1. **SCOPE**

1.1. **Description**

This method describes the installation, monitoring and maintenance procedures for U.S. Bureau of Reclamation (USBR) hydraulic piezometers. They are used to measure pore water pressures by means of a plastic tip with an embedded ceramic disc that allows the pore pressure to affect a closed system of water filled hoses extending to the surface.

1.2. **Application**

These piezometers are normally used during construction in fill areas. Once the piezometer has stabilized, the response time is immediate and changes in water pore pressure can be determined as they occur.

1.3. **Units of Measure**

Readings are taken from the pressure gauge installed with each unit and recorded as kPa or p.s.i.

2. **APPARATUS AND MATERIALS**

2.1. **Equipment Required**

Flat screwdriver.

Robinson screwdriver.

Set of open end wrenches.

Hand pump and pail (Figure 1).

Measuring tape, weighted at one end.

2.1.1. **Piezometer Tip**

A solid plastic body machined to specifications (Figure 2).

(4) 3 mm x 9 mm stainless steel or brass bolts.
(1) stainless steel end plate 50 mm in diameter with a 22 mm hole in the centre.

(1) ceramic filter disc 6.3 mm x 25.4 mm diameter.

(2) 6.3 mm brass to 9.5 mm tube compression coupling.

(1) 32 mm O-ring.

15 litres of clean water.

10 ml bottle of food colour.

2.1.2. Control Box

A wooden box of sufficient size to house the above ground apparatus. It must have a lid with a lock for security (Figure 1).

(1) Bourdon pressure-vacuum gauge, 206 kPa (30 psi pressure-vacuum).

(2) 6.3 mm brass gate valve.

(1) 6.3 mm "T" brass fitting.

(2) 6.3 mm x 6.3 mm male brass couplings.

(4) 6.3 mm x 8 mm brass-to-tube compression coupling.

8 mm I.D. plastic tubing (9.5 mm O.D.).

Teflon tape.

12 mm copper pipe brackets.
3. **PROCEDURE**

3.1. **Description of Preparation**

3.1.1. **Piezometer Tip**

Boil the ceramic filter disc in water for a few minutes to assist in removing trapped air bubbles.

Place the disc into the bottom of the tip.

Place the O-ring into the groove and secure with stainless steel end plate and screws (Figure 2).

Immerse the assembled tip in a container containing distilled water.

The remaining assembly is done during installation.

3.1.2. **Control Box**

Screw a brass-to-tube compression coupling into each end of a gate valve.

Note - use teflon tape on all screw joints.

Using the pipe brackets mount the valve to the wood trip at the back of the box, parallel to and near the bottom with the valve cock facing outward.

Screw one compression fitting into the left side of a "T" fitting and one into the right side of the other gate valve.

Connect the "T" fitting and valve using a 6.3 mm x 6.3 mm male brass coupling.

Screw the Bourdon gauge to the top of the "T" fitting.

Mount this assembly to the back of the box parallel to and near the top using the pipe brackets. The brackets should be loosely attached and securely fastened during the installation procedure. The Bourdon gauge should be flat against the wood strip and the valve cock should be facing outward (Figure 1).
3.2. **Installation**

3.2.1. **Materials Required**

Completed piezometer tip.

Completed control box.

A small cloth bag to enclose the tip.

A metal cage or perforated cup 12 mm x 8 mm in diameter.

A small amount of silica sand (½ lb).

Some fine clean sand (100% passing 5 mm and < 5% passing 71 µm). A 10 litre pail should be sufficient.

A screen sock 350 mm x 100 mm in diameter.

Lead weights no larger than 60 mm in diameter.

Electrical tape.

Approximately 9 kg of bentonite pellets.

Approximately 8 m of 19 mm diameter aluminum flexible conduit.

A 20 m roll of pipe wrap insulation.

A hand pump set up to deliver water through an 8 mm tube (Figure 1).

3.2.2. **Installation**

The borehole is drilled to the depth at which the piezometer is to be installed. The hole is cleaned out to remove all disturbed material and a thin wall tube sample taken. In the case of washbore drilling, the hole should be flushed with clean water.

If casing is used, the piezometer may have to be installed before the casing is removed.

Measure two equal lengths of plastic tubing with sufficient length enough to reach from the gauge box to the bottom of the hole. Note that the hoses need
additional length to allow installation over the top of the control box (Figure 1). Tape each end of one length for easier identification during installation.

Attach one end of the taped length to the vertical hole in the piezometer tip (inlet) using the compression fitting.

Attach the other tube to the diagonal hole in the piezometer tip (outlet). Make sure that both connections are secure.

Starting 1.0 m from the tip, tape both tubes together every 1 - 2 m.

Place the cloth bag into the wire cage and fill the bottom third with silica sand.

Place the piezometer tip into the bag and fill the remaining void with silica sand.

Tighten the drawstrings of the bag or wrap the top around the tubing and tape it shut.

Place lead weights, then fine clean sand in the bottom of the screen sock until one-third full.

Place the metal cage into the sock and add more clean sand leaving enough screening to wrap around the tubing. Tape this end securely (Figure 3).

Attach intake tube to the hand pump. Pump water through the system to check for leaks and line clearance.

Lower the piezometer to the bottom of the borehole. Because the piezometer is light weight, in deeper holes it may be necessary to push it in place with a placing tool. The tool is a simple fork that fits over the top of the sock. It is attached to E-rod and coupled together to whatever length is required.

Pour enough clean sand down the hole to cover 0.6 m above the top of the sock. The measuring tape with a weight attached is used for sounding.

Pour bentonite pellets down the hole to form a layer 0.5 m above the sand pack. The measuring tape is again used for sounding.

In a deep hole, the long screen sock used with the pneumatic piezometer may be substituted. The previous two steps are omitted and the top half of the sock is filled with bentonite pellets for added weight and to insure a proper seal.

In the case of an auger hole, pour some water down the hole to allow the pellets to expand.
The hole can be grouted to surface if required by the Engineer (refer to STP 240-19, grouting procedure).

Mark a 90 mm x 90 mm post with the piezometer number and place in or near the borehole and attach the control box. Care should be taken to see that the box is mounted as level as possible. It may be necessary to move the marker post and hose ends away from the borehole. In this case, a trench approximately 0.5 m in depth should be excavated from the borehole to the post location. A thin layer of sand is then placed in the trench and the piezometer hose laid in a meandering fashion to allow slack for differential settlement. Another layer of sand (approximately 0.2 m) is placed before backfilling and compacting the balance of the trench.

Cut two lengths of aluminum flexible conduit to protect the hoses starting from the left side and looping over the control box with about one metre buried in the trench (Figure 1).

Secure the sheath hoses together and wrap them with insulation (pipe wrap).

Run the taped tube (inlet end) through the hole in the side of the box and connect it to the left side of the bottom valve in the control box.

Connect the other tube end to the left side of the "T" connector with the Bourdon gauge.

Hook up the water pump to the right side of the bottom valve.

Open both valves.

Unscrew and invert the gauge. Using a syringe, inject water into the bottom opening until you are certain that no air bubbles are present.

Add food colouring to dye the clean water supplied to the pump. Pump water through the system until the coloured water appears at the outlet valve.

Continue pumping slowly as you install the Bourdon gauge into the top of the "T" fitting. Close the outlet valve. Slowly close the inlet valve until there is 103 kPa (15 psi) showing on the gauge. Pressure within the system should never exceed 206 kPa (30 psi).

Remove the pump line, close and lock the control box.
3.3. **Maintenance and Winterizing**

The piezometer should be flushed at least once a year or more often if air bubbles develop in the lines. Looping of the hoses above the control box allows the bubbles to accumulate in the top portion of the loop, keeping them away from the gauge.

Before winter, the piezometer must be flushed with a non-freeze solution consisting of 2 1/2 parts methyl alcohol or methanol, 1 part glycerine and 1 1/2 parts clean water. To inhibit bacteria, 100 ml of formaldehyde may also be added. For deep piezometers, 10 - 25 ml of a 25% solution of Aerosol O.T. should be added to make the water "slippery" reducing resistance in the lines.

4. **REPORTING RESULTS**

Installation procedures should be recorded on the "U.S.B.R. TYPE PIEZOMETER" report form (Figure 4). A diagram and a "FIELD BOREHOLE LOG" should accompany the "U.S.B.R." form.

The pressure gauge is read directly in kPa or p.s.i.

- Height of Head (m) = kPa x 0.10
- Height of Head (ft) = psi x 2.307

Reading should start 3 or 4 days after installation and be taken periodically (as directed by the Engineer) and submitted to Geotechnical and Materials Branch as well as the Project Engineer.

5. **REFERENCES**

Earth Manual, United States Bureau of Reclamation 1968
FIGURE 1
FIGURE 2

OUTLET  INLET

8 mm ID (9.5 DD) PLASTIC TUBING

6.3 mm BRASS to 8 mm TUBE

PLASTIC BODY

45°

"O" RING

25.4mm

32mm

51mm

19mm

3mm

6.3mm

3 mm x 9 mm BOLT
(BRASS or STAINLESS)

CERAMIC FILTER DISC

16mm R

END PLATE

6.3mm

25.4mm

ø 51mm

ø 22mm

STAINLESS STEEL
(<1 mm THICKNESS)
### U.S.B.R. PIEZOMETER SUMMARY SHEET

<table>
<thead>
<tr>
<th>CONTROL SECTION</th>
<th>PROJECT</th>
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<td>SPEZOMETER NO.</td>
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<tr>
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<td>DEPTH TO POROUS TIP</td>
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<tr>
<td>ELEVATION OF CENTRELINE OF GAUGE CONNECTION</td>
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</tbody>
</table>

If more than one gauge in box, give gauge position
eg. Number (from TOP LEFT hand corner)

WINTERZED | YES | NO |

* Detail borehole backfilling sequence from top of sand to natural ground.

FIGURE 4
APPROVAL SHEET

New _X_ Revision _ _ Date of Previous Document _ _ _ _

Effective Date:  94-03-18

Description of Revision (Reason for Revision):

_Fabrication and installation of a U.S.B.R. piezometer_

Review/Implementation Process:
_Circulated in Geotechnical and Materials Branch_

Other Manuals/Policies Affected:
_Nil_

Follow Up/Training Required:
_Nil_

Comments/Concerns/Implications (Budget/Environment/Stakeholders):

_None_

Prepared and Recommended by George Wasyliw 92-04-02
Geotechnical Testing Supervisor Date

Approval Recommended by R.A. Widger 94-03-15
Senior Materials Engineer Date

Approval Recommended by A.R. Gerbrandt - -
Dir., Technical Standards & Policies Br. Date

Approved by D.G. Metz 94-03-18
Assistant Deputy Minister, Operations Div. Date

Electronic File Updated 94-03-30
Update Mailed - -