**Regular station visits and checks:**

Stations will be visited according to the needs for instrument checks, clearing of weed and biological growth on and around the installations and controls, power supply, telemetry and other checks. Visits should include the following checks, as applicable:

1. In the office, check the telemetered data for any apparent problems related to comms performance, gaps or spikes in data, and any trends that may be due to sensor interference, rating change, or any other possible problems.
2. Make any arrangements required for access, such as keys, notifications, etc.
3. Go to the sensing site, and firstly observe any issues with growth, debris, damage, etc. Take a photograph if there is anything significant. Read the staff gauge or level pins.
4. Clear any growth or debris, clean the staff gauge plates and weir crest, and note any change to the staff gauge reading. Enter details of what was done and readings in the logbook
5. Connect to the logger (test mode) or key through the display to check the following:
* Stage readings agree with the staff gauge to within +/- 3 mm. Any difference may signal that a change is required to the off-set (pressure or acoustic sensors) or the encoder needs adjustment. However, particularly with pressure transducers, it is prudent to wait for two or three such visits to confirm the trend before making the adjustment.
* Velocity measurements are sensible, and/or agree approximately with a current meter spot measurement (see below).
* All other parameters in the logger (including time) appear accurate and sensible.
1. As required to either define the rating shape or to confirm that it is stable, carry out a gauging.
2. Check bubbler gas pressures on the gauges. The gas bottle pressure (gauge closest to the cylinder) should be in the range 0 to 20,000kPa and the regulated pressure to the bubbler (gauge furthest from the cylinder) should be at 400 kPa +/- 20. Note bottles should be changed if below 5000kPa – this depends on bubble rate and frequency of visits.
3. Measure the battery power supply voltage with a multi-meter and read the charge voltage if applicable. Note these in the logbook.
4. Check the instrument housing for damage, leaks, insects, etc., and clean and repair as necessary. Note any requirements for the next visit on the logbook page. Similarly, check the cabling, gas lines and their protection.
5. Carry out any non-routine tasks as required, taking care to follow the required procedures:
* Replace the gas cylinder once cylinder pressure is below 5000 kPa: Using the gas bottle spanner, close the cylinder valve, remove the regulator, and swap bottles. First, use the spanner on the new one to “crack” the valve open momentarily, giving a squirt of gas to clear any dirt. Then connect the regulator, taking care to seat the connection properly. Tighten the nut firmly, but not over-tight. Turn on the cylinder valve, listen for leaks, and check both pressure gauges. If leaks are suspected, use a small brush to apply detergent mixed with a small amount of water to the connections and look for bubbles.
* Flush the stilling well if it is suspected that the well or pipes may be blocked with silt. Pump water into the well to clear the pipes and continue until they run clear. It may also be possible to remove the bung at the bottom of the well to assist clearing silt, but water should still be pumped with it closed to ensure the pipes are clear – see details below.
* If the logger is to be re-programmed, ensure that either the telemetered record is fully up to date (phone the office and ask for a data retrieval) or download the most recent data to a laptop, taking a backup on separate media (memory stick).
* DAA loggers, which are typically setup with non-circular memories, need these cleared at least once per year to prevent the memory filling up and missing record occurring.
* If the bubbler stage sensor value shows a discrepancy, the first step is to use the purge process to ensure the gas line is not obstructed. To do this is it imperative that the valves are operated in the correct sequence otherwise the pressure sensor may be damaged.

First close the valve to the pressure transducer, then open the purge valve (often the red knob at top). This will send high pressure down the gas line to the orifice, where there should be strong bubbling which should be readily visible in all but high flows. No bubbling may mean that the gas line is well blocked or you have operated the valves wrongly. Once you have observed it purging, turn off the red valve. Then wait for at least 30 seconds for the line pressure to normalise, before turning on the valve to the pressure transducer. ENSURE THE CORRECT SEQUENCE IS FOLLOWED!

1. Comment on the accuracy of the records, the stability of the control(s), and any other factor not so far covered which has a bearing on the accuracy of data.
2. Before leaving, remove and safely store the logbook page for delivery to the office.

##

## De-silting stilling wells

Stilling wells and intake pipes can be subject to deposition of sediment within them that will prevent the well water‑level from being the same as that in the river and eventually interfere with the float and counterweight.

***Prevention***

The most effective prevention can be done when siting and building a tower:

* The lower intake pipe shall be at least 200 mm and preferably 500 mm above the bottom of the stilling well.
* Use a ratio of 1:12 between intake pipe and stilling well diameters (this is a nominal ratio, because it will be greatly influenced by the number of intakes and their length).
* All construction joints of the well and intake pipes shall be watertight.
* A convenient flushing system should be designed in, incorporating a means of closing off the static pipe at the tower end.

### Detection of silting

As silt‑affected data will be below‑standard data, efforts shall be made to detect silting before it becomes evident on the record. This can be done by:

* Using a device such as a crowbar on a length of rope to sound the depth of sediment in the well.
* Routinely using the EPB to sound the depth of sediment in the well. In the recorder house, display the stages of the bottom of the well and (the invert of) the lower intake pipe, and thus enable determination of the depth of silt and the "freeboard" left.
* Observing the amount of surging if it is a characteristic of the site. This is often most obvious during high-flow events, when the river may be surging. However, even at low flow some surging may be observed due to turbulence or seiche on a lake or pond. If the logger stage is slowly moving, even within 1mm, then the intakes can be assumed to be clear.

Sediment checks of both wells and intake pipes shall be carried out regularly as part of routine recorder servicing, and particularly following high flows that may have deposited sediment.

### Flushing

This process is an important part of operating a water‑level recording station. All stations on rivers should be flushed at least annually as preventive maintenance, and more frequently on rivers that carry a lot of suspended sediment.

Normally both the well and the intake pipes are flushed together; however as the intake pipes are the most important but the hardest to inspect, they may be done more regularly.

The various methods are:

***(a) Installed flushing systems***

Valve and pipe systems fed by header tanks can be fitted in to some recorder towers.

The system consists of a valve on each intake pipe at the tower end, usually capable of operation from the top, which will close off the intake pipe from the well. On the river side of the valve, a pipe tee connects in a header tank. In operation, the valve or valves are closed, the header tank is filled and then the water released into the intake pipe(s) to flush them.

Although the volume of water in the internal tanks is relatively small, an augmented supply (e.g. from an external tank fed from a hut roof or spring) may assist, and frequent use will ensure that intake pipes are kept clear. Flushing of the well will need to be carried out separately.

***(b) Modified flushing systems***

Where such systems are fitted but do not prove efficient, it may be better to replace the header tank with a convenient connection for a pump. This will enable considerable pressure and a large volume to be applied to the intake pipes and flush them effectively. Towards the end of the flushing, the valves could be opened with the pump still operating to clean them of silt also.

**NOTE:** Re-plumbing the ex‑header tank pipe could be done in galvanised pipe or a suitable plastic pressure hose, and it could terminate inside or outside the tower. Using a quick release coupling for the pump hose such as a "Camlock" brand fitting will be convenient.

***(c) Installing flushing systems***

When installing a recorder tower or new intake pipes, inclusion of a valve (a brass gate valve is best) and tee as described above will often be a worthwhile facility. They could either be inside the tower or just on the outside with access to the valve via a "well" of say, PVC pipe.

***(d) Connecting a pump to the static tube***

This can also be an efficient means of flushing the intake pipes, although it requires the stage to be low enough to get to the static pipe.

If the pump outlet hose has a “free” end (i.e., no fitting on the end), then a very quick and simple method is to remove the static tube and crease the end of the hose so that it can be inserted into the intake pipe for about 200 mm (this will only work for a 50 mm intake and pump hose, but these are the most common sizes). Once the pump is started, water pressure will expand the hose against the side of the intake pipe and thus produce a good seal. The benefit of this method is that the full pressure head of the pump is applied to the intake, and pumping for only a few minutes is all that is required. The disadvantage is that silt will be flushed into the stilling well. If two intake pipes are available, then the top intake is usually pumped and the overflow will emerge from the lower intake. Pumping should be continued until clear water is emerging from the lower intake.

 ***(e) Flushing the well***

The bottom of the stilling well operates as a reservoir for silt, which shall not be allowed to approach the elevation of the lowest intake pipe. Silt shall be regularly removed to prevent this.

The most straight‑forward method is to pump water into the well at a high flow rate so that the silt is stirred up into suspension and the mixture flows out of the intake pipe, finally flushing this also. With larger quantities or heavier particles this does not work well and alternatives can include :

* Entering the well and scooping out sediment directly, such as with a bucket on a rope. This can be effective, but often laborious. Having a person down a well with bucketfuls being lifted upwards on a rope is unacceptably dangerous, and NIWA’s policy of entering confined spaces must be followed (e.g., harness, recovery winch, gas meter, etc.). Consequently, this is a “last-resort” method, and alternatives shall be sought.
* One pump delivering water in and stirring up the sediment as another pumps it out.
* Alternating pumping water in and then out, particularly if the intake pipes are blocked.
* Using compressed air to stir up the silt into suspension while the mixture is pumped out.
* With the intake pipes blocked off, using a suitable pump (e.g. a diaphragm pump) to remove the thick silt and water mixture directly.

**NOTES:** Centrifugal pumps and most impeller pumps will not pump a thick mixture of sediment without damage to the seals or impeller. Diaphragm pumps can usually handle this. The manufacturer's specifications should be consulted to avoid high repair costs.

As silting of wells can be a prime cause of below‑standard data, a planned programme of detection and prevention is essential. An investment in effective flushing systems and equipment is likely to be most worthwhile.

## General site maintenance

All installations shall be maintained in good order so that they are fit for carrying out their intended task, are sufficiently tidy for efficient work practice and so that all who may visit gain the (correct!) impression of a professional operation. The latter point is important, both for the perception of visitors who are often providers of funding, and for the work attitudes of hydrological staff. Primary maintenance requirements include the following:

* Structures painted or finished in colours and textures which blend with the landscape (bare galvanising may well be acceptable, particularly if weathered).
* Weeds are absent or controlled.
* A standard sign which briefly explains who operates the station and its purpose, is good public relations and may reduce vandalism
* Access tracks shall be maintained in a safe condition, including being clear enough of weeds for safe passage.
* Timber work on catwalks, platforms and cable-cars shall be maintained in a sound and safe condition; replace any deteriorating timber with H5 grade timber where there is contact with ground or concrete, otherwise H4 is permissible. Note also that modern structures must meet building codes and NIWA has standard designs to follow where possible and guidelines for where custom solutions are required. See the NIWA Hydrometric Structures Manual.

## **Instrument maintenance**

Well-maintained recording and measuring instruments are vital, and need to be checked and treated with requisite care to ensure their accuracy and reliability.

**Procedure for Biennial Station Inspection**

**1. Form Heading**

Give the site number, date, etc., and date of last inspection. Note any work still not done.

**2. Levelling Check**

Give the date and all level book details of this levelling check, along with the start BM. Enter the name of the datum used.

Do the levelling, ensuring that all benchmarks, staff gauges, EPB, tower reference points (see 8 below) etc., are measured either twice if read as intermediates, or at least once if used as change points. Reduce and calculate the close on-site. It must be within ± 3 mm.

**3 Benchmarks**

List the differences between the RLs measured and those on the Station History Form. Enter the name of the datum used (if assumed, note the BM with the assumed value). Indicate whether each BM’s measured value is correct to within ± 3 mm and give explanatory comments if not.

**4 Staff Gauge Zero**

Compare the RL zero of each staff gauge and confirm if within 3 mm. Give full comments if not, including proposed remedies.

**5 Internal Gauge**

Record (with the staff gauge data) the internal gauge RL zero determined from the levelling and any difference with the value on the Form SH. Check that the EPB has a clear and stable index mark, the plumb-bob is secure, and that the connection to earth is reliable.

**6 Recorder RL zero**

The primary reference (exclude the BMs) refers to the measurement to which the record will be related and corrected to; state which this is (normally the EPB). Note whether the logger reading is in agreement with this.

**7 Logger Details**

Note the details of make, type, serial number and reading interval. Include details of other instruments and sensors. The nominal range refers to the sensor and the possible range should be determined by raising the float through the full range.

**8 Stilling wells and sensors**

Record whether the installation is generally adequate, and whether the station as a whole promotes NIWA as a professional organisation.

Check that the tower reference points (underside recorder floor, well invert, invert of upper and lower intake pipes) are unchanged.

Note whether sensor mounts are secure, clear of sediment and protected from likely damage, and that the sensor tube or cable is protected from damage by stock, vandals, floodwater and subsidence.

Check the intake pipes for damage and sediment and any detrimental effect on the record. Determine if the flushing frequency, techniques and facilities are effective.

If the gas purge pressure sensor shows a discrepancy with the staff gauge, carry out a purge cycle.

**9 Safety**

Consider whether access to the site and installations is safe.

Check the safety of the gauging location; bridges for soundness of decking, handrails and flood and traffic hazards; wading and other gauging sections for general safety of use.

**10 Recorder operation**

For both the backup and main recorders, note whether the recorder(s)/encoder are accurate, securely mounted and easy to service. Logbooks should be filled in properly and be legible.

**11 Power supply**

Consider whether adequate, test the voltage during a reading, check for diode protection between batteries/recorders, and check the wiring for tidiness, corroded terminals, unsoldered connections, undue tension and potential breaks.

Batteries should be marked with date of entry into service, as well as having a record of charging, discharge testing, conditioning, etc. as appropriate. Check and test any solar panel, lightning protection, etc.

**12 Float systems**

Raise the float and check it for leaks, growth, obstructions, that the connections are secure, and that the tape or wire is free of kinks and damage. Check that the float will travel through its full range without striking obstructions, and that the float tape is undamaged. Ensure that the logger resumes its correct reading, and beware of setting off alarms. Sound the depth of sediment in the well.

* 1. **Weir**

Check that it is clean, undamaged and there is no evidence or suggestion of leakage. Look for sedimentation and backwater effects that may be altering the rating.

* 1. **Gauging reach**

Check whether the gauging reach has relatively laminar flow, uniform depth, parallel flow lines, etc., and absence of weed growth, vegetation and other obstructions.

Check whether the gauging distance markings are clear if applicable, and if the gauging distances can be reliably referenced between gaugings to provide a record of the gauging cross-section.

**15 Records**

Comment on the accuracy of the stage record, the stability of the control(s), and any other factors not so far covered which have a bearing on the accuracy of data since last inspection.

**16 Certify correct**

Certify that this check is comprehensive, and that the data from this site is being collected according to the required standards and procedures, unless otherwise noted on this form.

**17 Reporting and filing**

The Manager ensures that:

* The inspection has been carried out correctly.
* Any work required is done or is in the team’s work programme.
* The completion of the work required is noted on the form, and that it is filed appropriately as a permanent record on the SH form of the effectiveness of the station and the integrity of its data.