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Instrument Update

NIWA
Taihoro Nukurangi

On-logger flow estimation at hydrometric stations

For most flow stations, flow data are derived by applying the stage–discharge relationship on a PC, after the stage data have been retrieved from the station logger.

At some stations real-time flow information is required to optimise operation of hydroelectric or irrigation schemes, or for consent monitoring, or applications such as volume proportional sampling.

Previously, two methods have been used to enable a logger to estimate flow in real-time. The preliminary step in both cases is to use a statistics package to fit a polynomial to a set of stage-discharge pairs from the rating curve. The polynomial relationship can then be built into the logger program and solved after each stage measurement, or alternatively the relationship is used to generate a flow look-up table, which is loaded to the logger to provide a flow value corre-sponding to each possible stage value.

Both these methods are time consuming, which is a costly disadvantage, especially at stations subject to rating changes. Often the agreement between the polynomial and the rating curve is found to be poor at the lower end of the range, and extra points, and possibly a second or third polynomial, are required for acceptable agreement.

Logger programs which solve the polynomials must be edited to introduce the new coefficients. The logger program execution time required to retrieve a flow from a look-up table is less than the time required to solve a polynomial, but look-up tables have the disadvantage that they are quite large, especially for large stage ranges. This is especially undesirable at stations where the logger program, including the look-up table, is to be loaded by telemetry.

Recently, Instrument Systems have developed a much simpler method for building flow-estimate programs for Unidata loggers. The method uses an external program, run from within the STARLOG software. The input for the program is a file containing a list of the rating pairs, automatically generated by TIDEDA. The output is another file containing the coefficients for a series of quadratic equations that represent the full range of the rating.

The output file automatically becomes part of the logger program, allowing flow to be calculated on the logger, every scan, following a stage measurement. A second text file written by the external program displays the difference between the rated flow and the estimated flow for each of the input pairs. Agreement is often better than 0.1% for much of the range.

Flow-estimation-capable schemes can be built using the NIWA Instrument Library for any stage sensor, in a few minutes. In the event of rating change, a few key strokes are all that is required to apply the new rating.

The new flow estimation method has already been implemented at some hydroelectric and irrigation scheme operational stations and for volume proportional sampling applications.

The method can be used with Starloggers, Hydrologgers, Prologgers and Microloggers.

For more information contact d.johnstone@niwa.cri.nz

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We would be glad to receive and publish letters from readers describing novel or innovative monitoring applications, or commenting on our articles.

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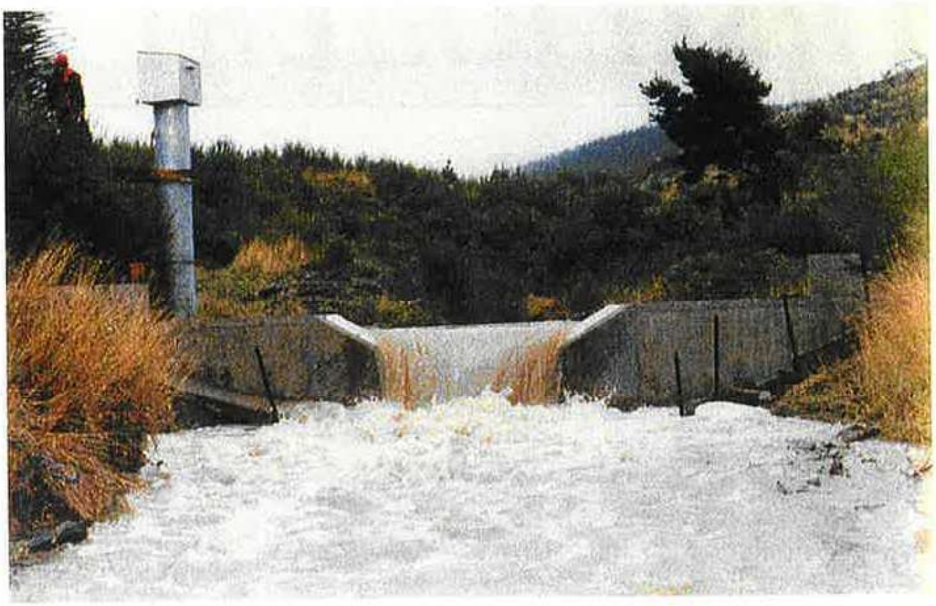
Pressure sensors for water level measurement



Pressure sensors are widely used to monitor water levels in rivers, lakes, ground water bores, and the sea.

At surface water stations where a stilling well already exists or can be constructed at an acceptable cost, digital shaft encoders generally offer better prospects than pressure sensors of a drift-free, unbroken record. A prime advantage of pressure sensors at stations without stilling wells is that installation costs are generally relatively low.

Pressure sensors are deployed in two modes: submersible and gas-purge.

A **submersible** sensor is housed in a waterproof body that is mounted below water and connected to the surface by a cable. A **gas-purge** sensor is mounted above the water and measures the water pressure indirectly via a gas line that passes into the water. Features of this gas purge mode of deployment are described below.

While the target parameter is water-level relative to a datum, pressure sensors measure the hydrostatic pressure above the transducer element of a submersible sensor, or the submerged orifice of a gas purge tube.

$$P = \rho g h$$

where: P = hydrostatic pressure

ρ = water density

h = the head, or depth of water above the transducer element or gas tube orifice

g = acceleration due to local gravity.

Measured pressure is directly proportional to water depth, but also varies with water density and local gravity.

Calibration relationships relating sensor output to water depth are true for the value of gravity at the calibration laboratory location, and usually assume a water density of 1 g/ml.

The value of gravity varies by 0.5% across the Earth's surface. Gravity may vary significantly over several kilometres, depending on local geology.

Water density varies with temperature and with its composition. Pure water has a maximum density of 1 g/ml at 4°C. This decreases by only 0.013% as the temperature falls to 0°C, and by 0.43% as the temperature rises from 4 to 30°C. Assuming a density of 1 g/ml at 30°C would result in an under-estimation of 4.3 mm/m.

The total dissolved solids concentration for New Zealand freshwaters is generally low, and errors introduced by assuming pure water density will be small.

Typical seawater densities range from 1.02 to 1.03 g/ml. Failure to correct for seawater density will result in a 2–3% over-estimation of depth, i.e., 20–30 mm/m.

For optimum water depth data from pressure sensor readings, the data must be adjusted by the datalogger program, or subsequently on a PC, for local gravity and density.

To convert a water-depth reading to water-level relative to a datum, an offset, corresponding to the height difference between the datum and the transducer element or gas tube orifice, must be added.

There are several factors to consider before selecting a sensor from the numerous brands and models available. Pressure sensors may be gauge, absolute or differential types. They may be "dumb" or "smart". Transducer types include piezo-resistive, capacitive, quartz crystal and vibrating wire. Output signals may be current, voltage, frequency or digital. Sensors may be designed for submersible or gas purge type deployments. Accuracy specifications and prices vary. The optimum combination of features for a particular application will depend on factors such as the budget, cable length required, and the purpose and physical nature of the station.

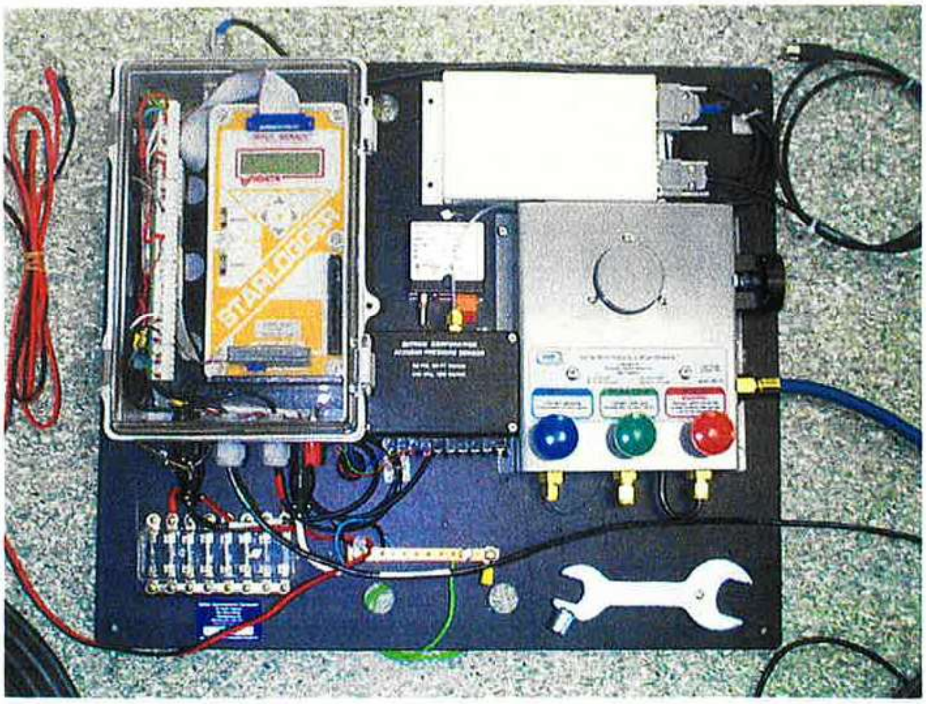
Pressure sensor types

Sensor types differ in the way they measure the total pressure at a point in a water column (i.e., the sum of atmospheric pressure and the head of water).

- **Gauge** sensors, the most common category for hydrometric applications, are designed so that the combined water head and atmospheric pressure is presented to the outside of the transducer element, and atmospheric pressure is presented to the inside. The net pressure on the element, and the transducer output, represents the water head only, and is independent of changes in atmospheric pressure. **Submersible gauge** sensors are vented to the atmosphere, usually via a narrow bore vent tube included inside the cable casing, along with the conductors. Gauge sensors are popular, but are susceptible to problems caused by ambient water vapour entering the vent tube. Temperature and atmospheric changes result in some "pumping" of air in and out of the vent tube and sensor body. In humid areas in particular, condensation of water vapour in the vent tube can result in erroneous diurnal fluctuations in the data and eventually to circuit board damage. To prevent these problems, it is important that the upper end of a vent tube is protected by a desiccant cartridge or a "bellows" bag system. A bellows bag fitted to the top of a vent tube allows atmospheric pressure to be maintained in the vent tube, without exchange of air.

- **Absolute** sensors are designed so that the combined atmospheric pressure / water head is presented to the outside of the element and a vacuum to the inside. Electronic barometers are absolute sensors designed to measure atmospheric pressure. Absolute water pressures are sometimes used for long-term submersible applications where the risk of water ingress via a vent tube is unacceptable, or to minimise cable cost at stations where long cables are required. Vented cable is more expensive than non-vented cable. Water-level data from an absolute sensor must be corrected for atmospheric pressure fluctuations, either on-board the datalogger using barometric pressure readings from a sensor connected to the logger, or later using local barometric pressure data from another source.
- **Differential** pressure sensors measure the difference between two pressures of interest. They are only occasionally used for environmental measurements. Applications include measuring the upstream/downstream head difference for a flume, and the difference between velocity head (pilot tube) and static head for a pipe or channel. A gauge sensor is in fact a form of differential sensor where the second pressure measured is atmospheric pressure.

below: *Equipment provided by NIWA to Northland Regional Council for a gas-purge sea-level station. The pressure sensor is a Sutron Accubar. The logger, bubble regulator, RF modem, and a barometric pressure sensor are also shown.*



Dumb and smart pressure sensors

- **Dumb** sensors provide a current, voltage or frequency output signal that increases in magnitude with pressure. The calibration relationship must be applied on the datalogger. The sensor's PCB usually amplifies the output from the transducer, provides temperature compensation of the transducer and PCB performance, and linearises the sensor output. Some of these functions may be carried out by a microprocessor on the PCB.
- **Smart** pressure sensors output a digital value in the required engineering units (e.g., mm), transmitted to the logger using standards such as RS232 or SDI-12. **SDI-12** pressure sensors are increasingly common, and allow simpler interfacing with loggers and simpler logger programs. A possible disadvantage of SDI-12 sensors is the relatively long time often required for a reading. SDI-12 instruments are often powered down between readings, and a warm-up delay of a few seconds is required when the logger requests each new reading. SDI-12 pressure sensors are not usually able to make high frequency readings to define or to smooth waves. Some more sophisticated instruments can be configured to be powered continuously and read at a relatively high rate, or to report the average of a number of rapid transducer readings.

The resolution of digital readings from a smart pressure sensor is determined by the sensor.

Greenspan Technology Pty Ltd use the term "smart" to describe their pressure instruments that include an integral datalogger.

Calibration corrections for dumb sensors often require hardware adjustments. Software calibration adjustments are usually possible for sensors that include a microprocessor.

The output signal from a dumb sensor may be a **voltage**, **current** or **frequency**. Voltage signals are preferable to current signals where cable lengths are less than 60 m. A 0–2.5 V sensor output will use the full range of a 0–2.5 V datalogger analog channel, thereby minimising the size of resolution steps corresponding to the logger A/D converter. A voltage divider will be necessary if the range of the sensor output is greater than the logger channel range. Voltage signals degrade in long cables due to cable resistance.

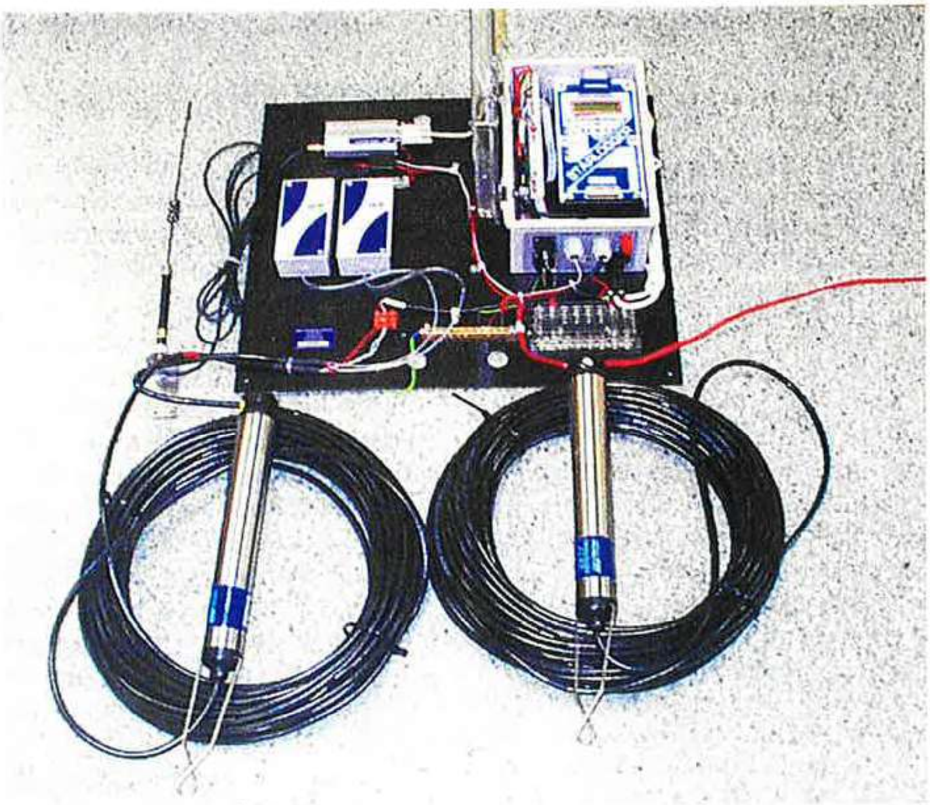
Very long cables (several hundred metres) are possible for current output sensors. A load resistor is required at the logger end of the cable to convert the current to a voltage that the logger channel can measure. Less than 80% of the logger channel range will be used and resolution steps will be correspondingly larger.

Where long cable runs are required, cable costs can be reduced by terminating the vented cable at a junction box situated safely above the maximum water level, and using a less expensive non-vented cable for the remainder of the distance. The junction box must provide an opening to the atmosphere, and desiccant or bellows bag protection for the vent tube.

Relatively long cables are possible for frequency signals.

Transducer types

- **Piezo-resistive** transducers consist of a resistive bridge embedded on a diaphragm. When the pressure acting on the diaphragm changes, the millivolt output of the bridge changes. Piezo-resistive transducers are the most common types used in pressure sensors.
- **Capacitive** transducers often consist of a ceramic capsule fitted with two metal electrodes. The capacitance varies as changing pressure alters the deformation of the capsule and separation of the electrodes.
- The raw output from **quartz crystal** transducers is a frequency, corresponding



left: *Equipment provided by NIWA to Environment Canterbury for a dual pressure sensor groundwater station. The sensors are submersible Greenspan SDI-12 sensors, protected by closed venting systems. The station Wavecom GSM phone is also shown.*

to the resonant frequency of a small quartz beam. The resonant frequency changes as varying pressure changes the end-loading on the beam.

- **Vibrating wire** transducers consist of a wire under tension. One end of the wire is connected to a diaphragm in contact with the water. As the pressure on the diaphragm changes, the tension on the wire and its resonant frequency changes. The output of vibrating wire sensors is a frequency signal.

Gas purge stations

Pressure sensors used in the gas purge mode at river stations or sea level stations are safe from damage or loss that might be caused by violent floods or storms. If the gas tube into the water is carried away, the record can be resumed by merely replacing the tube. Compared to submersible pressure sensor stations, however, these installations have the added complexity of requiring a high-pressure gas supply or pump.

Before the advent of electronic pressure sensors, the gas purge method was used with electromechanical sensors and recorders. These systems used gas supplied from a high-pressure gas cylinder and constant-bubble-rate regulator to provide a small, steady flow of gas into the water. A gas pressure in the tube, which is sufficient to prevent water entering the orifice is representative of the water pressure at the orifice. Earlier electromechanical systems used balance beams or mercury manometers to measure the gas pressure.

Gas cylinders and constant flow regulators are still frequently used with electronic pressure sensor systems. There are several installation, and operational details to be aware of for gas-purge stations.

The path of the gas line from the sensor housing to the water must always travel downwards so that there are no "u" sections that could trap condensation.

There is significant friction in long, small-bore gas tubes. A higher pressure is required at top of the tube where the sensor is to maintain the constant flow through the tube. This leads to a pressure offset in the system, which can be observed even when the orifice is held above the water. Friction in the tube can cause attenuation in the observed magnitude of waves passing above the orifice.

Gas-purge systems can follow falling water levels more quickly than rising water levels. Their ability to follow rapid rises depends on the bubble rate. A rapid rise in water pressure will cause water to enter the orifice and rise a small distance up the gas tube. While there is a column of water inside the tube, the head of water at the orifice is represented inside the tube by the sum of head of water inside the tube and the gas pressure above it. The gas pressure at the sensor is erroneously low until the flow of gas again expels the water from the tube.

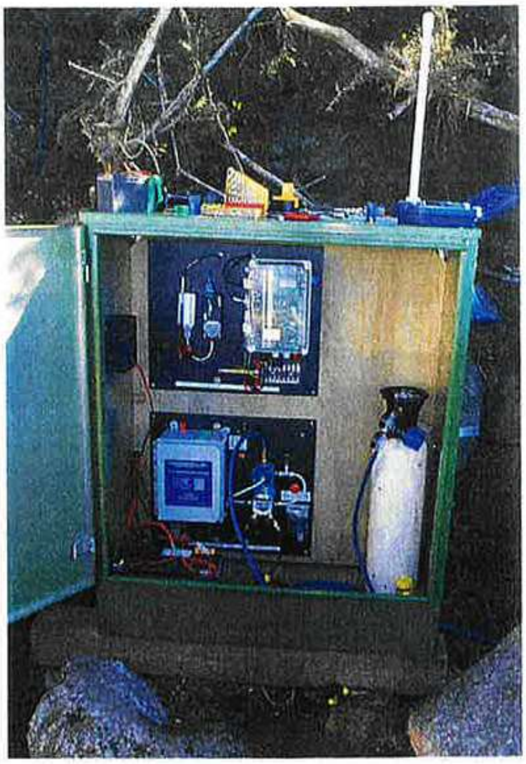
Bio-fouling at the orifice can be a problem, and can be reduced by terminating the gas tube with a copper pipe.

Pressure sensors in gas purge systems may be subject to much greater temperature ranges than sensors mounted below water, particularly if the housing is exposed to the sun. They must be capable of compensating for changes in the performance of sensor components over the appropriate range.

Subsurface pressure fluctuations due to surface waves are attenuated according to a power law with depth, and the ability of gas-purge or submersible pressure sensors to measure short period waves decreases rapidly as the depth of the orifice or submerged transducer increases.

Dry nitrogen has been recommended as the purging gas, particularly at locations where condensed water in the bubble tubing could

below: *Instruments and gas purge equipment provided by NIWA to Tasman District Council for a sea level station. The sensor is a Paroscientific PS2. Remote communication is via a Wavecom GSM phone.*

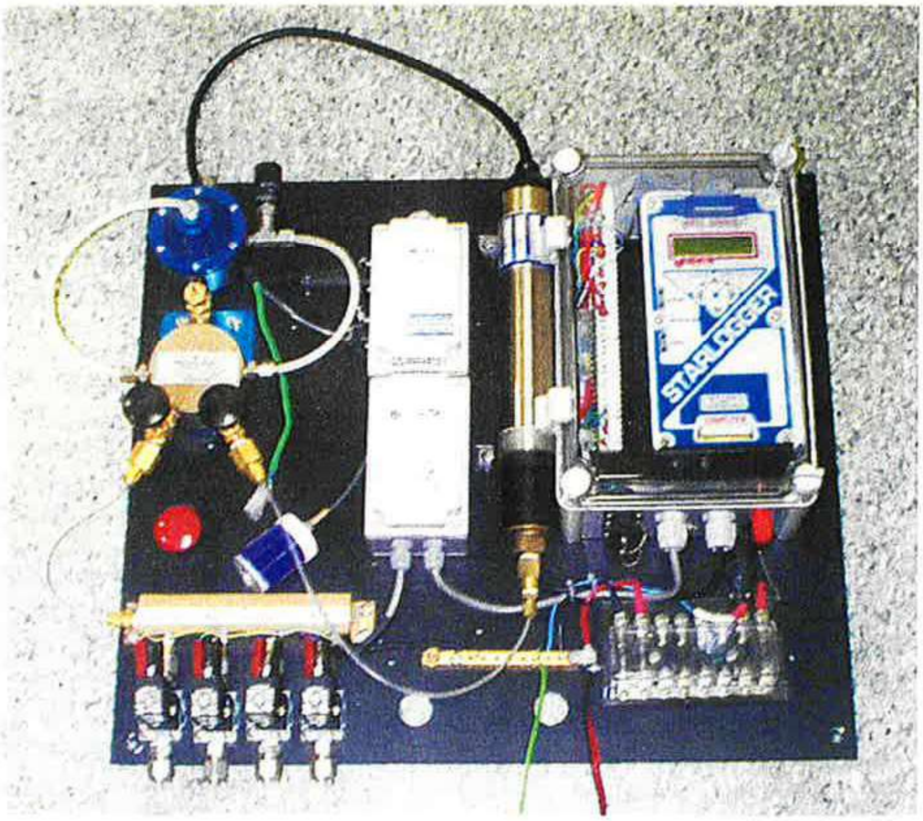


be subject to freezing. Compressed air and carbon dioxide can also be used. Carbon dioxide has the advantage that it liquefies at relatively low pressures, and approximately twice as much carbon dioxide as nitrogen can be stored in a given cylinder size. Because of the lower storage pressure, lighter, aluminium cylinders can be used to store carbon dioxide.

A high-range electronic gas pressure sensor can be used to monitor the gas available in a nitrogen or air cylinder, at telemetered stations.

In recent years compressed gas cylinders have been replaced at some stations by a variety of systems where the purging gas is supplied by pumps. These systems have overcome the need to transport and store heavy and bulky gas cylinders. The challenge at stations without mains power, has been to develop reliable, low-power systems.

Two types of 12V DC powered, pump-based systems are available. One type emulates the gas cylinder-based system, by providing continuous gas flow with an adjustable bubble rate. The second type is designed to purge the bubble tube periodically for a short burst, only when a reading is required. The latter systems don't have a flow regulator, and immediately after the pump has operated there is a large pressure gradient in the tube. These systems must be programmed so that the sensor reading is recorded after the initially fast flow of air from the orifice has slowed, and stopped.



A control-capable logger can be programmed to enable one gas source, and one sensor, to be used to measure water levels at several nearby points, such as a set of nearby groundwater bores. The bubble tubes to the respective measurement points are connected via solenoid valves to a manifold, which is in turn connected to the gas supply. After the gas is switched to a new measurement point, there is a programmed delay to allow time for the tube to purge, before the reading is recorded.

above: *A system provided by NIWA to Environment Canterbury for monitoring four bores at a groundwater station. The four bores are measured in turn, using a single gas supply and one Greenspan pressure sensor. The logger controls solenoid valves which switch the gas between the bores.*

For more information contact d.johnstone@niwa.cri.nz

Digital Cellular links providing reliable 9600 bps data retrieval

NIWA Instrument Systems is now a supplier of the Wavecom GSM integrated modem/cellphone unit for use in remote site data retrieval.

Unlike analogue cellular telemetry systems previously supplied by Instrument Systems, the Wavecom unit operates on the Vodafone GSM network, which provides encrypted, reliable 9600 bps data transfer.

The Wavecom is a cellphone and modem in one package, which reduces the amount of data and power cabling required, and is about one-tenth the physical size of its analogue predecessor.

Connection systems have been developed for interfacing to both Unidata and Campbell loggers, and power-switching systems are also available for installation in sites where power consumption must be minimised.

Wavecom external modems are designed to operate in harsh environments.

For more information and Vodafone coverage details, contact:

NIWA Instrument Systems,
Phone: +64-3-343 7890
email kainga@niwa.cri.nz

The Greenspan range of pressure sensors

Greenspan manufacture a variety of pressure sensors for water level measurement, with models suitable for a wide range of applications. Features of the different models are summarised in the table below.

Those shown are the minimum and maximum standard ranges. Other ranges are available upon request.

Although gauge type sensors are used for most applications, absolute transducers are also available for most models.

As an alternative to stainless steel, delrin may be selected as the body material for all models except the PS500 and PS600. Stainless bodies may be subject to "crevice corrosion" when mounting-clamps are attached to the body, and in some cases the corrosion is severe enough to penetrate the body. Delrin bodies are recommended where the intended mounting method involves a clamp in contact with sensor body.

Greenspan pressure sensors are designed as submersible sensors, but an adaptor is available which allows the sensors to be deployed in a gas purge system.

The transducer type used for all of the Greenspan pressure sensors is a corrosion resistant ceramic capacitive transducer.

A closed venting ("bellows bag") system is available to prevent water vapour ingress via the vent tube, and should be included with all gauge sensors.

The A/D resolution of the datalogger analog channel may lead to "steps" in data recorded from high range pressure sensors. The resolution of digital SDI-12 readings from a PS1200 sensor is 16 bit (1 part in 65536). The PS1200 is recommended where high resolution data are required from high range pressure sensors. Water temperature and battery voltage are available as additional outputs from PS1200 sensors.

The maximum cable length possible for SDI-12 signals is 60 m. Where long cables are necessary, high resolution can be achieved by using a 4–20 mA output sensor, with an analog/SDI-12 interface, at the logger.

The PS310 instrument includes an integral datalogger with up to 1 MB of memory. Data from a tipping bucket rain gauge can also be recorded, and an automatic water sampler can be controlled. Telemetered data retrieval is possible. A/D resolution for the PS310 is 16 bit. Overall costs for a new hydrometric station using a PS310 as sensor/logger are relatively low. The only items housed above water at a non-telemetred station are the battery and a closed vent system. Internal lithium batteries are available for the PS310. An internal-battery-powered absolute version of the PS310 can be deployed with no cable to the surface.

"Aquadata" software for the PSION Workabout hand-held rugged computer can be used to program and unload data from PS310 stations. The advantages of PSION Workabout computers compared to portable PCs are described in the previous edition of *Instrument Update*.

Model	Ranges available (m)	Accuracy specifications	Output signal options	Max. cable length (m)	Dimensions diam. (mm)	Dimensions length (mm)	Notable features
PS500	0-1 to 0-200	± 0.5% FS	4-20 mA	several 100	22	190	Smaller diameter - suitable for 1" (25 mm) piezometers. Low cost.
PS600	0-1 to 0-200	± 0.05% FS	4-20 mA	several 100	22	190	Small diameter. High accuracy specification
PS100	0-2.5 to 0-70	± 0.5% FS	4-20 mA	several 100	45	310	Low cost where high accuracy not important.
PS210	0-2.5 to 0-70	± 0.03% FS	4-20 mA 0-1 V 0-2.5 V	several 100 60 60	45	310	Microprocessor controlled. Calibration software included allows field adjustment of offset and full scale.
PS225	0-2.5 to 0-70	± 0.03% FS	4-20 mA 0-1 V 0-2.5 V	several 100 60 60	45	310	Windows software provided allows re-ranging down to 50% of full scale.
	0-2.5 to 0-70	± 0.03% FS	SDI-12	60	45	310	SDI-12 output. Calibration adjustment possible using SDI-12 commands.
PS310	0-2.5 to 0-70	± 0.02 %FS	RS232 (integral logger-PC comms)	300 (distance verified by Greenspan tests)	45	310	Integral datalogger with up to 1 MB of memory. High accuracy specification.

Environmental monitoring training courses

NIWA is offering the following courses in 2001–2002. These courses are tentative and will be finalised depending on interest from individual councils and other agencies. Other courses can be offered on request and consultation with Dr Clive Howard-Williams (address below). Courses are presented at a range of venues according to need and level of interest and in some instances can include in-house training on the premises of the agency requiring the course.

Course 02-01
General environmental data logging (1.5 days)
This course is intended for people involved in deploying sensors and multi-parameter, programmable dataloggers to collect environmental data, particularly hydrometric, meteorological and water quality data. The course involves hands-on exercises using Unidata and Campbell Scientific dataloggers, and a variety of sensors. Topics include: sensor types and operating principles, sensor/logger interfacing, station inspection procedures, fault finding and telemetry systems.

Course 02-02
Environmental datalogging/unidata STARLOG update (1.5 days)
An exercise-based course featuring new NIWA Instrument Library modules, new sensors and interfaces and data telemetry using GSM phones. Exercises cover a range of hydrometric, water quality and meteorological applications, including real-time, on-logger flow estimation, volume proportional sampling and automatic logger-based sensor calibration adjustment. This course is intended for people who are already users of STARLOG Version 3 software.

Course 02-03
Optimising data quality from environmental monitoring stations (1 day)
This course is designed to provide a basis for minimising and quantifying uncertainty associated with the stages involved in sensing and recording data from environmental sensors. Error sources and their mitigation are discussed for each stage of a datalogging system, from target/ measured parameter relationships, through transducer and sensor performance, sensor mountings, fouling and interference issues and datalogger configuration.

Specific examples are considered for a variety of common hydrometric, water quality and meteorological parameters.

Course 02-04
Successful use of hand-held water quality sensors (1 day)
The course is designed to provide information needed to optimise collecting of high quality and representative data using portable water quality instruments. Topics include: sensor types, sensor selection and their operating principles; calibration principles and procedures, sampling point selection and sampling procedures, interferences and sources of errors.

Course 02-05
Successful use of continuous monitoring water quality sensors/loggers (1 day)
The course is designed to provide training on calibration, deployment and maintenance procedures required to optimise collection of high quality data that can be confidently interpreted. Topics covered include those in Course 02.01 with additional special emphasis on water quality issues such as instrument fouling. The course includes some hands-on exercises.

Course 02-06
Establishing and operating meteorological data monitoring stations (1 day)
This course is designed to provide information for establishment and operation of meteorological stations capable of producing reliable data. Topics include: sensor types and operating principles, sensor deployment and mounting, datalogger programmes and procedures, calibrations, documentation and quality assurance.

Course 02-07
Electric fishing machine operators course
The Electric Fishing Machine Operators Course is designed to teach users safe, efficient and ethical use of both back-pack and bank-mounted electric fishing equipment. Field work is a major component of the course, with the aim of applying basic theories of electric circuits, machine function and fish physiology to the practical operation of machines over a range of situations and for a variety of fish.

Courses 02-08 to 02-11
Biological identification courses

Four courses are offered:

02-08 Identification of New Zealand native fish

02-09 Identification of algae (periphyton) in lakes and rivers

02-10 Identification of aquatic macrophytes in lakes and rivers

02-11 Difficult species in the MCI

These courses vary in length and detail depending on the needs of the agencies requiring the training. It is often also appropriate to offer a regional perspective in some cases; for example, a knowledge of South Island galaxiids may not be needed in the North Island. The courses that we run for council staff are generally short (one day) and concentrate on commonly encountered species, but we also offer specialist courses mostly for university and DOC staff on detailed taxonomy of invertebrate and fish groups. We have the potential to provide courses on other organisms such as phytoplankton and specific invertebrate groups depending on need.

OTHER POSSIBLE COURSES
If there is sufficient interest we can offer versions of several other courses which we have successfully run in the past. These include but are not limited to:

Water chemistry for data collection staff
This course covers aspects of water chemistry required for those technical field staff that collect samples for environmental water quality monitoring programmes. In such cases, field preparation, preservation, filtration and water quality changes during transport are very important for reliable data. Calibration of field instrumentation, simple indicators, and common questions such as "what is conductivity" "why must pH be measured at the site" "what are the common forms of nitrogen in water" are addressed.

Riparian implementation programmes
This is a one- to two-day course run at a field site (in conjuction with staff from AgResearch) generally for land management staff. Topics include practical aspects of riparian strip management such as benefits and disadvantages, how wide, where in the catchment, types of vegetation, defining the objectives of the protection, and interactions with farming practices.

Hydrological statistics
This course provides an understanding of, and methods for, the estimation of hydrological statistics including floods and droughts.

Hydrological modelling
Provides hands-on experience in using a range of hydrological models including rainfall runoff models for purposes such as flood forecasting and low flow estimation.

Electronics for environmental monitoring
This course is designed to provide some background concepts and practical advice to field staff who operate electronic field equipment and data logging systems. It

covers the basic concepts of voltage, current, resistance and power and how to measure and calculate them, determination of cable size and wiring, power systems and calculation of battery capacity, interfacing sensors to loggers, over voltage protection and other topics appropriate to the audience.

For further information regarding courses please contact:

Dr Clive Howard-Williams
NIWA, PO Box 8602, Christchurch
Phone: +64-3-348 8987; Fax: +64-3-348 5548
email c.howard-williams@niwa.cri.nz

The NIWA Battery Management System

The NIWA Battery Management System, BMS2000, provides a new, simple to use, effective solution to many battery management issues.

It has been developed as a tool to enhance the maintenance of 12 volt lead acid rechargeable batteries that are commonly used in environmental data collection systems. The BMS2000 provides two main functions – controlled charging of a battery and measurement of a battery's storage capacity in ampere hours.

Up to six batteries can be connected to the BMS2000 at once.

In **Discharge Mode** the BMS2000 measures battery capacity in Ampere hours by timing the discharge of a fully charged battery at a defined constant current, down to a specific end voltage. Final battery capacity is displayed on the LCD screen.

In **Charge Mode** the BMS can charge batteries with capacities from 1 to 100Ah using a multi-stage charge characteristic in which the charge rate (charge current) is dependent upon the measured state of the battery.

The BMS2000 has a central role in 'preventative maintenance' procedures for data collection networks, in which the capacities of batteries are periodically verified as a part of quality assurance procedures. Correct charging of a battery can also extend its useable life.

Providing outputs to PLCs from field dataloggers

Data are normally retrieved periodically from hydrometric stations established for water resources archive records. Telemetered stations are usually unloaded every day, and can notify the base office of alarm conditions.

In some instances electricity generators or other agencies require continuous, real-time information from existing hydrometric stations for operational purposes. The information must be in a form that can be read by PLCs (Program-mable Logic Controllers). PLCs are designed to receive 4–20 mA signals, and can be programmed to receive SDI-12 data.

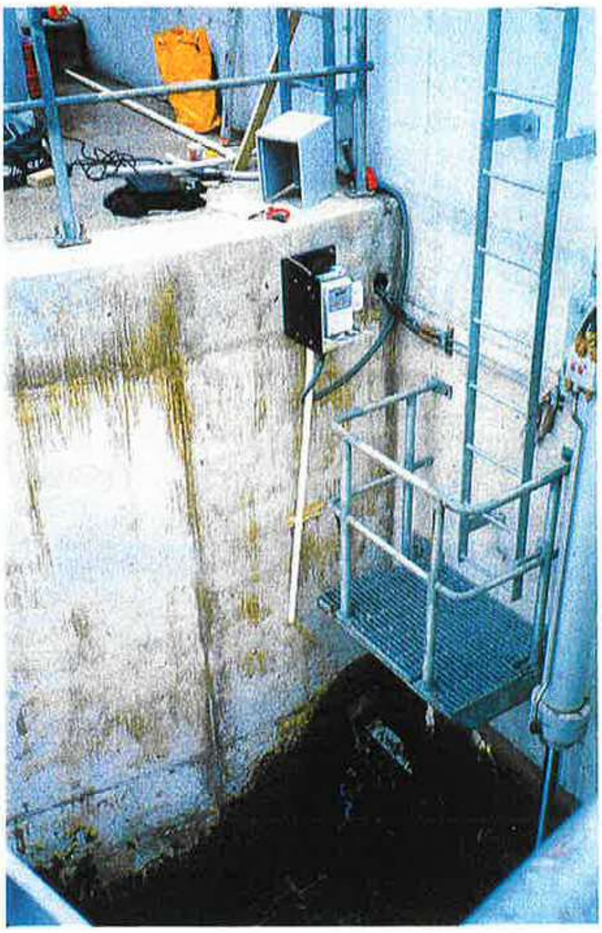
Instrument Systems has supplied a variety of hardware components and complete systems to provide real-time readings from monitoring stations to PLCs.

Stage data can be output as a 4–20 mA signal from the Unidata 6541 shaft encoder, by using a Unidata interface, or an MEA 2061. The stage range that corresponds to the 4–20 mA output span is selected from a number of fixed-range options.

The PLC's resolution of stage, as represented by the 4–20 mA signal, is maximised by selecting the smallest adequate stage range. MEA2061 interfaces can be configured so that the selected range can be offset, within the full range of the encoder. In some cases this allows a smaller stage range to be selected from the allowable ranges.

The interfaces can both provide the 4–20 mA output corresponding to the encoder stage reading, when the encoder is also connected to a logger, or when the encoder is operated in isolation.

Two further methods of providing real-time readings to PLCs do require a datalogger. In one case the logger is configured as an SDI-12 sensor, and is interrogated by a PLC configured as an SDI-12 master. In the second case a Unidata Microwire to 4-20 mA interface is used to present readings from the logger as 4–20 mA signals. For both methods, any quantity from the loggers memory (a sensor reading, or estimated quantity such as flow) can be made available to the PLC, and the PLC's resolution of the quantities can be optimised. The digital SDI-12 readings of course retain full resolution.



A Hydrologger / Microwire combination transmits a radial gate level reading as a 4–20 mA signal.

In the case of the Microwire to 4–20 mA outputs, the logger can be programmed so that the 4–20 mA span corresponds exactly to the required range of the parameter.

Currently, a PLC configured to read SDI-12 data from a Unidata logger can retrieve a string of up to five readings with each interrogation.

Single and dual channel microwave to 4–20 mA interfaces are available.

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