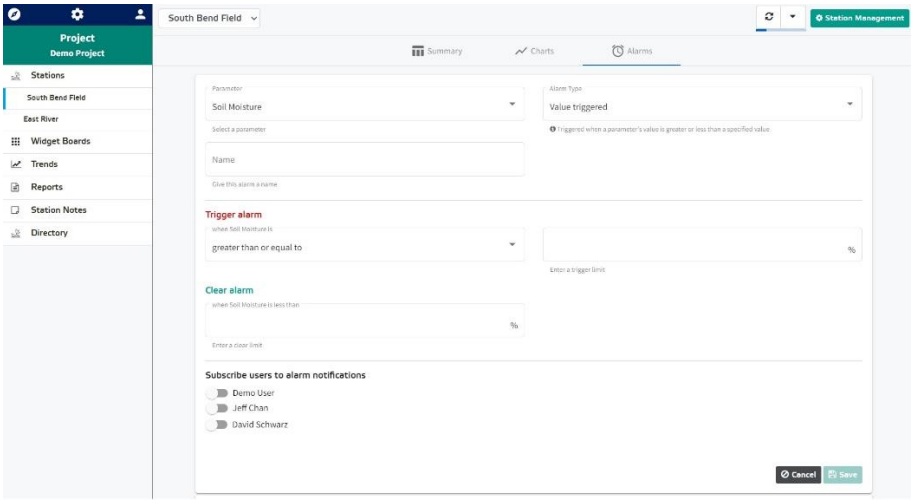
Alarm Name will be the reference for the alarm. The alarm name can be alpha / numeric. It will be used in email or text (SMS) messages to indicate which alarm has been triggered.

Trigger Value is the amount of time in hours with no communication from the Steelhead to Stevens-Connect before sending an alarm. It can be a number between 1 and 72.

Users Subscribed to Notifications is a list of all users that will receive a notification. One or more users can be selected.

Parameter Alarms

Used to notify users when a condition has been triggered on sensor(s) and/or Steelhead parameters.



Parameter is a drop-down selection menu of all parameters configured on the Steelhead. The selected alarm condition will be applied to values from this parameter.

Name will be the reference for the alarm. The alarm name can be alpha / numeric. It will be used in email or text (SMS) messages to indicate which alarm has been triggered.

Alert Type:

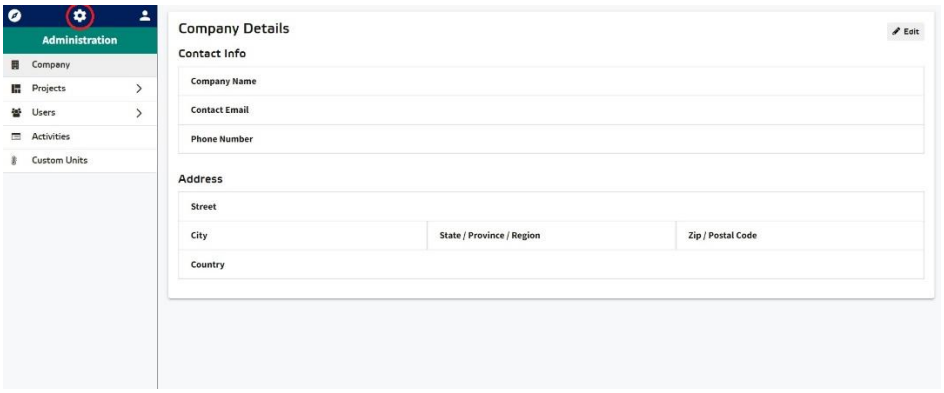
Value Triggered: Alarm is sent when sensor value or Steelhead parameter meets the trigger value condition. An alarm cleared message is sent when value is at or below Clear Value.

Rate of Change: Alarm is sent when sensor value or Steelhead parameter changes by a supplied value over a specified number of minutes. Alarm cleared message is sent when condition no longer applies.

Totalization Between Time Span Reaches Value: Alarm is sent when totalization of parameter or Steelhead parameter reaches the trigger limit over the number of hours specified.

Users Subscribed to Notifications is a list of all users that will receive a notification. One or more users can be selected.

Users need to have email and/or SMS turned on under user settings to receive alarm notifications. Users can modify notification settings under User Settings. New users can be added by a Project Administrator under the Administration tab indicated with a gear icon. User profiles can also be edited here and the method of contact can be selected or modified.



10. Troubleshooting and Frequently Asked Questions

10.1 General troubleshooting steps

- Ensure the battery power switch has been turned on. This needs to be done before mounting hardware is installed.
- Double check power via the
  - the mobile app, and/or
  - visually seeing the integrated switch is in the “on” position, and/or
  - seeing the Bluetooth connection on a phone or computer (see section 2.7)
- If the Steelhead has an external antenna, ensure the antenna is connected and fully tightened
- Ensure sensor connectors are fully tightened and on the right ports
- Check configuration on Stevens-Connect or the mobile app. Check
  - Sensor addresses are correct
  - Reporting and logging intervals
  - SUI number

10.2 Steelhead cannot access the cell network or Stevens-Connect

- The device may be out of cell network range
- RSSI may be week
- Check external antenna connection (if applicable)
- Check battery levels

10.3 What is RSSI and how do I interpret the number?

The RSSI (Received Signal Strength Indicator) is the received signal strength relative index between the cell modem and the cell tower. The measurement result for RSSI displays the radio signal level at the receiver in dBm. The RSSI is displayed as a number between -51 to -113 dBm (the negative numbers are typical levels in dBm at a receiver). The higher the RSSI value, the better the signal. When the RSSI drops below -85, other actions should be considered such as a higher gain antenna.

In general (depending on region and cell service provider), -1 to -64 is excellent, -65 to -74 is strong, -75 to -84 is good, -85 to -94 is weak, and -95 or less is poor.

To see additional detail about RSSI, refer to the following links:

http://www.metageek.com/training/resources/understanding-rssi.html
https://en.wikipedia.org/wiki/Received_signal_strength_indication

10.4 What do I do if there is poor coverage from the cell tower?

The RSSI will indicate the quality of the coverage. The Steelhead has an optional SMA connector, which allows adding a higher gain antenna. You may need an SMA to Type N Bulk head connector (Part Number 92824-002), an N to N cable (92845-010), and a higher gain and/or directional antenna. See part number list in section 2.3.

10.5 How do Over-the-Air (OTA) updates work?

The Steelhead will automatically receive firmware upgrades when connected to a cellular network ensuring the device is always up to date. OTA is independent of Stevens-Connect and the Steelhead will continue to receive the latest firmware regardless of Stevens-Connect subscription status.

10.6 What if the Steelhead works during the day but not at night?

If the Steelhead is operating on a solar powered system and external battery, the Steelhead may only be receiving power from the solar panel. Check the battery power system to ensure the solar panel is charging the external battery. Use a hand-held voltmeter to check the battery voltage going to the Steelhead as well. The battery voltage can also be verified from Stevens-Connect after a transmission.

10.7 What is NFC and how does it work?

Product information is stored on an NFC (Near Field Communication) tag inside the Steelhead. In case the Steelhead label has become damaged or you need to know the product information, you can use an NFC reader app to wirelessly access the information. Just position your NFC reading capable device near the NFC icon on the Steelhead. NFC reader apps can be downloaded from the Google Play store or Apple App store.

Information found on the NFC tag includes:

- SUI (station unique id)
- serial number
- communication and modem type
- input power
- enabled sensor protocols

10.8 Stevens-Connect Alarms don’t seem to be working

A user needs to have email and/or SMS turned on under user settings to receive alarm notifications.

10.9 What is the minimum voltage before the Steelhead will stop logging/reporting?

Part Number	Steelhead Version	Description
80065B-YYY-Z	Battery Only	28 Ah / 3.7V, non-rechargeable internal battery that will operate until the battery voltage is below 3V.

80065S-YYY-Z	Stevens solar panel direct connection to power input	Operation is on the internal rechargeable battery until battery voltage is below 3 V. In conditions of low solar energy during seasonal conditions or extreme cold (below -20 C), an additional integrated non-rechargeable battery (operates to -35C) inside the Steelhead is recommended. With two internal batteries, the Steelhead will automatically switch to the non-rechargeable battery when needed and then back to the rechargeable battery when not needed with a 0.4V hysteresis.
80065E-YYY-Z	External power supply	The Steelhead will automatically switch to the internal rechargeable battery power supply when external power drops below 6.7 V. If power is restored above 7V, the Steelhead will automatically switch back to the external power supply.

10.11 Why do the sensors stop working when it is wet?

Water intrusion in the sensor connectors can impact the sensor communication. If the Steelhead is exposed to the elements with the connector caps off, water can get in the connector which will cause communication failure. After the water has dried, the sensors will communicate as normal. If you are seeing sensor data issues during and immediately following rain events, verify the connector caps are on.

If you are still having trouble with your device, Stevens Technical Support can be reached via our website at https://www.stevenswater.com or via phone 503-445-8000 or 800-452-5272.

11. Warranty

Stevens Water Monitoring Systems, Inc. warrants that the product you have purchased will be free from defects in material and workmanship. This warranty covers all defects which you bring to the attention of Stevens within two years from the date of shipment. If your Stevens product is defective, Stevens will repair or replace it and will ship it back to you free of charge. You must return your Stevens product within two years of the ship date, shipping prepaid, to our factory at this address: Stevens Water Monitoring Systems, Inc. 12067 NE Glenn Widing Dr. #106, Portland, Oregon 97220 (800) 452-5272. In any correspondence with us, or if you send us part of the product but not all, please include both the model and the serial number of the product. Your rights and remedies are limited to those sent out in this warranty. Stevens Water Monitoring Systems, Inc. disclaims all implied warranties, including the warranties of merchantability and fitness for a particular purpose. This warranty does not cover damage due to improper installation or use, lightning, negligence, accident, unauthorized modifications, or incidental or consequential damages. Stevens shall not be liable for special, incidental, or consequential damage. In no event will Stevens' liability to you exceed the purchase price of your Stevens product. Before returning any unit, please obtain and complete a Returned Materials Authorization (RMA) from Stevens which will help best resolve any issues. Before shipping, place the battery power switch to the OFF position.

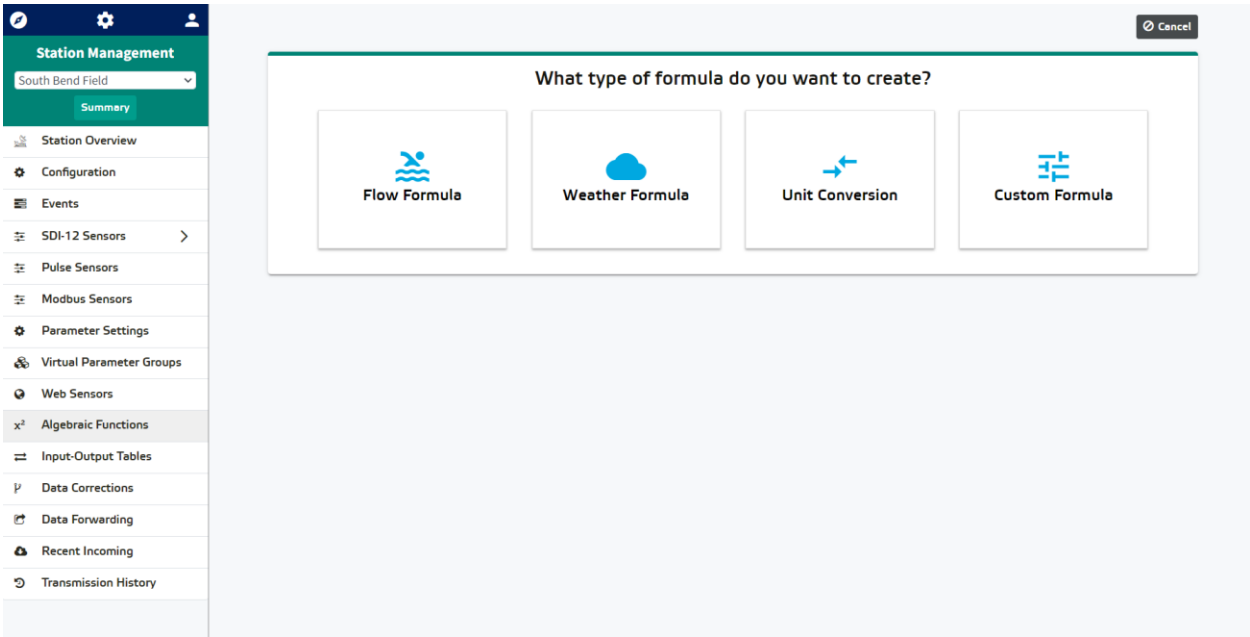
The RMA form can be found here:
https://www.stevenswater.com/resources/downloads/Stevens_RMA_Form.pdf

Appendix A: Advanced Stevens-Connect Features

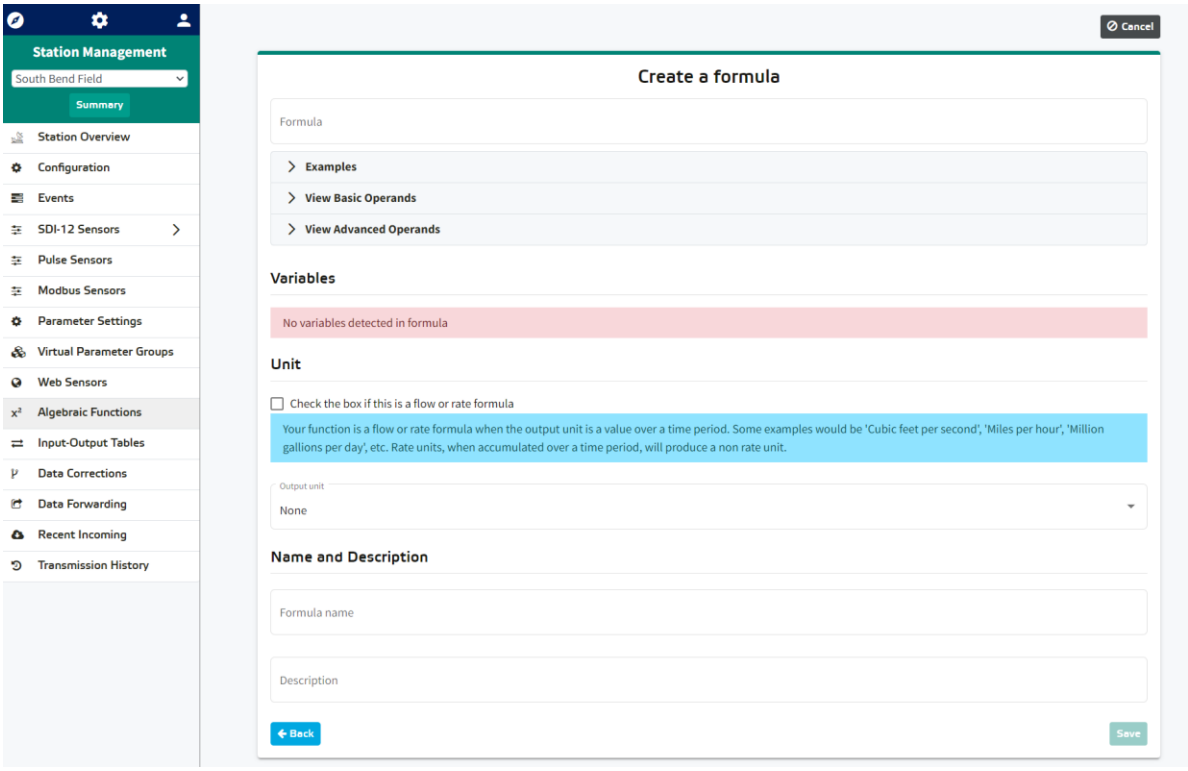
A.1 Algebraic / Customer Calculations

Algebraic Functions allow you to perform simple to complex math functions using any sensor data as variables and display the resulting calculated data as graphs or tables. Algebraic Functions can also be used in conjunction with a Virtual Sensor to allow the calculated data to be stored and tracked. Numerous predefined formulas for common uses such as unit conversion, flow or weather formulas are provided. You can also create your own custom formulas by utilizing the supported basic or advanced operands.

Under **Station Management**, select **Algebraic Functions** to implement or create a new function. Algebraic Functions is a post-processing feature of Stevens-Connect for displaying calculated values online only. Such functions and values are not saved on each Steelhead but can be accessed on Stevens-Connect.



There are many predefined flow, weather, and unit conversion formulas available. Each provided formula can be edited if needed or a custom formula can be created.



Formula. Enter the formula to calculate a value based on the variable(s) from the sensor(s) measurements. Each variable of the formula should be denoted as an alpha variable of “a” through “z” in this formula field. Each time the formula has such a variable, a variable field is automatically created for that variable with a pull-down selection of the sensor value for that variable represents

Basic Operands

- **+** Plus
- **-** Minus
- ***** Times
- **/** Division
- **^** Exponent

Advanced Operands

- **sin(x)** Sine of x (x is in radians)
- **cos(x)** Cosine of x (x is in radians)
- **tan(x)** Tangent of x (x is in radians)
- **asin(x)** Arc sine of x (in radians)
- **acos(x)** Arc cosine of x (in radians)
- **atan(x)** Arc tangent of x (in radians)
- **sinh(x)** Hyperbolic sine of x (x is in radians)

- **cosh(x)** Hyperbolic cosine of x (x is in radians)
- **tanh(x)** Hyperbolic tangent of x (x is in radians)
- **asinh(x)** Hyperbolic arc sine of x (in radians)
- **acosh(x)** Hyperbolic arc cosine of x (in radians)
- **atanh(x)** Hyperbolic arc tangent of x (in radians)
- **sqrt(x)** Square root of x. Result is NaN (Not a Number) if x is negative
- **log(x)** Natural logarithm of x (not base-10)
- **abs(x)** Absolute value (magnitude) of x
- **ceil(x)** Ceiling of x — the smallest integer that's >= x
- **floor(x)** Floor of x — the largest integer that's <= x
- **round(x)** X, rounded to the nearest integer, using "grade school rounding"
- **trunc(x)** Integral part of a X, looks like floor(x) unless for negative number
- **exp(x)** ex (exponential/antilogarithm function with base e) Pre-defined functions
- **random(n)** Get a random number in the range [0, n). If n is zero, or not provided, it defaults to 1
- **fac(n)** n! (factorial of n: "n * (n-1) * (n-2) * … * 2 * 1″)
- **min(a,b,…)** Get the smallest ("minimum") number in the list
- **max(a,b,…)** Get the largest ("maximum") number in the list
- **pyt(a, b)** Pythagorean function, i.e. the c in "c2 = a2 + b2"
- **pow(x, y)** This is exactly the same as "x^y"
- **atan2(y, x)** Arc tangent of x/y. i.e. the angle between (0, 0) and (x, y) in radians.
- **hypot(a,b)** The square root of the sum of squares of its arguments.
- **if(c, a, b)** The condition function where c is condition, a is result if c is true, b is result if c is false

Output Unit, if applicable, is the calculated units of measure. If not applicable, say "None". This is for reporting such information on charts and graphs. There is no mathematical adjustment to the sensor values in selecting the units of measurement.

Formula Name will be the reference for each Algebraic Function resulting calculation that is to be reported. Up to 100 characters are allowed, however, no more than 20 characters is recommended because this name is used in reporting the calculated value in tables, graphs, charts, and other visual insights.

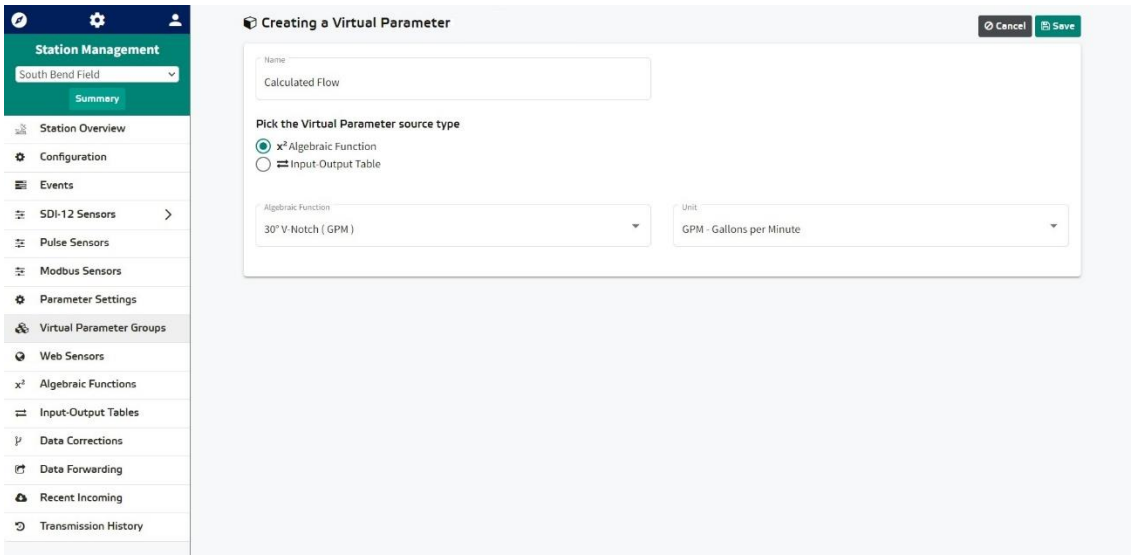
Description will be seen on the Algebraic Functions page and should provide a short description of the formula and pertinent information such as variables used or explain constants that may be in the formula.

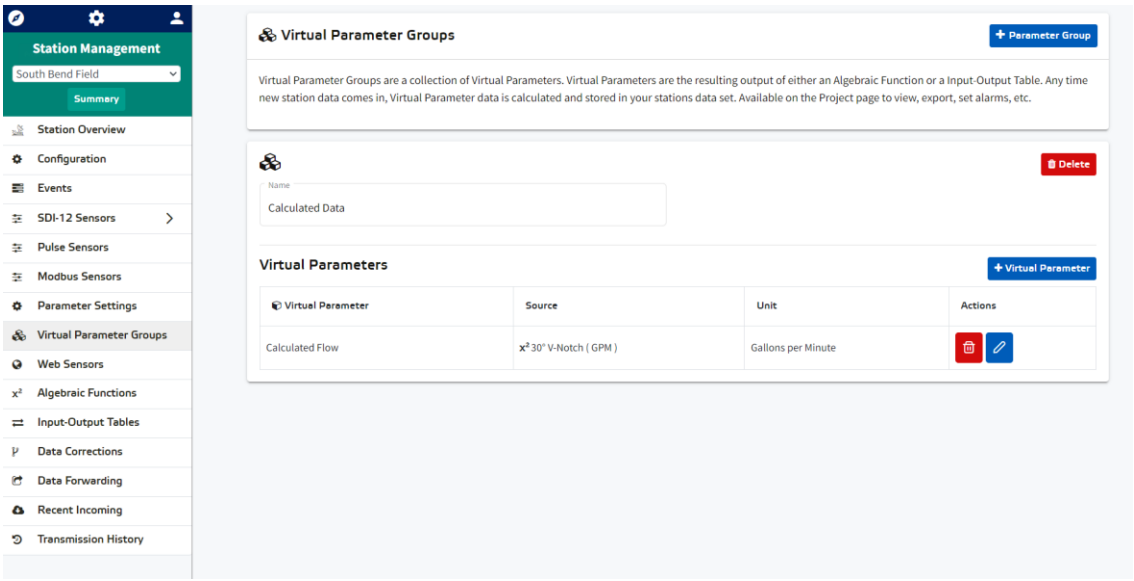
After selecting **Save**, the formula will be displayed under the Algebraic Functions section and can be used when creating a **Virtual Parameter**.

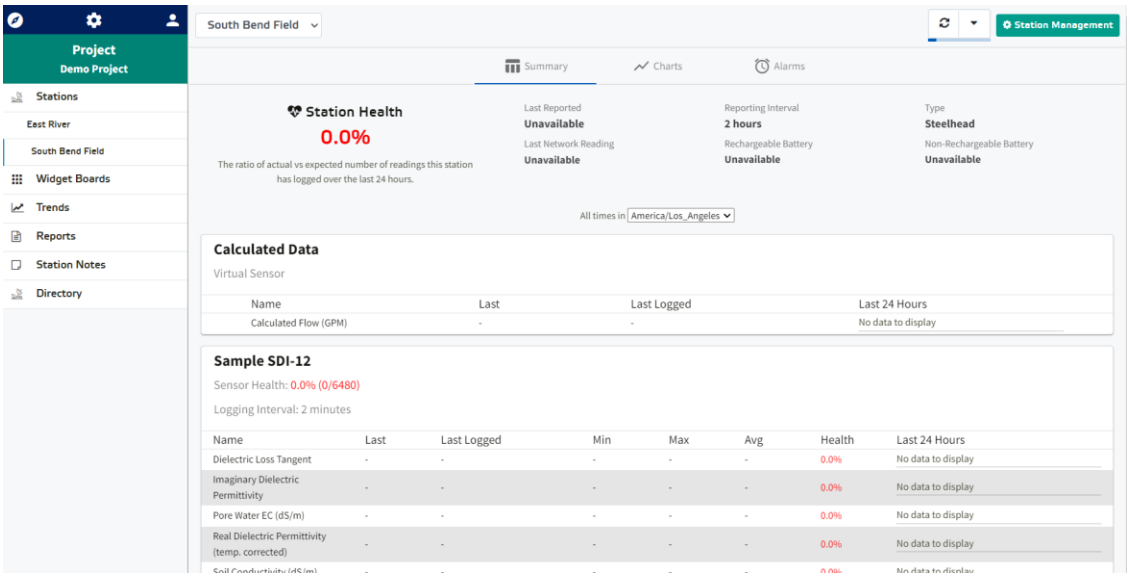
A.2 Virtual Parameters

Virtual Parameters are the resulting output of either an Algebraic Function or an Input-Output Table. Any time new station data comes in, Virtual Parameter data is calculated and stored in your

stations data set and is available on the Project page to view, export, set alarms, etc. Virtual Parameter Groups are a collection of Virtual Parameters.







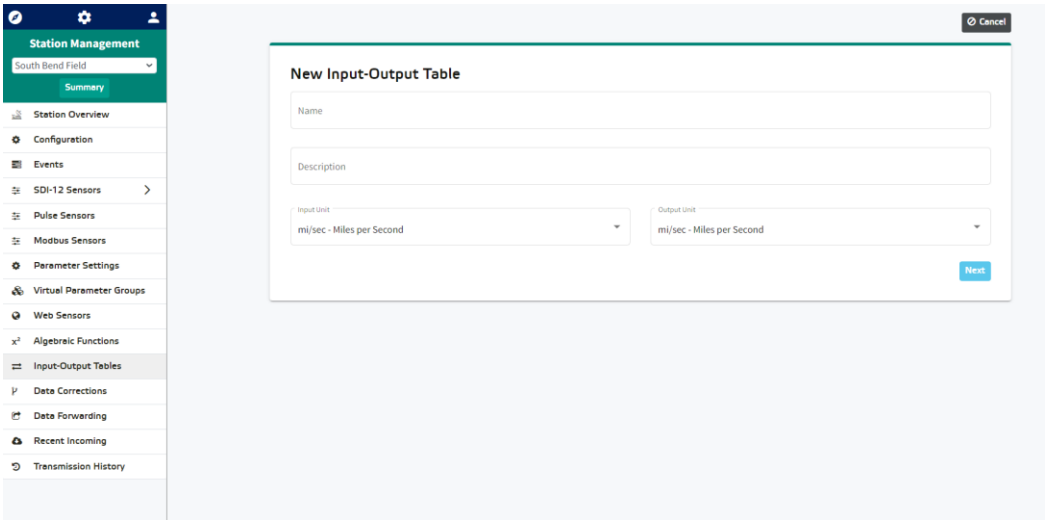
Once a virtual parameter has been created it can be seen on the Summary page and the data can be used the same way as any other sensor or Steelhead parameter.

A.3 Web Sensors

Web Sensors allow you to pull in weather data from external sources and create a sensor to store this data. You can use web sensor data in the same way you would use your physical sensor's data. For example, the data could be used on charts alongside your physical sensor data to spot trends or predictive analysis.

A.4 Input/Output Tables

Input-Output Tables, or value lookup tables, transform one input value to another based on table lookup. Input-Output Tables can be used to measure flow in a pipe, open channel, and more. Picking a rate-based output unit will change how totalization of the recorded value is performed. After creating your Input-Output Table, create a Virtual Parameter to start recording values when the dependent variable is recorded.

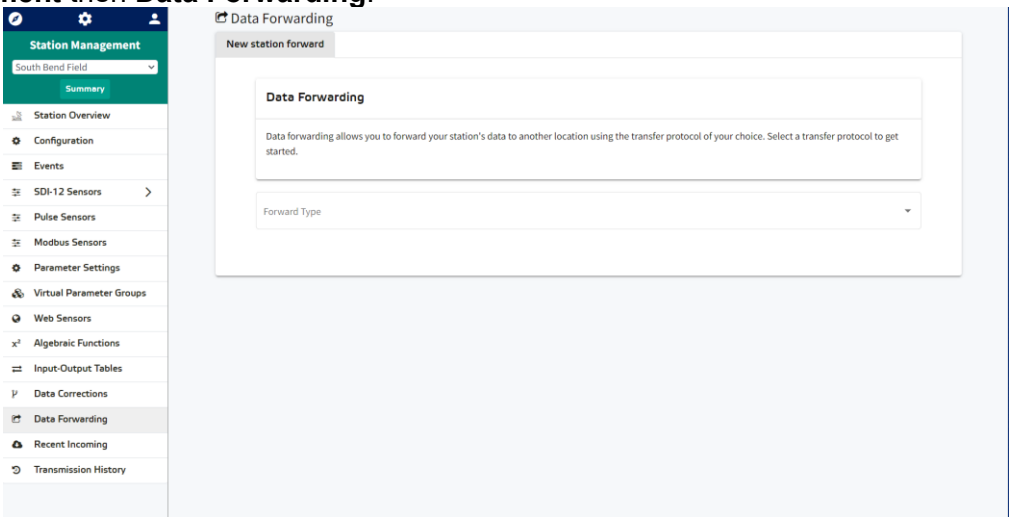


A.5 Data Corrections

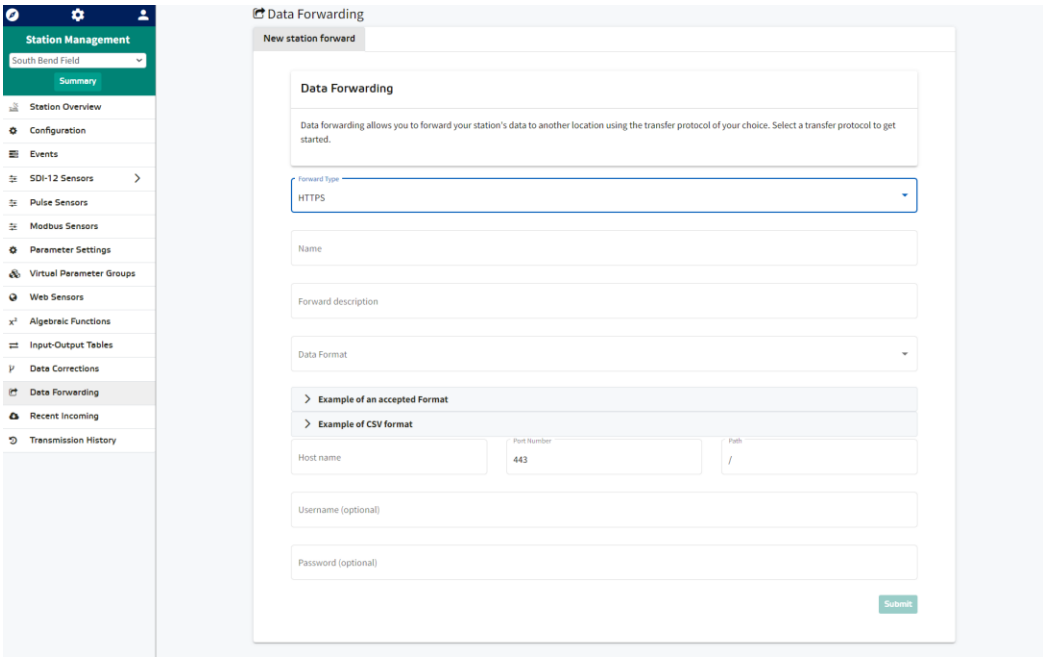
The data correction feature allows you to set corrected values or perform mathematical operations on a sensor's reported readings. You can perform these operations on either a single reading, all readings or a subset of readings filtered by date. You can also add readings to your sensor if needed.

A.6 Data Forwarding

Data forwarding allows you to forward your station's data to another location using the transfer protocol of your choice: FTP, SFTP, HTTP, and HTTPS. To get up forwarding, go to **Station Management** then **Data Forwarding**.

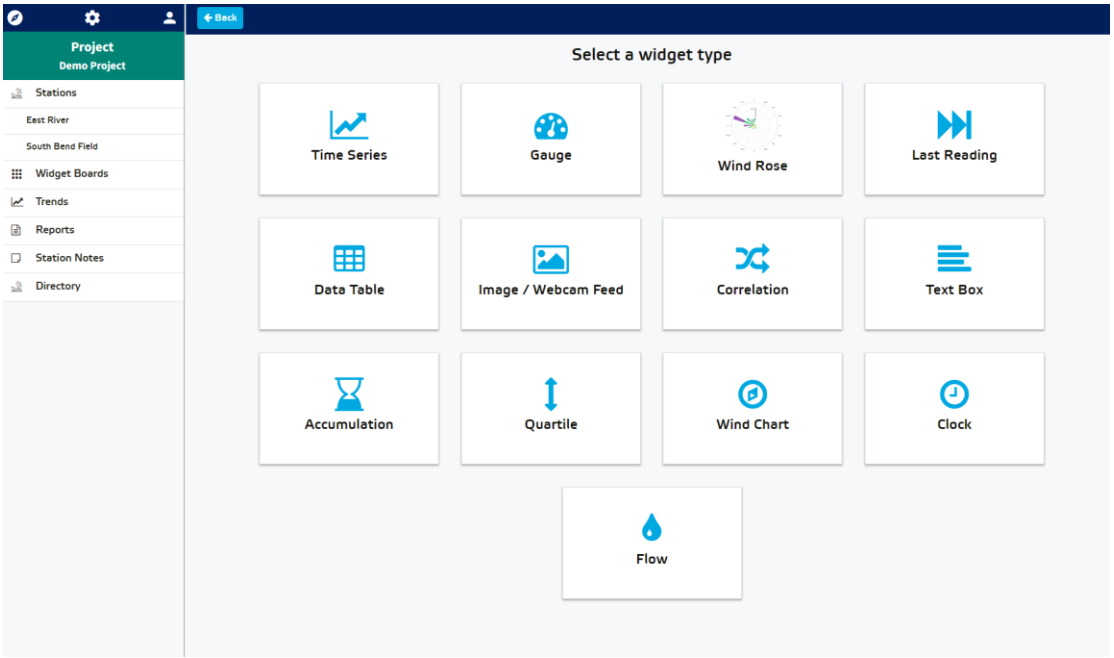


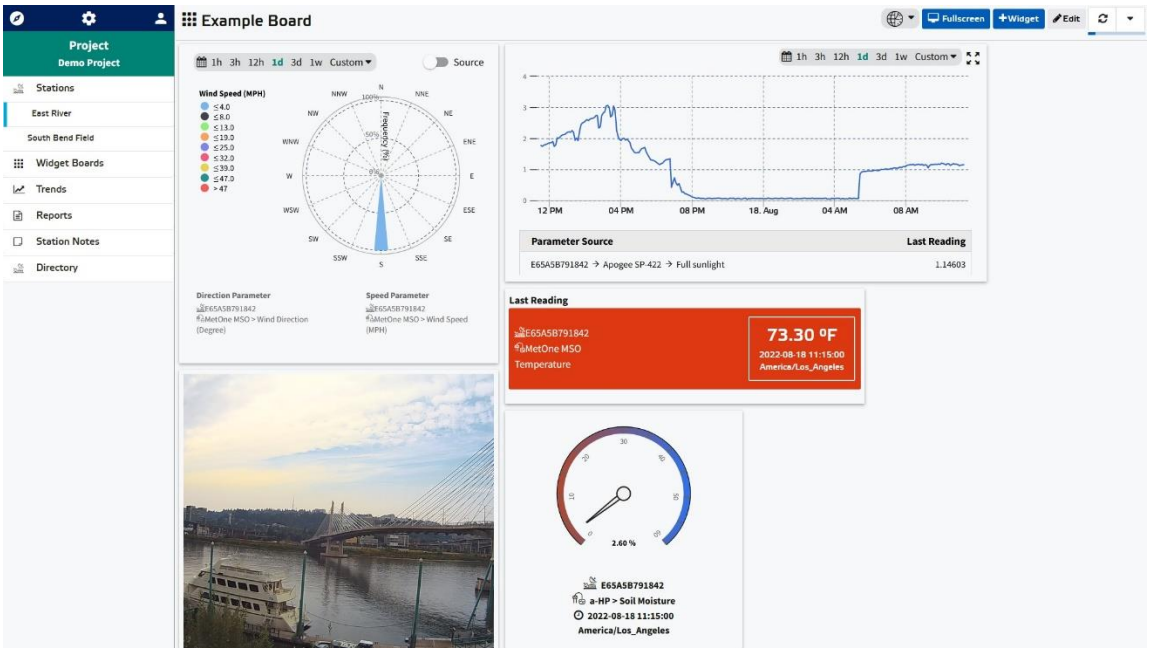
Fill out the information required for the transfer protocol of your choice. Examples are provided.



A.7 Widgets

Widget boards are a way to easily visualize data. Many options are available and parameters from multiple stations in the same project can be displayed together. Widget boards can be shared with other users as well.

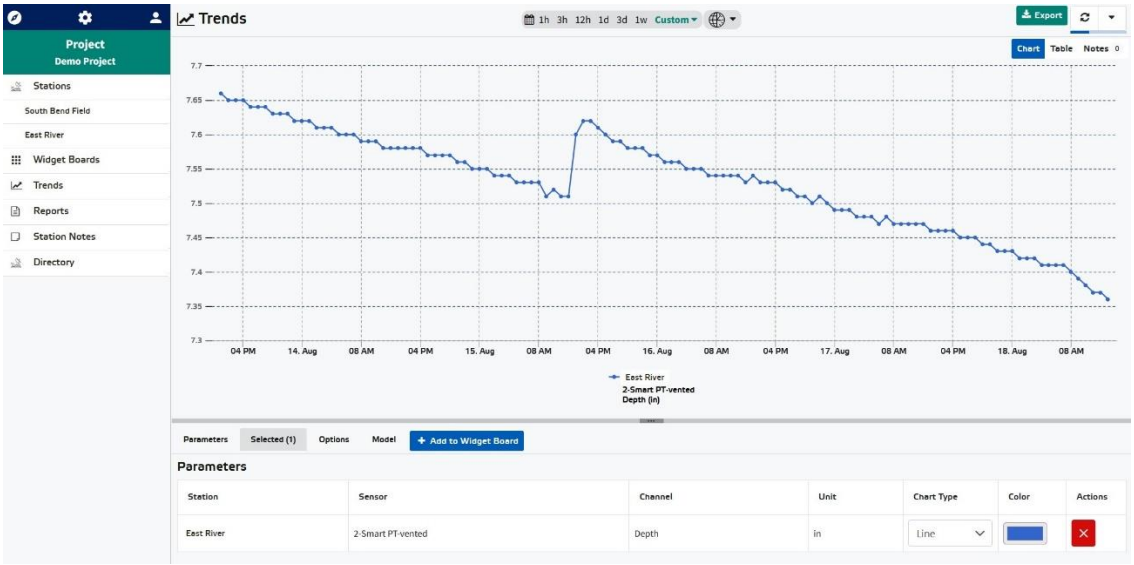




A.8 Trends

Data can be plotted on graphs to visually see fluctuations and quickly interpret. Multiple parameters from different stations in the same project can be compared in the same graph. There are options to plot lines, averages, accumulation, and rate of change. Data can also be downloaded by selecting **Export**.

To select parameters to view, go to **Trends** then **Parameters**. You can also select parameters from the summary page. When a parameter is selected on the summary page, a **Trend Parameters** button will appear on the bottom right of the screen.

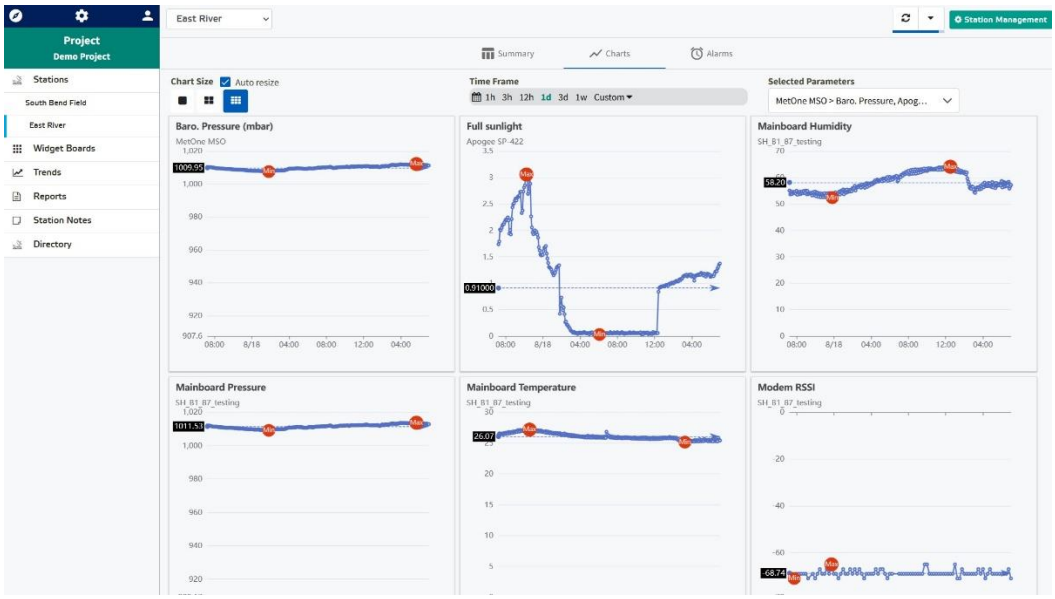


A.9 Reports

Create scheduled or on-demand reports that can be emailed to one or more project users. Reports can also be downloaded and are a convenient way to download desired data.

A.10 Charts

Charts visually display the data from the summary page. The time frame is adjustable, and parameters can be selected or deselected to be viewed as needed.



A.11 Recent Incoming and Transmission History

Recent Incoming shows the last received raw data packet from the sensor. Transmission History shows historical records of raw data and can be searched by month. These sections are used primarily for diagnostic information and troubleshooting.

Appendix B: Advance Diagnostic Parameters

B.1 How to turn on/off diagnostic parameters

Steelhead diagnostic parameters can be turned on or off under User Settings. These parameters will only be shown for users who select this option and only in the browser used when toggling on or off. Example: A user turns on diagnostic parameters while using Chrome. This will not change other user's view. It also will not turn on diagnostic parameters if the user logs into Stevens-Connect in a new browser such as Firefox. Diagnostic parameters can be turned on for multiple web browsers if desired.