Installing Monitoring Wells & Piezometers

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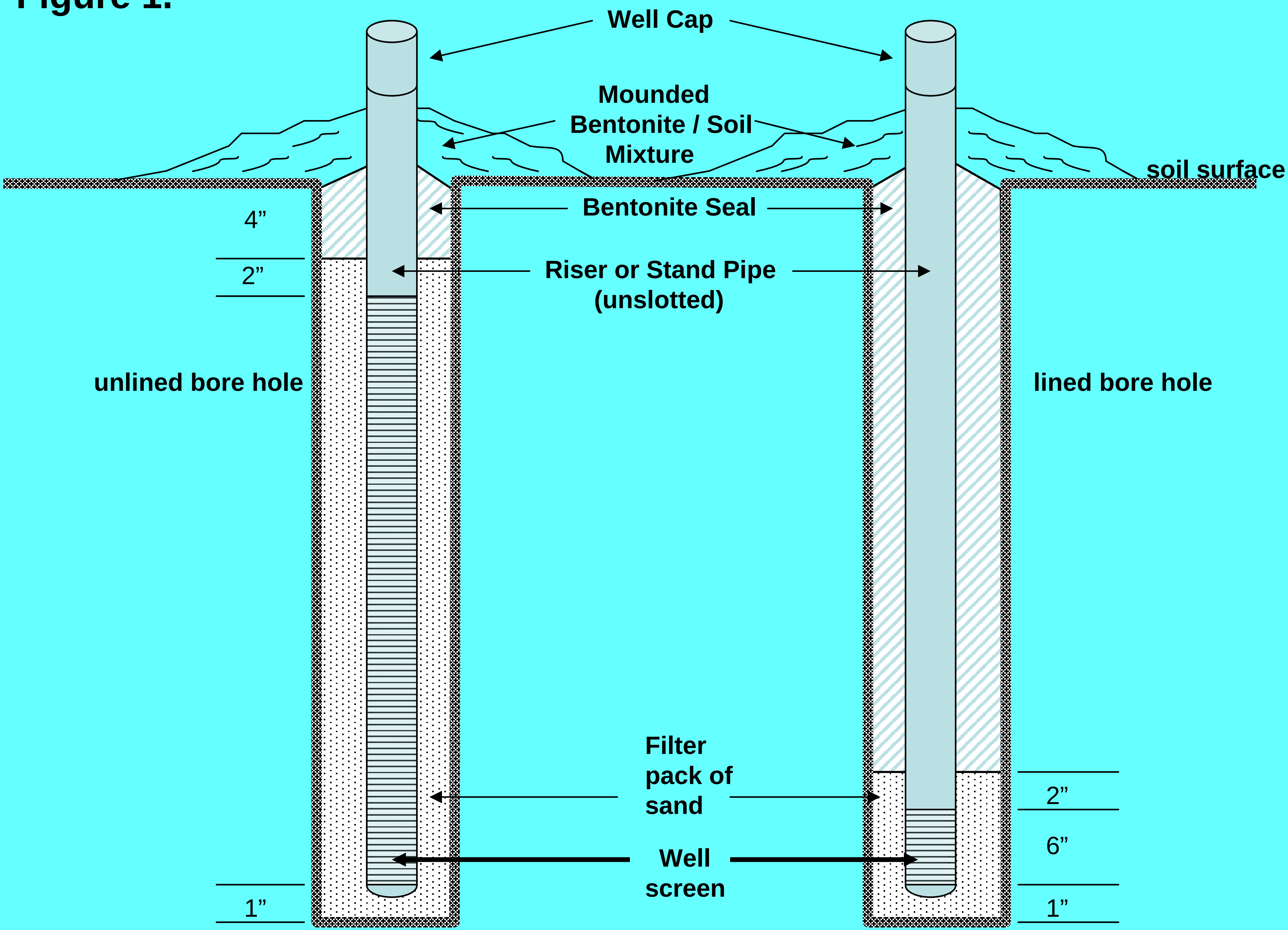
Acknowledgements

- Jim Richardson for inviting my participation
- Wes Miller for sharing his years of experience and still taking an interest in these, even after retirement

Applications

- Soil Survey Technical Guidance
- Hydropedology Research

Figure 1.



1A. Shallow monitoring well

1B. Piezometer

Overview

- **Wells**
- Unlined Boreholes
  - no bentonite seal
- Slotted full profile
- Used for
  - max ht of free water over intake length

- **Piezometers**
- Lined Boreholes
  - bentonite seal
- Slotted 1 horizon
- Used for
  - free water pressure at intake depth
  - presence of free water at intake depth

Overview, cont

Wells

- fill from top
  - Ksat high
- drain from bottom
  - Ksat low
- Reservoir effect common

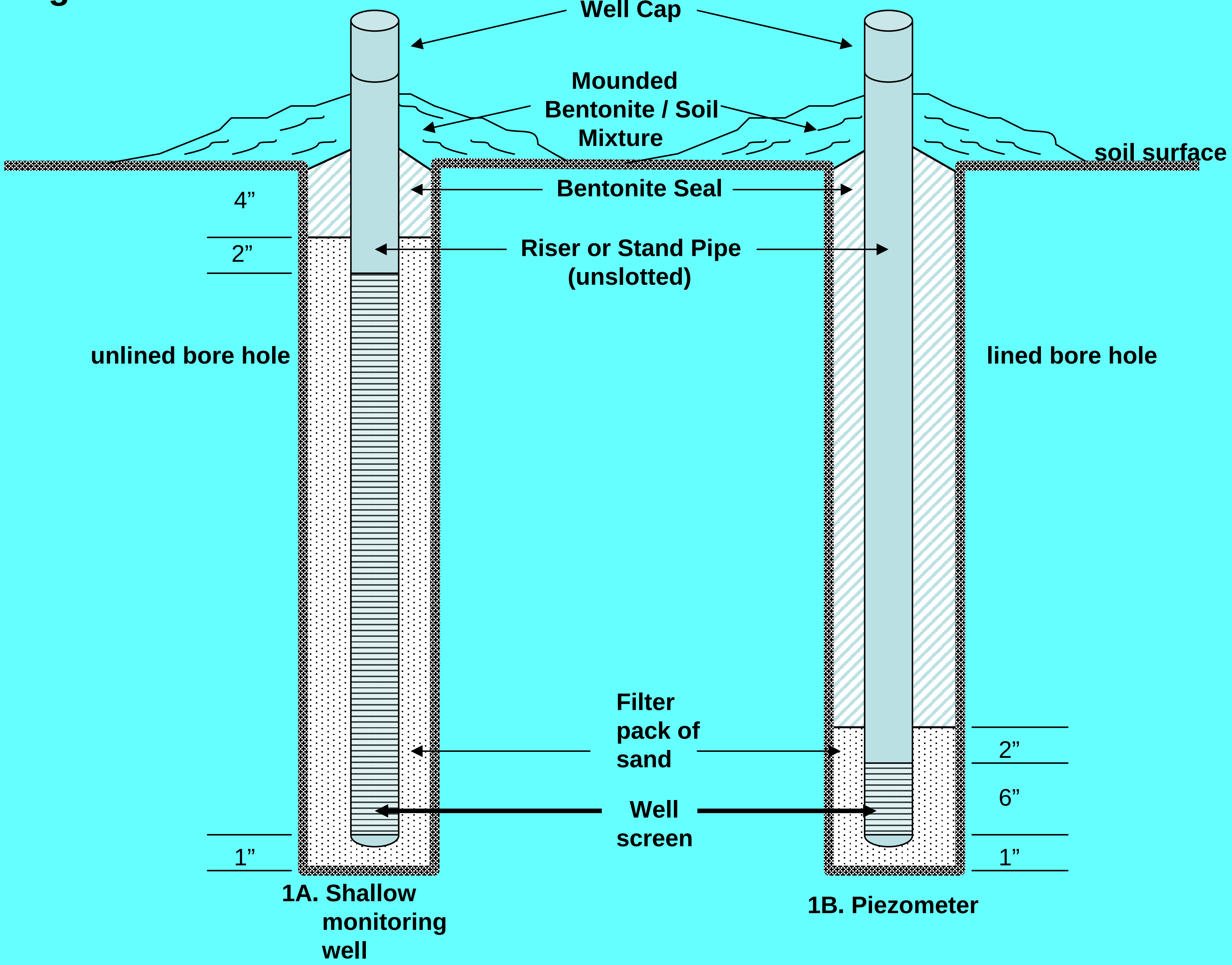
Piezometers

- fill & drain from same horizon
- Minimal reservoir effect

Installation

- See Figure 1 at end of draft

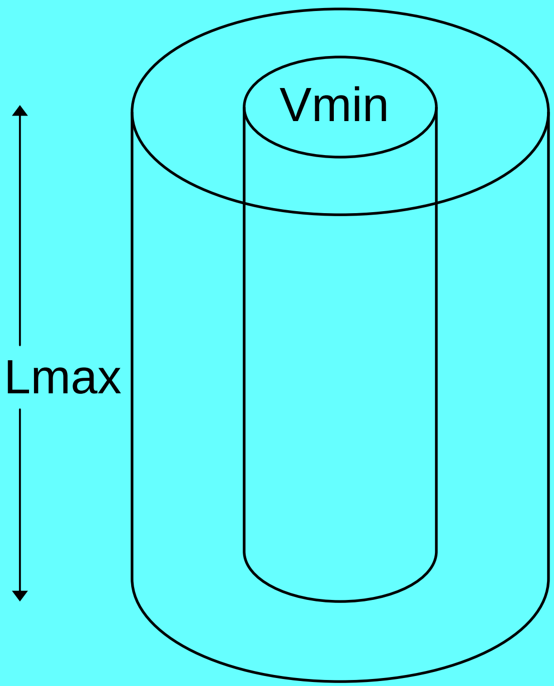
Figure 1.


Well Cap
Mounded
Bentonite / Soil
Mixture
soil surface
Bentonite Seal
4”
2”
Riser or Stand Pipe
(unslotted)
unlined bore hole
lined bore hole
Filter
pack of
sand
2”
6”
Well
screen
1”
1”
1A. Shallow
monitoring
well
1B. Piezometer

QUESTIONS

1. Slotted vs drilled intake screen
    1. How many drill holes?
    2. How big drill holes?
    3. How long is the screen? 6”? 4”?

Wetlands 21:412-421, 2001, Hanschke & Baird



RESPONSE-TIME THEORY

The theory of piezometer response time was first elucidated by Hvorslev (1951). Hvorslev's theory assumes a rigid soil in which Darcy's Law describes the flow of water below the water table. For simplicity, Hvorslev (1951) considered a hydrostatic situation in which the water level in the piezometer was initially in equilibrium with pore-water pressures around the piezometer intake. He then assumed that pore-water pressures in the real system changed instantaneously to a new constant level. Following the notation given in Figure 2, he noted that the instantaneous discharge of water into the piezometer is given by

$$Q = A\frac{dH}{dt} = FKh \qquad (2)$$

where A is the inside cross-sectional area of the piezometer standpipe (L^2), H is now the water level in the piezometer (L) (compare with equation (1)), t is time (T), h is the difference in head between the piezometer and the soil around the intake (i.e., $P - H$) (see Figure 2; when h is negative, Q is also negative and water flows *from* the piezometer; when h is positive, water flows into the piezometer), and F is the shape factor of the piezometer intake (L), which is a function of the size and shape of the piezometer intake and the pattern of flow around the intake. Hvorslev

Wetlands 21:412-421, 2001, Hanschke & Baird

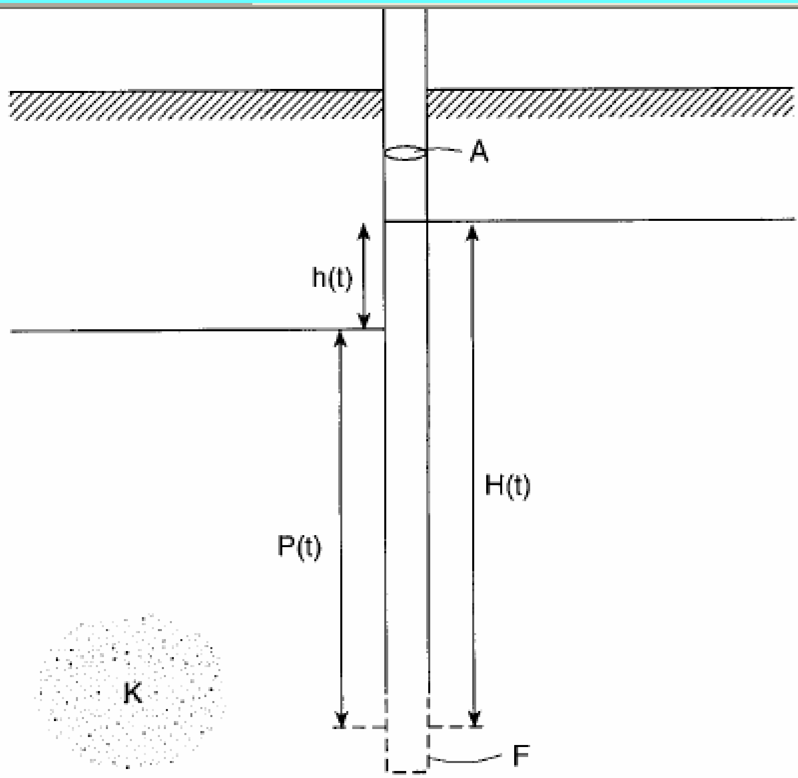


Figure 2. Piezometer notation.

(1951) showed that if a new variable, the basic hydrostatic time lag, T, is defined by

$$T = \frac{Ah_0}{FKh_0} = \frac{A}{FK} \qquad (3)$$

where h_0 is the initial difference in heads between the

(cf. Hvorslev 1951, Anderson and Kneale 1987).

F for closed bottom, cylindrical intakes can be calculated using the empirical formula of Hvorslev (1951) as modified by Brand and Premchitt (1980) (see also Brand and Premchitt 1982):

$$F = \frac{2.4\pi l}{\log_e(1.2l/d + \sqrt{1 + (1.2l/d)^2})} \qquad (6)$$

where d is the o.d. of the intake and l is the length. The efficient piezometer had a standpipe inside di-

NOTE

Equation (5) was coded in a Visual Basic (v.3) program, which allows the user to change F, K, and A and enter any series of P(t) data. The program is available free of charge from the second author.

QUESTIONS, cont

2. Well Stock

   How narrow is practical for automatic recorders?

3. Automatic Recorders

   Solinst, Georgetown, Ontario

   Slope Indicator, Mukilteo, WA (vibrating wire)

   Geotech, Sweden

   RST Instruments, Coquitlam, BC (pneumatic piezometers)

QUESTIONS, cont

4. Automatic Recorders

Solinst, Georgetown, Ontario

Slope Indicator, Mukilteo, WA (vibrating wire)

Geotech, Sweden

RST Instruments, Coquitlam, BC (pneumatic piezometers)

Drive-Point Piezometers

Model : 615 Data Sheet

Model 615

Stainless Steel

Drive-Point Piezom

The Model 615 Drive-Point Piezom
personnel a truly inexpensive meth
in suitable conditions.

Solinst 615 Drive-Points attach t
steel drive pipe which is widely
plumbing and hardware stores.

Solinst Drive Point Piezometers
permanently as wells, for short-term
of groundwater level and quality. T
and removed. Drive-point, tubing
available to suit almost every situa

High quality samples can be obta
Teflon® lined tubing is attached to
point. A shielded version is availab
or smearing of the screen during in
head measurements are taken wit
diameter equipment, as described

Solinst Drive-Point Piezometers
ground, or the soil at the bottom of a

neters

neter is designed to give field
od to monitor groundwater

o inexpensive 3/4" NPT
available through local

are most often installed
n or long-term monitoring
hey can also be used once
and pipe alternatives are
tion.

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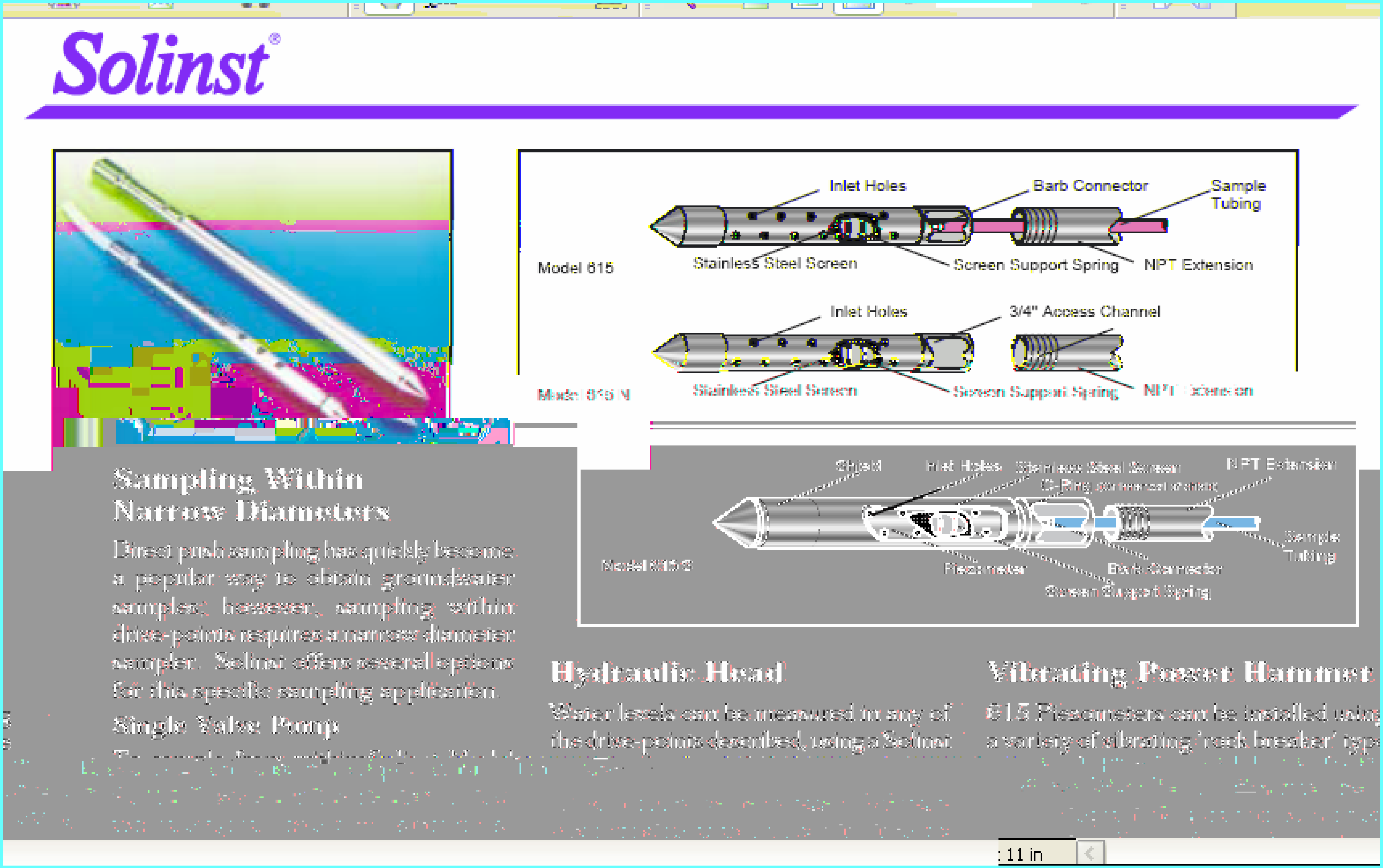
stallation. Sampling and
hin the tubing with small
overleaf.

can be driven into the
a borehole with any direct

Manual Slide Hammer

: 11 in



3/4” drive pipe, 3/8” electric junction, manual sensor

Vibrating Wire Piezometer

Applications

The VW piezometer is used to monitor pore-water pressure. Typical applications include:

- Monitoring pore water pressures to determine safe rates of fill or exca-
- Monitoring pore-water pressures to
- Monitoring the effects of dewatering systems used for excavations.
- Monitoring the effects of ground improvement systems such as vertical drains and sand drains.
- Monitoring pore pressures to check the performance of earth fill dams and embankments.
- Monitoring pore pressures to check containment systems at land fills and tailings dams

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The piezometer is

Advantages

Groutable: The VW piezometer can

Installation Overv

Grout-In Method: T

19 mm od

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GEOTECH Web Site for Geotechnical Field Equipment

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  - Barrel sampler
  - Fill perforator
  - Open standpipe
- Piezometer
- Software

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Electric piezometer

The newly developed Geotech Piezometer is a precision gauge and still very price competitive compared to vibrating wire instruments. At each measurement the user gets the serial number of the gauge, the pore pressure, temperature, date and time. The piezometer contains parts of the new Geotech electronics for the CPT probes and can therefore be delivered with or without a programmable memory (the standard version capacity is of over 2 000 measurements points). The piezometer can be read with a PSION Workabout handheld

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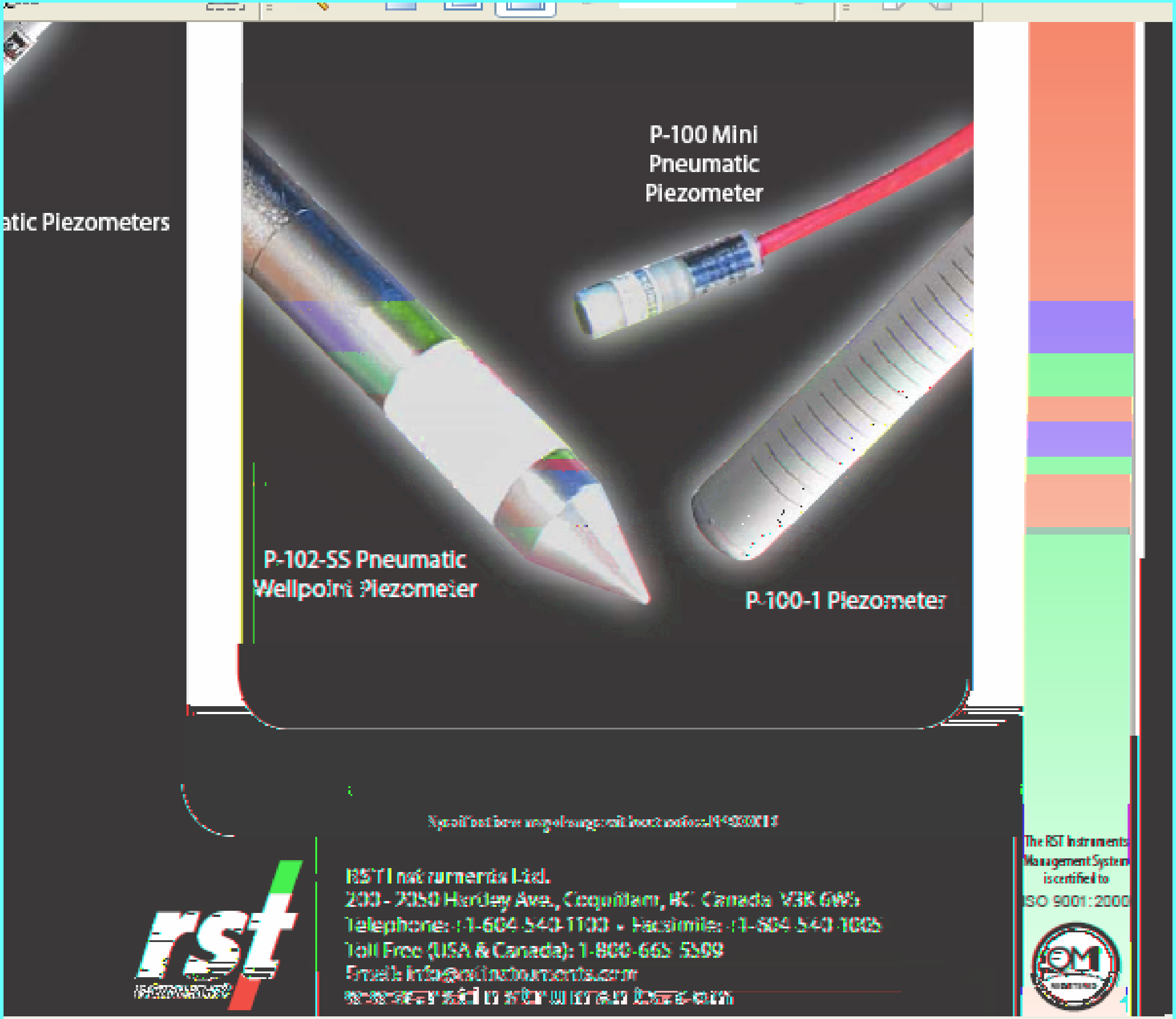
NEWS

2007-03-14
Transportation case for CPT cone and sound transmitter

Geotech can now offer a very good transportation case for your cone and sound transmitter. For more information please contact Christina Örtendahl at sales@geotech.se

1.3” diameter

“pneumatic piezometer, 0.5” o-d

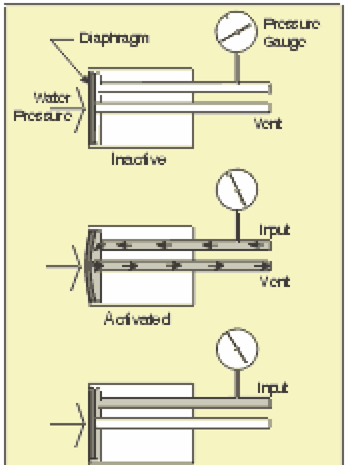


Pneumatic Piezometers, such as Slope Indicator

Slope Indicator's pneumatic piezometers employ a simple and reliable transducer that is free from zero drift. Long term performance is enhanced by corrosion-resistant plastic construction, polyethylene tubing, and in-line filters in all connectors. Compatible with both flow and no-flow reading techniques.

Operating Principle

In a typical installation, the piezometer is sealed in a borehole, embedded in fill, or suspended in a standpipe. Twin pneumatic tubes run from the piezometer to a terminal at the surface. Readings are obtained with a pneumatic indicator.



The piezometer contains a flexible diaphragm. Water pressure acts on one side of the diaphragm and gas pressure acts on the other. When a reading is required, a pneumatic indicator is connected to the terminal or directly to the tubing. Compressed nitrogen gas from the indicator flows down the input tube to increase gas pressure on the diaphragm.

When gas pressure exceeds water pressure, the diaphragm is forced away from the vent tube, allowing excess gas to escape via the vent tube. When the return flow of gas is detected at the surface, the gas supply is shut off.

Gas pressure in the piezometer decreases until water pressure forces the diaphragm to its original position [illegible] pneumatic indicator [illegible]

For more information

QUESTIONS, cont

4. Bentonite vs Grout

most commercial instructions require grout, but

most pedology studies use bentonite

5. Wells vs Piezometers

Is there a Ksat threshold for wells because of

the reservoir effect?

6. Install into sand

Jetting?

Vibrating?

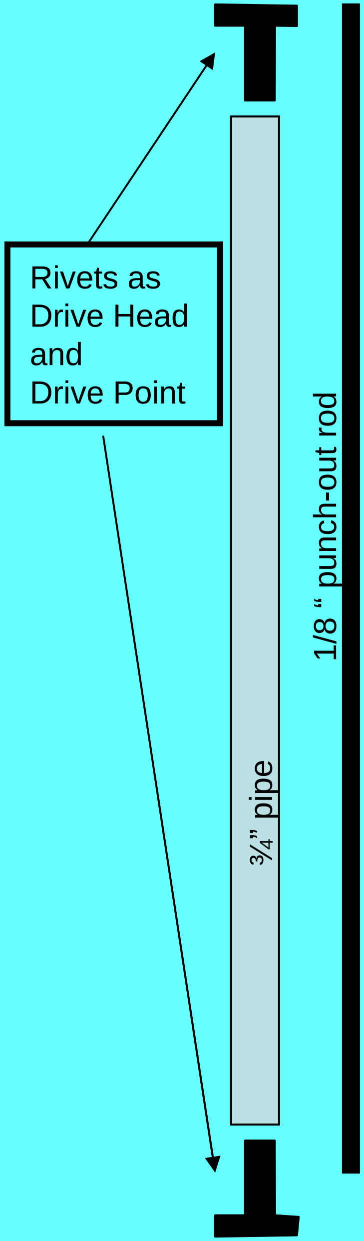
QUESTIONS, cont

7. Filter cloth vs Sand pack
   How attach cloth (epoxy? hardware ties?)
   Filter fabric vs Filter sock
   What common mistakes should be noted?

8. Slotted screen (0.006 vs 0.010 inch)
   Does it make a difference?
   If so, does 40-60 sand pack make a difference?

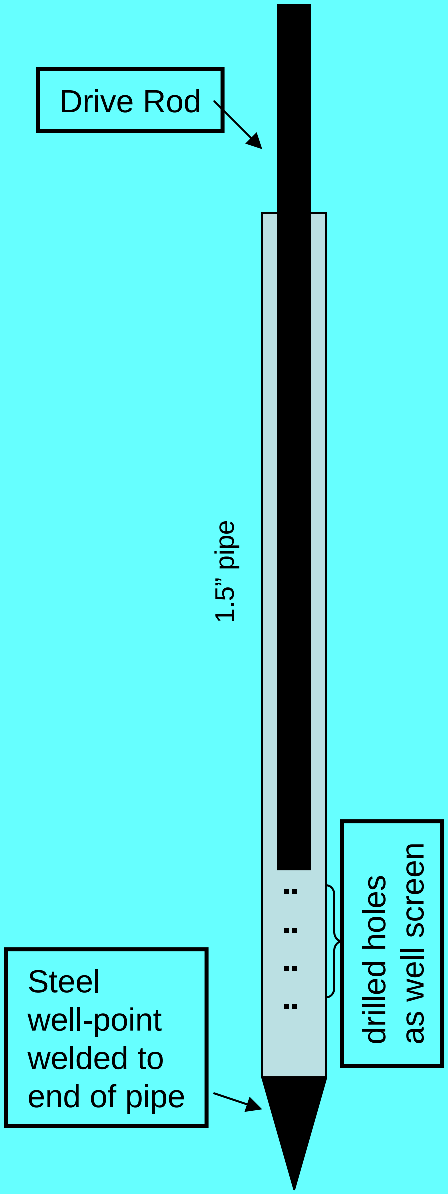
9. Install in rocky soil
   Driving methodology?
   What common mistakes should be noted?
   How prevent bypass flow?

Figure Driven Well-a



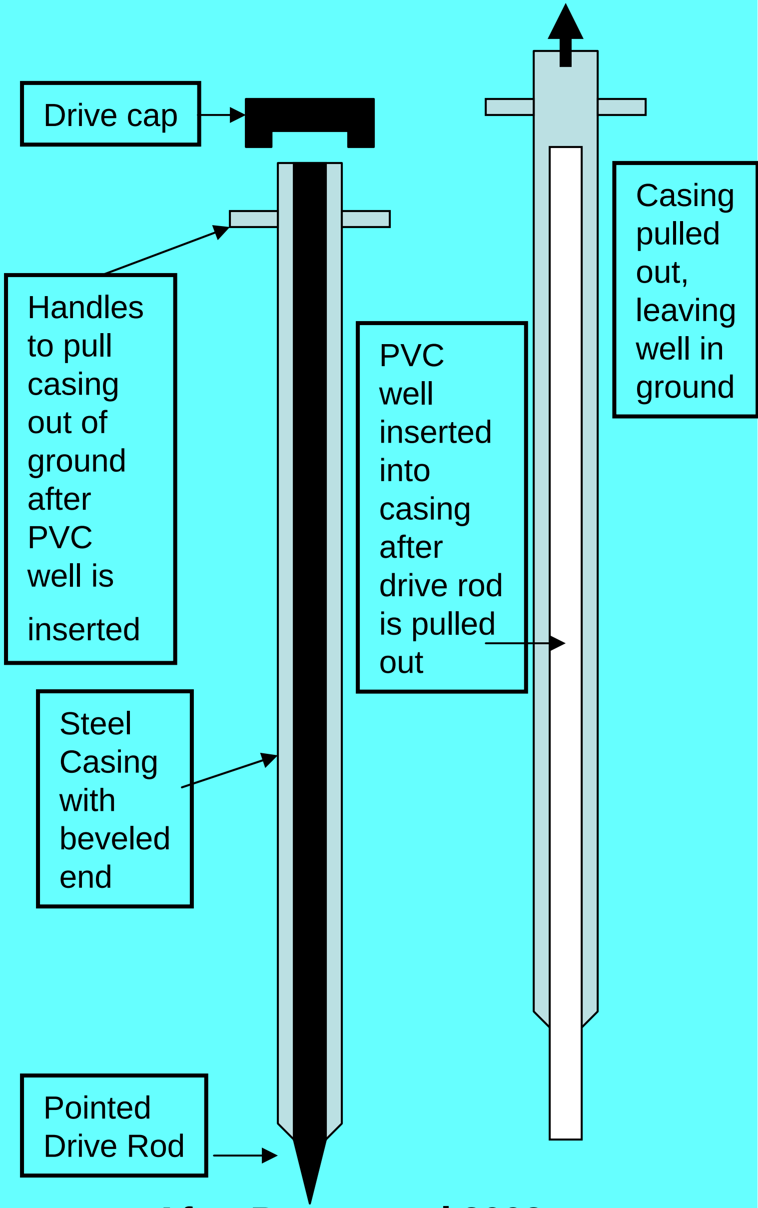
After Reeve 1986

Figure Driven Well-b



After Geist 1998

Figure Driven Well-c



After Baxter et al 2003

QUESTIONS, cont

9. Install in rocky soil

    Driving methodology?

    What common mistakes should be noted?

    How prevent bypass flow?

10. Other Technical Guidance protocols

    USGS

    USFS

    other countries

QUESTIONS, cont

11. Packing material at ground surface

    Any need to specify technique beyond having a mound, not a cavity around the riser?

12. Bore hole and annular space

    How minimize volume yet fill fully?

QUESTIONS, cont

13. Local laws and concrete pads

    Is this really an issue?

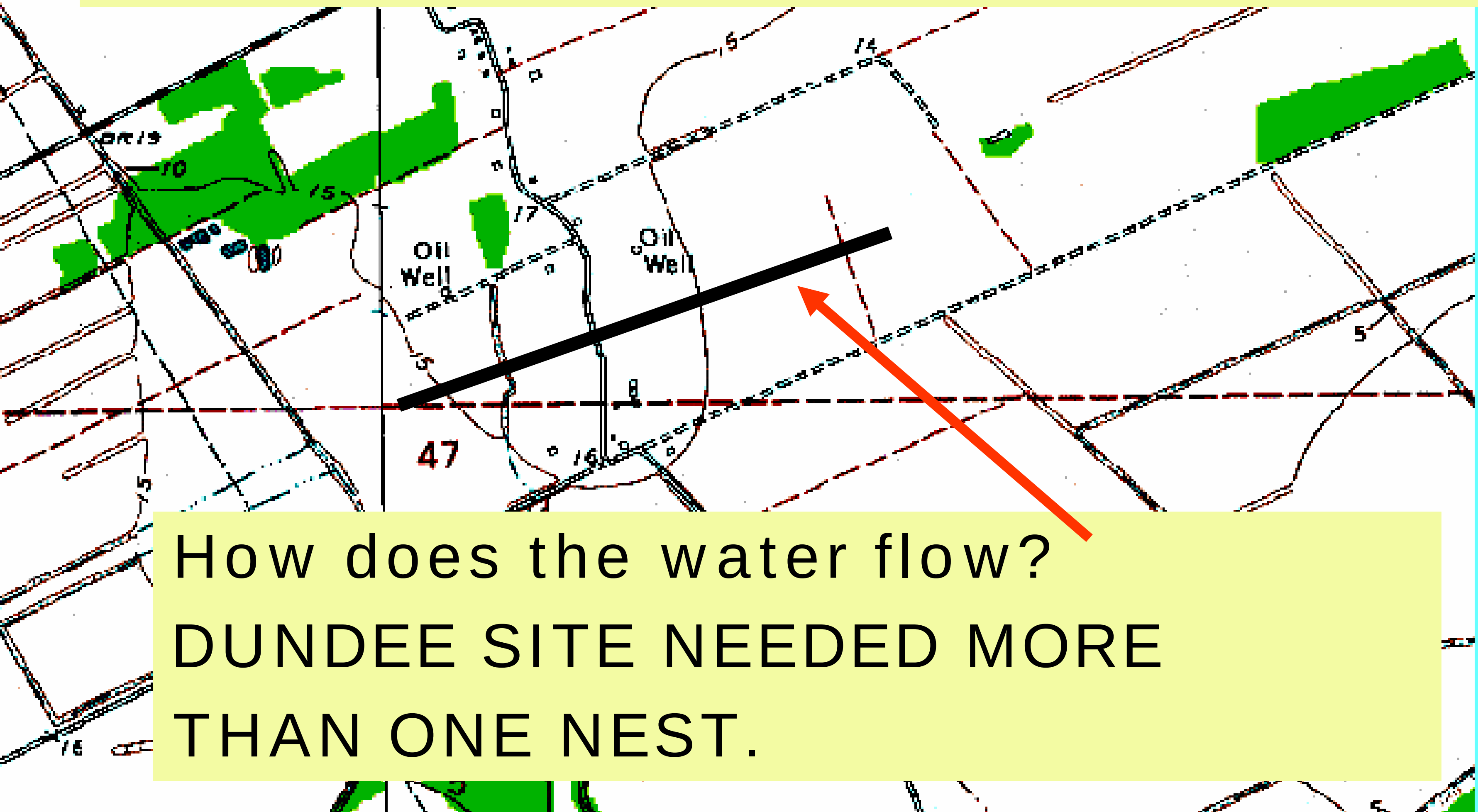
14. Manual reading

    How frequently?

    How does missing data get skewed?

15. Other issues???

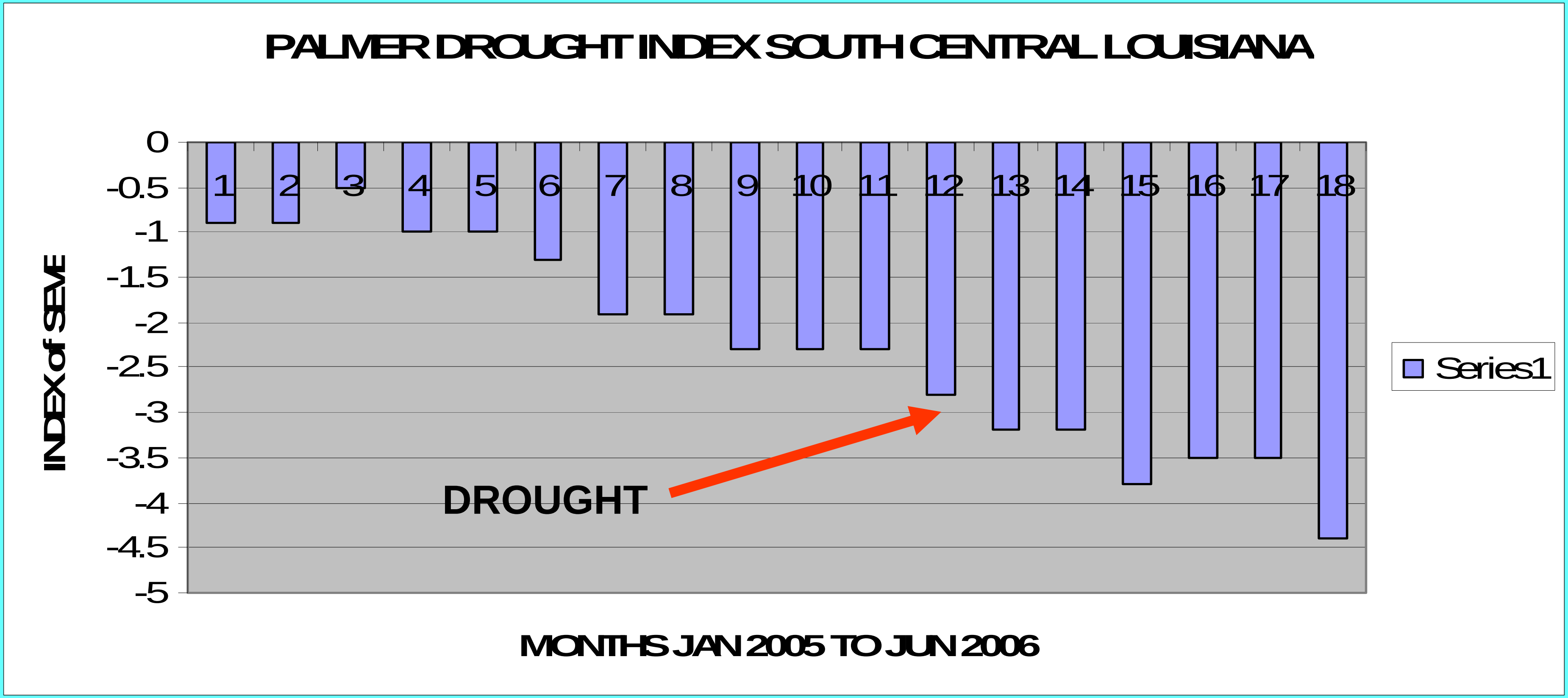
LANDSCAPE FACTORS to CONSIDER



How does the water flow?

DUNDEE SITE NEEDED MORE THAN ONE NEST.

PALMER DROUGHT SEVERITY INDEX
SOUTH CENTRAL LOUSIANA



EASIEST WAY OF KNOWING WHERE ONE IS IN THE DROUGHT PLUVIAL CYCLE IS THE PALMER INDEX.