

### The Waterloo Multilevel Monitoring Well System

The Waterloo Multilevel Monitoring System is comprised of modular units designed to allow discrete monitoring from several zones within a single borehole. A variety of portable or dedicated instrumentation allows users to retrieve samples, determine piezometric head, temperatures and conduct basic hydraulic conductivity tests at each zone.

Casing modules incorporating a patented Slip Joint Connection form the backbone of the system. Packer and port combinations are employed to isolate sampling zones. All instrument tubing and cabling is contained within these modules and collected at the top of the system into an efficient and uncomplicated well head manifold.

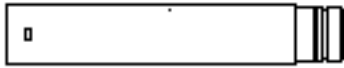
### Component Lengths for layout determination/calculation

**The Base Plug:** PVC, 0.08 feet length.



**The Casing:**

SS or PVC 1, 2, 5,  
& 10 foot lengths.



**The Port:**

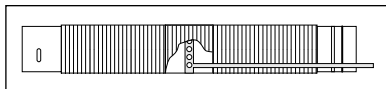
Std. PVC  
0.5 foot length



Std. Stainless Steel  
0.5 foot length



Screened PVC,  
2.5 foot length



**The Packers:** - 3.0 ft. length



### Designing the Waterloo System Layout

In designing the layout it is preferable to allow one to two feet of clearance above the bottom of the borehole. Problems of measurement inaccuracy, sloughing during installation and other unforeseen events which may prevent well completion are thus minimized.

The order in which units of the system are to be assembled must be determined ahead of time. It is best to design the layout with a schematic drawing and/or using the Waterloo System Installation Logs included in the Fitting Kit.

Borehole sections between monitoring zones are spanned by Casing Modules and/or Infill Packers. The number and length of casings are determined by the distance between the upper packer of the lower zone and the lower packer of the upper zone, (where packers are used/required).

**Note:** Your chosen port locations may have to be adjusted up or down slightly since the smallest standard casing length is one foot.

An installation log should be filled out once the final well design has been determined (see the example log).

A well log will provide a permanent record of all pertinent information regarding the well and the installation process. General information regarding the well is recorded at the top of the log. Required inventory for well completion is recorded in the upper right section. The left side of the log is used to record and confirm the order in which the units are to be assembled starting from the bottom of the well at the top of the page.

### Record on the Log:

- The order in which the modules are to be assembled in the "Unit" column.
- The quantity of each module required in the "Equipment Required" box.
- The depth from datum to the top of the unit in the "Depth to Top" column. (The top of each unit is measured at the shoulder of the male joint.)
- The required dedicated instrumentation and/or any other special information in the "Notes" column.
- Have the site supervisor double check all information on the log and sign-off the layout in the space marked "Approved".

### Installation of the Waterloo Multilevel Monitoring System

#### In General During Installation:

- One person should be in control of the Installation Log and direct others according to the Log.
- Add only enough water to the casing string to counteract buoyancy if the system begins to float.
- The system will become heavy if the water table is more than 50 feet below grade. Extra personnel will be needed to hold and lower the system as installation progresses.
- Some form of mechanical assistance to hold and lower the system will be required if the water table is more than 100 feet below grade.

#### Before You Begin:

- Ensure that the full shipment has been received and that none of the equipment has been misplaced or damaged.
- Locate the Fitting Kit (white plastic box with black lid) and ensure that the proper tools and equipment are available (a list of the contents is provided in the kit).
- Transport the required equipment to the borehole (use the Installation Log as an inventory check-list).
- Check the depth of the borehole immediately prior to installation.

## Before You Begin Continued:

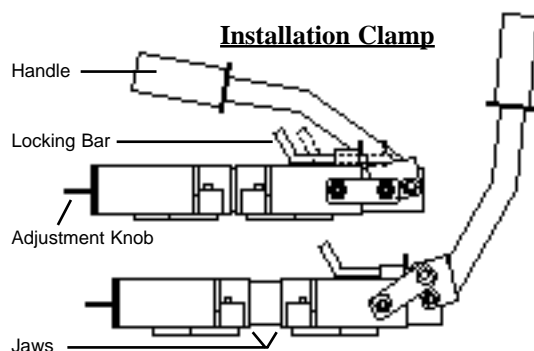
- Measure and mark a straight line distance equal to the depth of the first port plus 10% along the most suitable ground (clear, level, dry) out from the borehole. It may be desirable to lay plastic sheeting around the borehole and in a straight line (greater than 3' and less than 6' wide) to the marker.
- Arrange all equipment and inventory near to the borehole (preferably in a shaded area). Leave all modules boxed and bagged until they are needed. Bags are to be opened but not to be removed until each unit has been assembled at the borehole.
- Use the wooden rod (provided) as an axle for the tubing reel(s). The reel(s) should be located in close proximity to the borehole.
- Locate the installation clamp(s). The clamp(s) can be used to hold and to lower the system during installation.
- Ensure approximately 15 US gallons per 100 feet (60 L per 30 m) of system of "clean" water is available.

## Begin The Installation:

- Locate the base plug, check that the o-ring is in position and lightly lubricate the outside of the male end of the joint with the white lubricant provided.
- Lightly lubricate the inside of the female end of the next unit and push/twist the units together. Use the spray bottle provided in the Fitting Kit (filled with "clean" water) to wash any grit from the joints prior to assembly.
- Lock the units together by pushing the nylon tie through the "window" until it meets itself. Pull the tie through the "window", lock and pull it tight. Cut off the excess.

**Note:** All remaining Slip Joint Connections will be assembled in the same manner.

- Adjust and lock the installation clamp(s) onto this assembly.
- Slide the locking bar to the unlocked position and open the clamp by lifting on the handle. Adjust the width of the jaws via the adjustment knob so that the casing is held tightly when the clamp is closed. **Return the locking bar to the locked position.**



Hang the assembly in the well.

- Install the next modules (as indicated by the Installation Log) up to and including the first Port. Loosen the clamp(s) and lower the system as necessary.
- Check-off progress in the "In" column of the Installation Log as each module is attached.
- Attach Open Tubes to the Port.

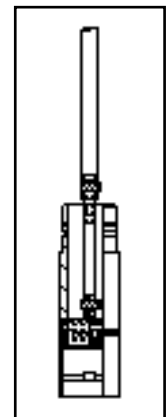
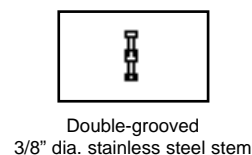
**Note:** Each tube/cable must be identifiable upon completion of the well. Use a knife to carve small "v" notches approximately 5 cm (2") back from the end of each tube (all tubing attached to the first port will receive one notch, all tubing attached to the second port will receive two notches etc).

- Push a cap (from the Fitting Kit) onto each tube and, with the reel in position at the borehole, walk each tube from the first port only out to the marker. The end of this tubing will advance toward the bore hole as the system is lowered into the well. Tubing from each successive Port is simply reeled out to the end of this tubing (no further measuring is required).
- Cut the tubing from the reel. Carve the appropriate number of "v" notches into the tubing on the reel and place a cap on this end of the tubing.

## To Attach 5/8" x 1/2" Open Tubes:

### PVC Ports

- Push a double-grooved 3/8" Ø stainless steel stem (from the Fitting Kit) all the way into the 1/2" x 3/8" tubing protruding from the port.
- Slide a #17 clamp onto the 5/8" x 1/2" Open Tube.
- Push the 5/8" x 1/2" Open Tube over the 1/2" x 3/8" tubing until it passes the 3/8" Ø stem.
- Locate the clamp over a groove and, using the red handled end-cutters provided, crimp the ear of the clamp fully.



PVC Port with 5/8" x 1/2" open tube

## Continue The Installation

- Continue to assemble the system by walking the required modules female end first, in their proper order, over the tubing/cable extending from the borehole.
- Connect all modules as described under "Begin The Installation".
- Add water to the casing string to counteract buoyancy if the system begins to float.

**Note:** The water level inside the system must not exceed the static water level of the borehole during installation.

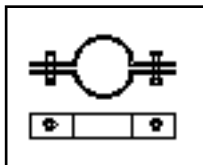
- The external to internal water level differential should not exceed 30 m (100 ft) at any time **during** installation.
- The internal to external water level differential should not exceed 30 m (100 ft) at any time **after** installation.

## Always Remember To:

- Ensure that all o-rings are in place, clean and undamaged.
- Lightly lubricate both the male and the female ends of the joints just prior to connection.
- Properly install the nylon tie and remove the excess.
- Check-off each unit on the Log as it is connected.
- Mark all tubing/cable with the appropriate number of notches.

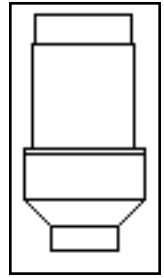
## To Attach the Standard Well Head Manifold:

- Determine the desired "stick-up", include the height of the Well Head Manifold, when the final depth has been reached.
- Install and tighten the "Riser Clamp" (provided in the Fitting Kit) such that the proper "stick-up" is maintained when the system is hung.
- Raise the casing string and re-install an installation clamp below the final casing joint.
- Remove the last length of casing from the system/tubing/cable and cut off the male end at least 10 cm (4") above the top of the "Riser Clamp" using the hacksaw (provided in the Fitting Kit).
- Reinstall the casing.
- Remove the installation clamp and lower the casing string to hang via the "Riser Clamp" in its final position.
- Take a water level reading in the borehole and record in the "Water Level at End" box on the Log.
- Fill the system with "clean" water. Do not exceed 30 m (100 ft) above the water table.
- Remove the two screws from the white Riser of the Well Head Manifold Base (screwdriver provided in the Fitting Kit).
- Pull the Manifold out of the Riser.
- Slide the Manifold Base (small end first) over the tubing/cable and casing string until the proper final elevation is reached.



Installation  
Clamp

- Hold the Manifold at its proper elevation relative to the Manifold base to determine proper trim lengths for all tubing/cable.
- Choose a "convenient" final trim length for the Open Tubing, DVP Sample Tubing. Open tubes are typically trimmed approximately 2" above the top of the manifold.



Well Head  
Manifold

- One at a time, trim the Open Tubes, to this length while transferring the appropriate number of notches to the appropriate tubes.
- Push the Manifold base down onto the casing string to allow access to the compression fittings on the bottom of the Manifold.
- Slide the natural Open Tube tubing, through the appropriately numbered holes on the Manifold.
- Slide the Manifold Base up over the Manifold and replace the two screws.
- Replace the caps on the shortened tubing.