



U.S. Department of Energy

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June 2, 2006

Mr. Myron Fliegel
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Subject: Transmittal of Calculation Sets, Attachment 3, Remedial Action Plan, Moab Uranium Mill Tailings Remedial Action (UMTRA) Project

Dear Mr. Fliegel:

Enclosed are four sets of the following calculation sets for *Attachment 3, Ground Water Hydrology* to the *Moab UMTRA Project Remedial Action Plan*.

1. Saturated Hydraulic Conductivity Determination of Weathered Mancos Shale (a.k.a. Air Entry Permeameter Calc)
2. Hydrologic Characterization – Field Permeability “Bail Testing”
3. Field Permeability “Packer” Testing
4. Hydrologic Characterization – Ground Water Pumping Records

Please be advised that one of the calculations (*Travel Time to Uppermost Aquifer*) is not included in this transmittal because it is still being reviewed. This calculation will be forwarded to you on June 9.

If you have any questions, please call me at (970) 248-7612 or Joel Berwick of my staff at (970) 248-6020.

Sincerely,

6/ J. Berwick
Donald R. Metzler
Moab Federal Project Director

cc w/enclosure:
Project File MOA 2.12 (R. Burrows)

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VDB\Moab\RAP\Calc Sets, Att 3, to NRC.doc

Office of Environmental Management – Grand Junction



**Remedial Action Plan and
Site Design for Stabilization of
Moab Title I Uranium Mill Tailings
at the Crescent Junction, Utah,
Disposal Site**

Attachment 3: Ground Water Hydrology



**U.S. Department
of Energy**

Office of Environmental Management

Work Performed Under DOE Contract No. DE-AC01-02GJ79491
for the U.S. Department of Energy Office of Environmental Management.
Approved for public release; distribution is unlimited.

Contents

- Appendix A Saturated Hydraulic Conductivity Determination of Weathered Mancos Shale
(a.k.a. Air Entry Permeameter Calc)**
- Appendix B Hydrologic Characterization–Field Permeability “Bail” Testing**
- Appendix C Field Permeability “Packer” Testing**
- Appendix D Hydrologic Characterization – Ground Water Pumping Records**

U.S. Department of Energy—Grand Junction, Colorado

Calculation Cover Sheet

Calc. No.: MOA-02-02-2006-2-07-00 Discipline: Geotechnical/Hydrological No. of Sheets: 8

Project: Moab UMTRA Project

Site: Crescent Junction Disposal Site

Feature:
Saturated Hydraulic Conductivity Determination of Weathered Mancos Shale

Sources of Data:

See appendix

Sources of Formulae and References:

Bouwer, H. 1966. "Rapid field measurement of air-entry value and hydraulic conductivity of soils as significant parameters in flow systems analysis," in *Water Resource Research*, Resource, vol. 2, No. 4, pp. 729-738.

Department of Energy (DOE), 1994. "In situ Testing to Determine Field-Saturated Hydraulic Conductivity of UMTRA Project Disposal Cell Covers, Liners, and Foundation Areas Special Study," DOE/AL/62350-100, prepared by Jacobs Engineering Group, Inc., Albuquerque, New Mexico, February.

Youngs, E.G., Leeds-Harrison, P.B., and Elrick, D.E., 1995. "The hydraulic conductivity of low permeability wet soils used as landfill lining and capping material: analysis of pressure infiltrometer measurements," *Soil Technology*, Vol. 8, pp. 153-160.

Waugh, W.J., S.J. Morrison, G.M. Smith, M. Kautsky, T.R. Bartlett, C.E. Carpenter, and C.A. Jones, 1999. *Plant encroachment on the Burrell, Pennsylvania, Disposal Cell: Evaluation of Long-Term Performance and Risk*, GJO-99-96-TAR, Environmental Sciences Laboratory, U.S. Department of Energy, Grand Junction, Colorado.

Preliminary Calc. ☐

Final Calc. ☐

Supersedes Calc. No.

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Problem Statement:

Determine the saturated hydraulic conductivity of the weathered Mancos Shale (wrthd K_m) interval at the proposed Crescent Junction disposal site.

Method of Solution

Use Air-Entry Permeameter (AEP) testing following installation procedures and methods as discussed in the Calculation section.

Assumptions:

1. AEP testing provides realistic saturated hydraulic conductivity results for wrthd K_m located at the Crescent Junction disposal site.
2. Excavating a soil "pedestal" and placing the AEP permeameter ring around the pedestal accurately tests pedestal materials.
3. Hydrated sodium bentonite adequately seals the AEP test and does not adversely affect results.

Computer Source:

Microsoft Excel

Calculation:

The AEP, developed by Herman Bouwer (Bouwer 1966) for determining air-entry and saturated hydraulic conductivity values for soils above the ground water table, is illustrated in Figure 1.

The AEP was initially designed to test agricultural soil, however the device and method have been successfully extended to test air-entry and saturated hydraulic conductivity values for bedrock foundation materials. Sandstone and sandstone/siltstone bedrock materials have been tested with the AEP at the DOE Estes Gulch disposal site north of Rifle, Colorado (DOE 1994).

When the AEP is used to test soils, the permeameter ring is driven into the soil forming a tight seal between the soil and ring. When foundation bedrock materials are tested, a circular channel must be excavated into the bedrock, see the following Figure 2 through Figure 6. The channel is subsequently filled with sodium bentonite to create the seal around the permeameter ring. By doing this, an assumption is made that the saturated hydraulic conductivity of the foundation materials is greater than the saturated hydraulic conductivity of the bentonite. This assumption is easily tested by comparing the computed saturated hydraulic conductivity value to 5×10^{-9} cm/sec, which is a typical saturated hydraulic conductivity value for sodium bentonite.

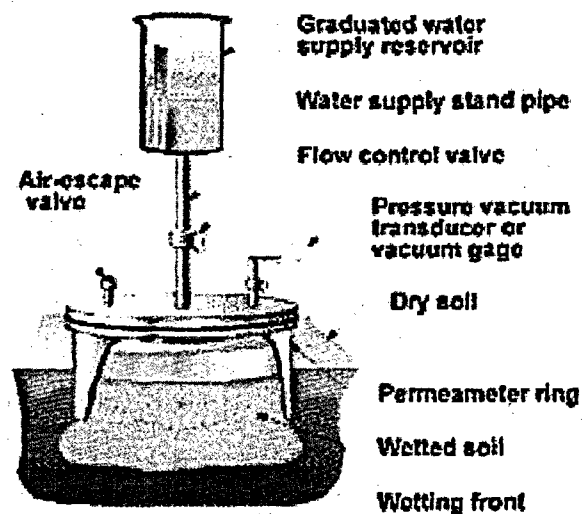


Figure 1. Air-Entry Permeameter
(ref. unknown)

The AEP consists of a 12 inch (30 centimeter) tall sealed ring with a 12 inch (30 centimeter) inside diameter embedded approximately 6 inches (15 centimeters) into the surface. A graduated water supply is mounted to the sealed ring via a standpipe of varying lengths allowing different hydraulic heads to be applied to the soil.

Field Procedure

Installation:

1. Clear and smooth a surface excavated into the wrthd K_m approximately 2 feet by 2 feet.
2. Excavate a circular channel approximately 2 inches wide and approximately 6 inches deep into the wrthd K_m as shown in Figure 2. Diameter of the circular channel should be such that the AEP test ring can be positioned in the approximate center. Base of the channel should be smoothed to provide a level and horizontal contact for the AEP test ring as shown in Figure 3.



Figure 2. Excavating Circular Channel into Weathered Mancos Shale to Place AEP Ring



Figure 3. Smoothing and Leveling Channel Base

3. Two to three inches of powdered sodium bentonite should be placed in the base of the channel as shown in Figure 4.



Figure 4. Sodium Bentonite in Bottom of Circular Channel Excavated into Weathered Mancos Shale

4. Mix water with bentonite in channel before placing ring in channel. Add more bentonite, refill channel with water and allow to hydrate bentonite for a minimum of 3 days (see Figure 5).



Figure 5. AEP Ring Placed in Channel With Bentonite Prior to Adding Water to Fully Hydrate Bentonite

5. Backfill the channel along the ring exterior with spoil as shown in Figure 6.

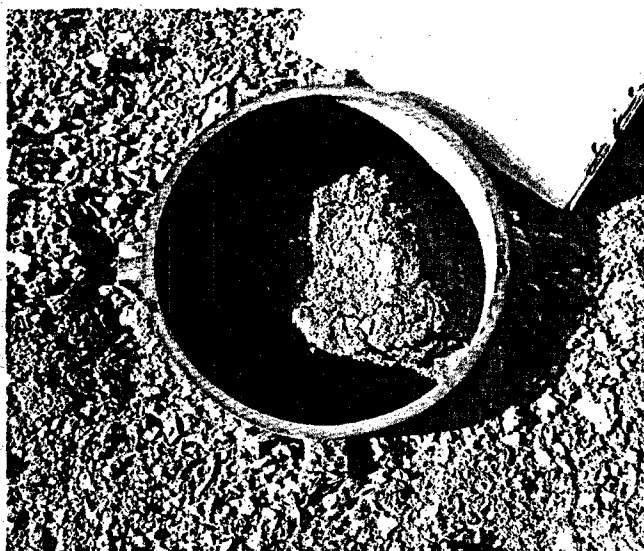


Figure 6. Channel Along Ring Exterior Filled with Spoils Prior to Testing

6. The ring is filled with water prior to attaching and sealing the lid and water supply cylinders.
7. The water supply is filled and flow-control and air valves are opened to allow water to flow out of the AEP set-up. All air bubbles are removed from the ring to ensure complete saturation of the permeameter. Figure 7 shows an installed AEP.

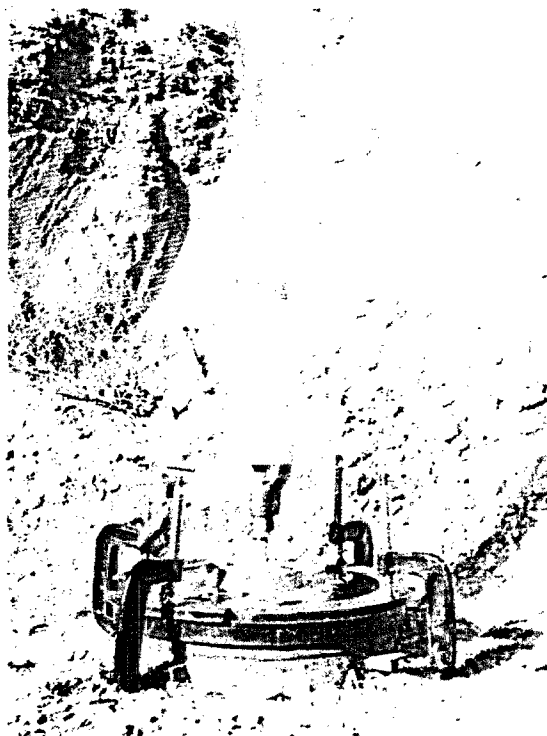


Figure 7. AEP Installed in Withrd Km - TP 0154

Testing:

1. The water supply is refilled; Initial readings (listed below) are taken and recorded before the flow control valve is opened to initiate the test.
2. Water level readings are taken and recorded at specified time intervals until steady-state infiltration is achieved.
3. The flow control valve is closed and a final water level (H_f) is recorded.
4. A hand held vacuum pump is attached to the vacuum gauge and valve attachment. A vacuum is applied to the AEP and the greatest vacuum pressure achievable is recorded. The highest vacuum pressure will occur immediately prior to air bubbles flow.

Analysis:

The equation to compute a saturated hydraulic conductivity (K_{sat}) value from the AEP test is (Bouwer 1966; DOE 1994):

$$K_{sat} = 2 \frac{dH}{dt} L \frac{R_r^2}{R_s^2} \left/ \left(H + L - \frac{1}{2} P_a \right) \right. \quad [1]$$

where: dH/dt (cm/sec) = change in hydraulic head with respect to time,
 L (cm) = depth of infiltration,
 R_r (cm) = radius of water supply reservoir,
 R_s (cm) = radius of soil pedestal,

H_f (cm) = final height of water in water supply reservoir, and
 P_a (cm) = air-entry pressure (vacuum pressure + gauge height + depth of infiltration).

Three test pits, TP 0152, TP 0154, and TP 0156, were excavated to the wrthd K_m interface at the Crescent Junction Disposal site. Two AEPs were installed in TP 0152, one AEP in TP 0154 and two AEPs in TP 0156. Bentonite failed to seal one AEP permeameter ring in each of TP 0152 and TP 0156; thus, a total of three AEP test were performed.

Copies of field data sheets and plots of hydraulic head versus time for each test are attached to this report in the Appendix. Also included are copies of hand calculations.

Results:

Table 1 presents results of the AEP tests. Shown on the table are values for air-entry (cm), dH/dt (cm/sec) and computed K_{sat} .

Table 1. AEP Results

Location	Air-Entry (cm)	dH/dt (cm/sec)	K_{sat} (cm/sec)
TP 0152	183	7.8×10^{-4}	4.4×10^{-5}
TP 0154	140	5.8×10^{-3}	1.6×10^{-4}
TP-0156	241	1.7×10^{-2}	2.6×10^{-4}

Geometric mean of all K_{sat} values = 1.2×10^{-4} cm/sec.

Discussion:

Other methods exist to compute field saturated hydraulic conductivity in fine-grained materials based on infiltration results. A method proposed by Youngs et al. (1995) has been used to validate the saturated hydraulic conductivity of compacted clay barrier layers on UMTRA disposal cells (Waugh et al. 1999). This method assumes that the soils are initially "wet", or close to saturation. Based on the air-entry values tested, the wrthd K_m is considered sufficiently "dry" to account for soil suction, therefore the method proposed by Youngs et al. (1995) is no longer considered.

Tests were performed during the winter of December 2005 and January 2006. Upon returning to TP 0152 after installation of permeameter rings and the required 3 days for bentonite hydration was allowed to occur, the installation was frozen as shown in Figure 8.

The ice was chipped out and the diameter of the enclosed wrthd K_m inspected. The approximate upper 1 inch of soil was frozen over an approximate 6 inch diameter forming an "ice cap" on the soil pedestal. Water does not infiltrate into soils below the ice cap. Accordingly, the area receiving flow was measured to compute the flow area. The test was run, and an effective area representing the reduced flow area was used computation of K_{sat} . This consisted of computing an equivalent area and radius, R_e in equation [1] of the soil pedestal. Errors introduced by doing this are considered to be of the same order as errors introduced by excavating the circular channel and embedding the permeameter ring, so the results are still considered applicable for use in design.

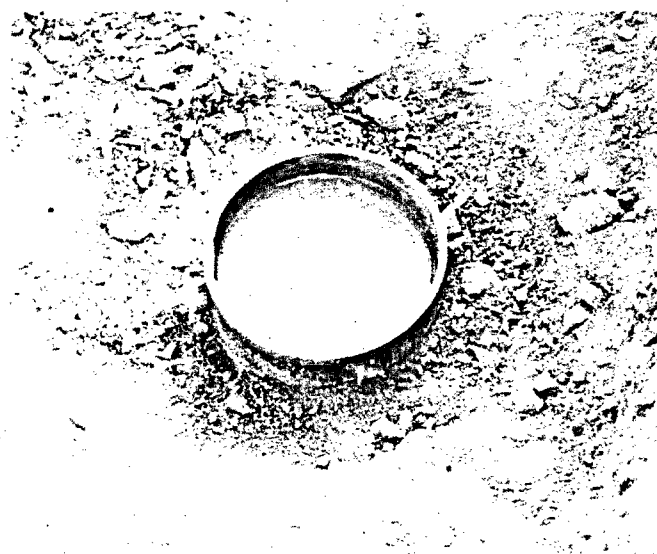


Figure 8. Frozen Hydration Water in the Non-Leaking AEP Test Performed in TP 0152

Conclusion and Recommendations:

A design saturated hydraulic conductivity value of 1.2×10^{-4} cm/sec should be used for wrthd K_m material, based on AEP test results conducted December 2005 and January 2006 at the proposed Crescent Junction, Utah, disposal site.

The resulting geometric mean of measured in situ saturated hydraulic conductivity values for the weathered Mancos shale at the proposed disposal cell site, should be considered a first-order approximation, due to of the small sample size. Although the 12-inch diameter size of the permeameter ring is large enough to measure preferential flow around shale fragments, as illustrated in Figure 4, statistical confidence in the mean is low. Increasing the number of data points will provide more confidence of the mean, however given that the range of tested values are within one-order of magnitude, the mean is not expected to vary significantly.

Appendix

Field Notes and Hand Computations for K_{sat} Determination

TP 0152 Field Data Sheets and Plots

Date: 11/10/06

Staff: R. Pupp
G. Smith

Measured Parameters

R_{ws} (Radius of Water Supply Reservoir)
25 cm

R_{sr} (Radius of Soil Ring) 6
 $9.5 \text{ cm} \times \frac{1}{2} = 4.75 \text{ cm} \approx 4.8 \text{ cm}$

G (Height of gauge above soil surface)
8.5" gm 21.6 cm

H_f (Final water head reading when water flow valve is shut)

$73.7 \text{ cm} + 38.1 = 111.8$

P_{\min} (Gauge pressure at air entry, a negative value)
10 cm centibars $\times 10.2 \text{ cm/centibar} = 102 \text{ cm}$

L (Depth from soil surface to wetting front)
 $\frac{2'' \text{ below base of ring}}{26.7 \text{ cm}}$ excess bentonite
 after installation

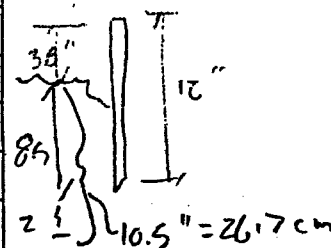
Data

[illegible]

Soil in ring
initially frozen
water @ 4%

has 4 applications.

152E 'baker'
upon remaining
water stays high
in hole



$$P_a \text{ (Air entry value, negative value)} = P_{\min} + G + L = 102 + 21.6 + 26.7 =$$

$$dH/dT = (\text{Change in head/Change in time}) \text{ for last two data points}$$

$$K_{sat} = -(2 * dH/dT * L * (R_{ws}/R_{sr})^2) / (H_f + L - (0.5 * P_a)) \text{ (cm/s)} = 237.1 \times 10^{-3} / 13.35$$

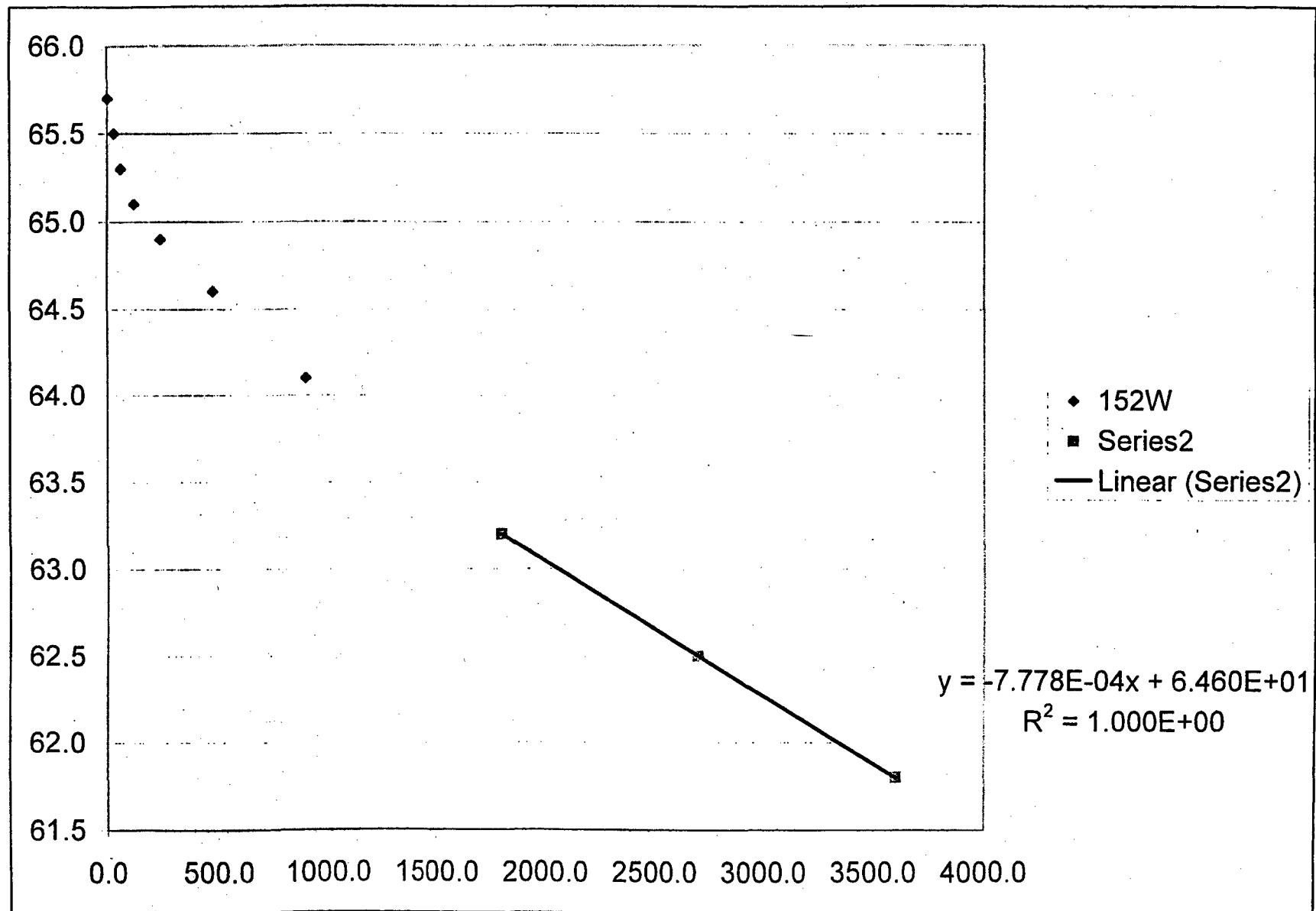
150.3 cm

-0.000844 m/s

$$\frac{1.8 \times 10^{-4} \text{ cm/s}}{= 2 \times 10^{-4} \text{ cm/s}}$$

$$A_6 = 70.88$$
$$A_4 = 12.57$$
$$\frac{58.32}{}$$

$$d = 8.62; r = 8.62/2 = 4.31 \text{ m} = 10.9 \text{ cm} \checkmark$$



0152W

Given

$$R_{ws} = 25 \text{ mm} = \underline{2.5 \text{ cm}}$$

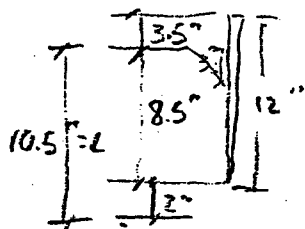
$$R_{sr} = 9.5''/2 (2.54) = \underline{12.1 \text{ cm}}$$

$$G = 8.5'' (2.54) = \underline{21.6 \text{ cm}}$$

$$H_f = 23.7 \text{ cm} + 15'' (2.54) = \underline{61.8 \text{ cm}}$$

$$L \Rightarrow 2' \text{ below base of ring} = 10.5'' (2.54) = \underline{26.7 \text{ cm}}$$

$$\text{to } 10.5-3 (2.54) = \underline{19.1 \text{ cm}}$$



$$P_a = 10 \text{ cent. bar} (10.2 \text{ cm/cent. bar}) = \underline{102 \text{ cm}}$$

Find K_{sat}

Solution

$$K_{sat} = \frac{- (2 \frac{dH}{dt} L (R_{ws}/R_{sr})^2)}{H_f + L - P_a/2} \quad \frac{dH}{dt} = -7.778 \times 10^{-4} \text{ cm/s}$$

$$= \frac{- (2 (-7.778 \times 10^{-4} \text{ cm/s}) (26.7 \text{ cm}) (2.5/12.1)^2)}{(61.8 + 26.7 + 102)/2} = \frac{1.773 \times 10^{-3} \text{ cm}^2/\text{s}}{95.3 \text{ cm}}$$

$$= \frac{- (2 (-7.778 \times 10^{-4} \text{ cm/s}) (19.1) (2.5/12.1)^2)}{(61.8 + 19.1 + 102)/2} = \frac{1.268 \times 10^{-3} \text{ cm}^2/\text{s}}{91.5} = 1.4 \times 10^{-5} \text{ cm}^2/\text{s}$$

consider upper 6" ϕ of pedestal frozen:



$$A_{9.5} = 70.882 \text{ in}^2$$

$$A_6 = 28.274 \text{ in}^2$$

$$\left(\frac{42.608 \text{ in}^2 \times 4}{\pi} \right)^{1/2} = \text{equivalent } \phi = 7.37 \text{ in} = R_{sr}$$

0152W

$$k_{sat} = \frac{-(2)(7.778 \times 10^{-4} \text{ cm/s})(19.1) \left(\frac{25}{7.37} \right)^2}{(61.8 + 19.1 + 102)/2}$$

$$= \frac{3.42 \times 10^{-3} \text{ cm}^2/\text{s}}{95.3 \text{ cm}} = 3.6 \times 10^{-5} \text{ cm/s}$$

$$k_{sat} = \frac{-(2)(7.778 \times 10^{-4} \text{ cm/s})(26.7) \left(\frac{25}{7.37} \right)^2}{(61.8 + 26.7 + 102)/2}$$

$$= \frac{4.78 \times 10^{-3} \text{ cm}^2/\text{s}}{91.5 \text{ cm}} = 5.2 \times 10^{-5} \text{ cm/s}$$

k_{sat} (cm/s)

R_{gr}	12.1	7.37
L		
26.7	1.9×10^{-5}	3.6×10^{-5}
19.1	1.4×10^{-5}	5.2×10^{-5}

Discussion

k_{sat} is not sensitive to L, is sensitive to R_{gr}

Since upper portion of pedestal was frozen, used approximated frozen diameter to compute k_{sat} ;

i.e. $k_{sat} = \underline{4.4 \times 10^{-5} \text{ cm/s}}$

TP 0154 Field Data Sheets and Plots

Air-Entry Permeameter Tests

Date: 1-10-06Staff: G. Smith

Measured Parameters

154

 R_{ws} (Radius of Water Supply Reservoir)5 cm / 2 cm = 2.5 cm H_f (Final water head reading when water flow valve is shut)3.8 + h cm = 35.6 R_{sr} (Radius of Soil Ring)9.5 in ϕ cm = 24/2 = 12.1 cm P_{min} (Gauge pressure at air entry, a negative value)8 cm centibar \rightarrow 810.2 cm/cm centibar = 81.6 cm G (Height of gauge above soil surface)6.375 cm = 16.2 cm L (Depth from soil surface to wetting front)9 in cm = 22.9 cm

Data

h₀ = 0.0 cm = 12.5 in

	Time (hr:ST) (min)	Reservoir Reading (cm)	Head (cm)	dH (cm)	dT (s)	dH/dT (cm/s)	mean dH/dT
0	11:31:00	27.7			0		
0.5	:30	23.4					
1	:32:00	21.6					
2	:33:00	17.5					
4	:35:00	10.7					
6	:37:00	5.5					
7	11:39:00	28.8					
7.5	:30	24.9					
1	:40:00	23.7					
2	:41:00	21.8					
4	:43:00	18.5					
8	:47:00	13.8					
15	:54:00	9.6					
30	12:09:00	3.8					

ambient temp
= 12°C

$$P_a \text{ (Air entry value, negative value)} = P_{min} + G + L = 81.6 + 16.2 + 22.9$$

120.7 cm

$$dH/dT = (\text{Change in head/Change in time}) \text{ for last two data points}$$

-0.0073 cm/s

$$K_{sat} = -(2 * dH/dT * L * (R_{ws}/R_{sr})^2) / (H_f + L - (0.5 * P_a)) \text{ (cm/s)} = 0.0144 / 1.85 = 7.7 \times 10^{-3} \text{ cm/s}$$

$$\approx 8 \times 10^{-3} \text{ cm/s}$$

$$= 77 \times 10^{-4} \text{ cm/sec}$$

0154

Given

$$\text{Radius of reservoir} = 50 \text{ mm} / 2 = 25 \text{ mm} = \underline{2.5 \text{ cm}} = R_{ws}$$

$$\begin{aligned} \text{Radius of soil ring (pedestal)} &\sim 9.5'' \text{ dia} \\ &= 4.75'' \text{ radius } \left(\frac{2.54 \text{ cm}}{1''} \right) \\ &= \underline{12.1 \text{ cm}} = R_{sr} \end{aligned}$$

$$\text{Gage height} = 6\frac{3}{8}'' = 6.375 \left(\frac{2.54 \text{ cm}}{1''} \right) = \underline{16.2 \text{ cm}}$$

$$H_f = 3.8 \text{ cm} = 12.5'' \left(\frac{2.54 \text{ cm}}{1''} \right) = \underline{35.6 \text{ cm}}$$

$$P_{min} = 8 \text{ centibars } (10.2 \text{ cm/centibar}) = \underline{81.6 \text{ cm}}$$

$$L \approx 9 \text{ in } (2.54) = \underline{22.9 \text{ cm}}$$

Find

K_{sat}

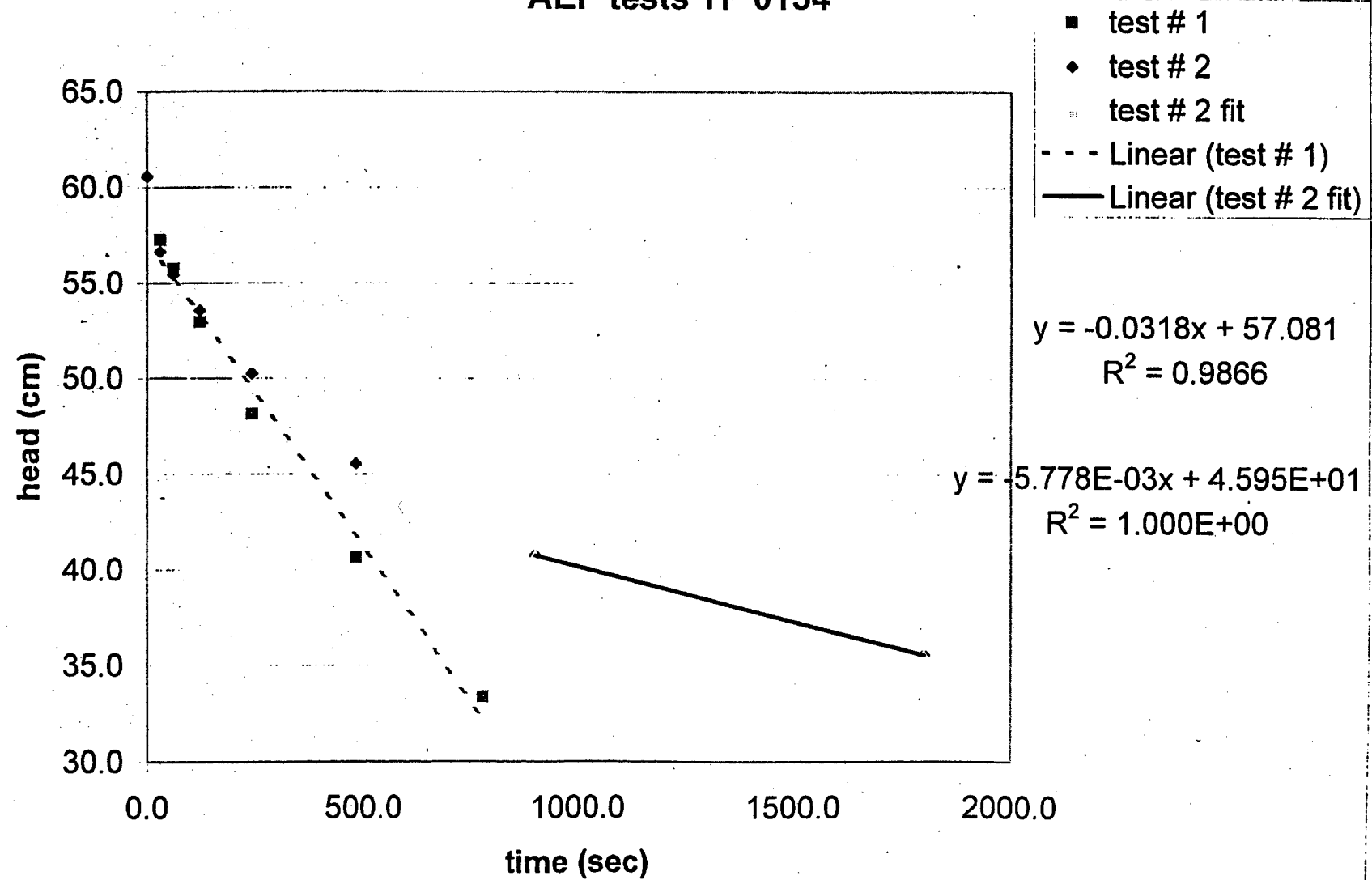
Solution

$$K_{sat} = - \left(2 \frac{dh}{dt} L \left(\frac{R_{ws}}{R_{sr}} \right)^2 / (H_f + L - \frac{1}{2} P_a) \right)$$

$$\frac{dh}{dt} = -5.778 \times 10^{-3} \text{ cm/sec (see attached graph)}$$

$$\begin{aligned} K_{sat} &= - \frac{ \left(2 (-5.778 \times 10^{-3} \text{ cm/sec}) (22.9 \text{ cm}) \left(\frac{2.5}{12.1} \right)^2 \right) }{ (35.6 + 22.9 + 81.6) / 2 } \\ &= \frac{ 1.130 \times 10^{-2} \text{ cm}^2/\text{s} }{ 70 \text{ cm} } = \underline{1.6 \times 10^{-4} \text{ cm/sec}} \end{aligned}$$

AEP tests TP 0154



TP 0156 Field Data Sheets and Plots

Air-Entry Permeameter Tests

0156 W

Date: 12-02-05

Staff: Greg Smith

Ralph Papp

Measured Parameters

R_{ws} (Radius of Water Supply Reservoir)

50/2 = 25 cm

H_f (Final water head reading when water flow valve is shut)

37.1 cm

R_{sr} (Radius of Soil Ring)

11.11 cm (8" + 1 1/2")

P_{min} (Gauge pressure at air entry, a negative value)

-203.9 cm

G (Height of gauge above soil surface)

17.5" cm 19.7

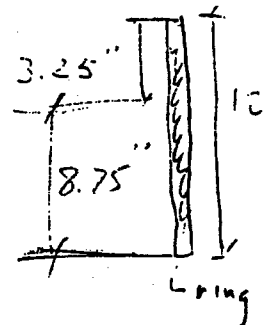
L (Depth from soil surface to wetting front)

17.8 cm

Data

$H_{air} = reading + 1' 1.5" = 34.3$

Time (min)	Reservoir Reading (cm)	Head (cm)	dH (cm)	dT (s)	dH/dT (cm/s)	mean dH/dT
0	27.3	27.3				
0.5	23.9	23				
1.0	23.1					
1.5	22.5					
2.0	22.0					
7.0	19.8					
8.0	15.6					
15.0	9.2					
25.0	24.75	200.2				
0	29.9					
0.5	27.5					
1.0	27.0					
2.0	25.7					
4.0	23.1					
8.0	18.5					
15.0	11.3					
20.0	6.6					
25.0	2.5					



1' - 1.5"

P_a (Air entry value, negative value) = $P_{min} + G + L$ - 203.9 + 19.7 + 17.8

-166.40

dH/dT = (Change in head/Change in time) for last two data points

-0.0187
-1.1227

cm/s
(2.3 x 10⁻⁴ cm/s)

$K_{sat} = -(2 * dH/dT * L * (R_{ws}/R_{sr})^2) / (H_f + L - (0.5 * P_a))$ (cm/s)

2.5 x 10⁻⁴ cm/s

$-(-3.48 \times 10^{-2}) / (37.1 + 17.8 - (0.5 * -166.4))$
3.48 x 10⁻² / 138.1 =

6.3 x 10⁻⁴ w/o P_a

Date: 11/11/2001

Staff: _____

Measured Parameters

R_{ws} (Radius of Water Supply Reservoir)


 cm

H_f (Final water head reading when water flow valve is shut)

 $2.8 \pm H$ cm R_{sr} (Radius of Soil Ring) cm

P_{min} (Gauge pressure at air entry, a negative value)

20 cont $d_{\text{bars}} = 203.94 \text{ cm}$

G (Height of gauge above soil surface)

A horizontal ruler with a dotted line extending from the left edge to the 10 cm mark. The text "10 cm" is written at the end of the dotted line.

L (Depth from soil surface to wetting front)

7" cm 17.8

Data

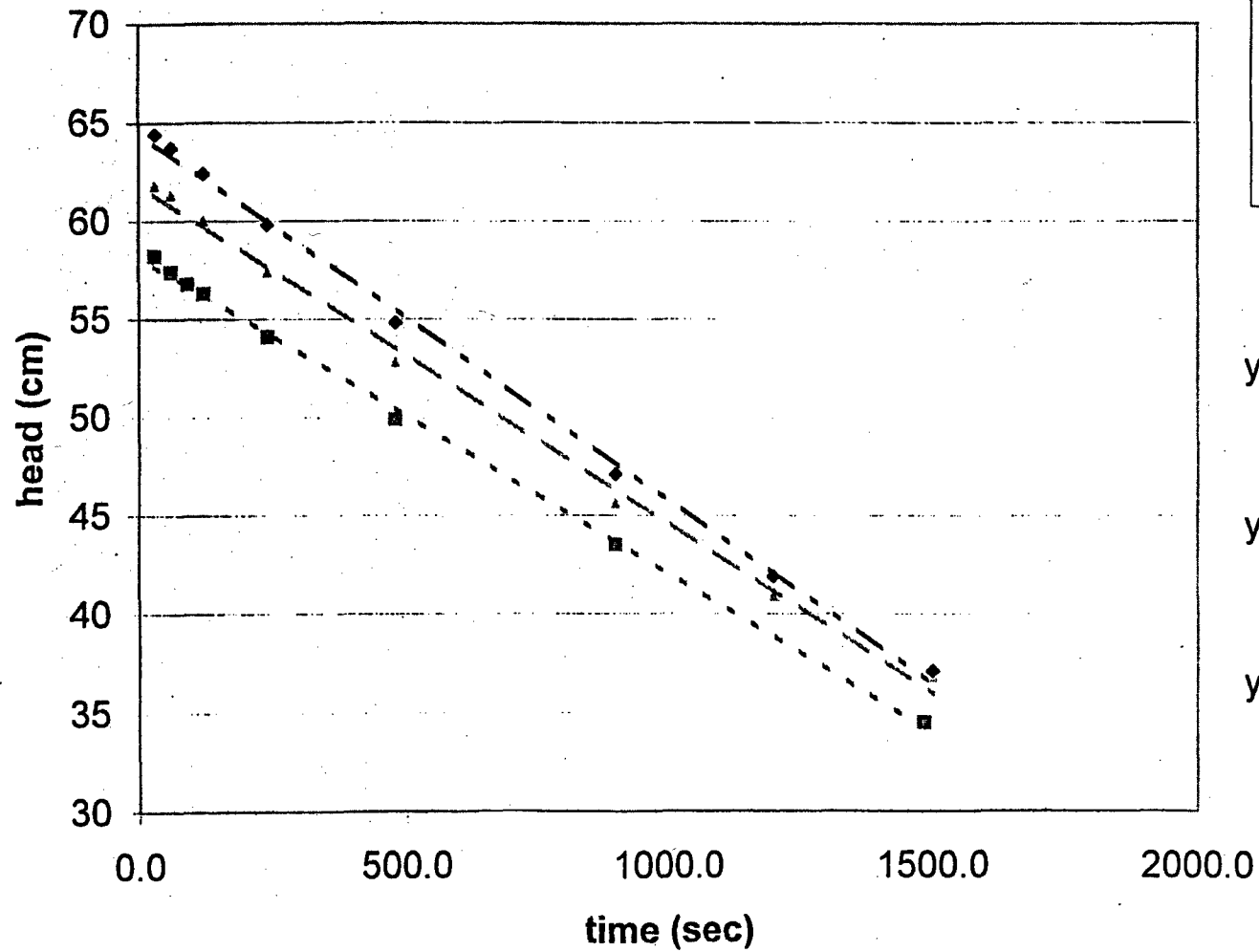
[illegible]

$$P_a \text{ (Air entry value, negative value)} = P_{\min} + G + L$$

$dH/dT = (\text{Change in head}/\text{Change in time})$ for last two data points

$$K_{sat} = -(2 * dH/dT * L * (R_{ws}/R_{sf})^2) / (H_f + L - (0.5 * P_a)) \text{ (cm/s)}$$

AEP tests TP 0156



- test # 1
- ▲ test # 2
- ◆ test # 3
- Linear (test # 2)
- - - Linear (test # 1)
- . - Linear (test # 3)

$$y = -0.0162x + 58.223$$
$$R^2 = 0.9985$$

$$y = -0.0173x + 61.857$$
$$R^2 = 0.9963$$

$$y = -0.0187x + 64.496$$
$$R^2 = 0.9979$$

0156W

Given $R_{ws} = 25 \text{ mm} = \underline{2.5 \text{ cm}}$

$$R_{sr} = \frac{\left(\frac{8 + 9.5}{2}\right) 2.54}{2} = \underline{11.1 \text{ cm}}$$

$$G = 7\frac{3}{4}" (2.54) = \underline{19.7 \text{ cm}}$$

$$H_f = 13\frac{1}{2}" (2.54) + 2.8 \text{ cm} = \underline{37.1 \text{ cm}}$$

$$P_{min} = (20 \text{ cent. bars } \left(\frac{10.2 \text{ cm}}{\text{cent. bar}} \right)) = \underline{204 \text{ cm}}$$

$$L = 7" (2.54) = \underline{17.8 \text{ cm}}$$

Find

k_{sat}

Solution

$$k_{sat} = \frac{-\left(2 \frac{dH}{dE} L \left(\frac{R_{ws}}{R_{sr}}\right)^2\right)}{H_f + L - P_a/2}$$

$$P_a = P_{min} + G + L = 204 + 19.7 + 17.8 = 241.5$$

$\frac{dH}{dE} = -\text{avg. of all three slopes shown on attached plot;}$

$$\frac{0.0162 + 0.0173 + 0.0187}{3} = 0.0174 \text{ cm/sec}$$

$$k_{sat} = \frac{0.0314 \text{ cm}^2/\text{sec}}{120.75 \text{ cm}} = \underline{2.6 \times 10^{-4} \text{ cm/sec}}$$

U.S. Department of Energy—Grand Junction, Colorado

Calculation Cover Sheet

Calc. No.: MOA-02-03-2006-2-10-0

Discipline: Hydrologic Properties

No. of Sheets: 4

Project: Moab UMTRA Project

Site: Crescent Junction Disposal Site

Feature: Field Permeability "Ball" Testing

Sources of Data:

Ball testing records were obtained electronically from pressure transducers installed in coreholes at the Crescent Junction site during the field characterization project, November 2005 through January 2006.

Sources of Formulae and References:

Freeze, R. Allen, and J.A. Cherry, 1979. *Groundwater*, Prentice-Hall, Inc. Englewood Cliffs, NJ 07632, 604 p.

Hvorselv, M.J., 1951. *Time Lag and Soil Permeability in Ground-Water Observations*. Bulletin No. 36 U.S. Waterways Experiment Station, U.S. Army Corps of Engineers, Vicksburg, Mississippi.

Preliminary Calc. ☐

Final Calc. ☐

Supersedes Calc. No.

Author:

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Don Petersen 5/4/2006
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[Signature] 5/4/06
Name Date

Approved
by:

R. de Koo 5-22-06
Name Date

Problem Statement:

Preliminary site selection performed jointly by the U.S. Department of Energy (DOE) and the Contractor has identified a 2,300-acre withdrawal area in the Crescent Flat area just northeast of Crescent Junction, Utah, as a possible site for a final disposal cell for the Moab uranium mill tailings. The proposed disposal cell would cover approximately 300 acres. Based on the preliminary site-selection process, the suitability of the Crescent Junction disposal site is being evaluated from several technical aspects, including geomorphic, geologic, hydrologic, seismic, geochemical, and geotechnical. The objective of this calculation is to impart the field permeability "bail test" results obtained from the Mancos Shale during the investigation of subsurface conditions at the Crescent Junction disposal site.

This calculation will be incorporated into Attachment 3 (Hydrology) of the Remedial Action Plan (RAP) and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site, and summarized in the appropriate sections of the Remedial Action Selection (RAS) report for the Moab site.

Obtaining the hydraulic parameters of the host rock in which a disposal site will be situated is one of the fundamental measurements required to evaluate the suitability of the site. Because the bedrock is a shale aquitard containing only sparse saline groundwater, the number and type of measurements that might be made are rather limited. In addition, the types of measurements that are available, packer tests and piezometer tests, reveal different characteristics about the rock mass. Packer tests, which reveal spatially discrete estimates of hydraulic conductivity, were carried out on this project and are documented in Calculations MOA-02-02-2006-2-06-00 (Field Permeability "Packer" Testing) and in MOA-02-02-2006-2-07-00 (Saturated Hydraulic Conductivity Estimate—Mancos Shale).

Piezometer tests, which are described in Freeze and Cherry (1979), will yield vertically averaged hydraulic conductivities that do not represent the full vertical variability in hydraulic conductivity. These averaged hydraulic conductivity determinations were done to evaluate hydraulic properties representative of the entire rock mass. The tests are performed by causing an instantaneous change in the water level in a piezometer through a sudden introduction (or removal) of a known volume of water. When the water is removed, the tests are often called *bail tests*. For this project the hydraulic properties of the Mancos Shale are important for the purpose of developing the water resources protection strategy. The tests were performed in coreholes 201, 202, 203, 204, and 208 (see Table 1).

Method of Solution:

Instantaneous removal of ground water from each corehole was accomplished using dedicated submersible pumps. Water levels were measured using submersible electronic pressure transducers that were programmed to read either at 5- or 15-minute intervals. The water-level recovery data were downloaded into a portable laptop computer and then copied onto the data analyst's computer. The test results were analyzed using equation 8.34 in Freeze and Cherry (1979).

For a piezometer intake of length $(L/R) > 8$, Hvorslev (1951) has evaluated the so-called *shape factor* F of the piezometer and presented the following equation for calculating the hydraulic conductivity:

$$K = [r^2 \ln (L/R)] / (2LT_0), \quad [1]$$

where

K = hydraulic conductivity [length/time]
 r = radius of corehole [length]
 L = length of ground water intake zone [length]
 R = radius of ground water intake zone [length]
 T_0 = basic time lag [time]

To interpret a set of field recovery data, the data are plotted graphically in the form of dimensionless drawdown $[(H-h)/(H-H_0)]$ versus elapsed time. The basic time lag value is read off the graph at the point where the dimensionless drawdown equals 0.37.

Assumptions:

- Pumping ground water from a corehole tapping a low-permeability formation causes a valid, essentially instantaneous change in the water level.
- Bail tests in bedrock systems such as the Mancos Shale yield estimated values of average hydraulic conductivity for the entire test interval.
- The absence of a piezometer tube does not invalidate the recovery test data.

Calculation:

To interpret a set of field recovery data, the data are plotted graphically in the form of dimensionless drawdown $[(H-h)/(H-H_0)]$ versus elapsed time. Appendix A presents plots of each test that was conducted during this study. Each plot displays dimensionless drawdown versus the elapsed time since the bail test began. Using the Microsoft Excel program, the raw drawdown data were converted to dimensionless drawdowns, and the dimensionless drawdowns were plotted versus elapsed time. The basic time lag value was read off the graph at the point where the dimensionless drawdown equals 0.37. The basic time lag value is posted on each plot. Equation 1 was then used to solve for hydraulic conductivity.

Inputs to the equation are:

r = radius of corehole [length] = 0.16 ft

L = length of ground-water intake zone [length] = depth of static water in corehole

$L_{\text{corehole 201}} = 95$ ft

$L_{\text{corehole 202}} = 188$ ft

$L_{\text{corehole 203}} = 203$ ft

$L_{\text{corehole 204}} = 75$ ft

$L_{\text{corehole 208}} = 120$ ft

R = radius of ground-water intake zone [length] = 0.16 ft

T_0 = basic time lag [time] = 0.37

Results from these calculations are tabularized below:

Table 1. Bail Test Results

Corehole	Hydraulic conductivity (cm/sec)				
	Test 1	Test 2	Test 3	Test 4	Geometric Mean
201	1.4×10^{-6}	1.4×10^{-6}	1.9×10^{-6}	ND	1.6×10^{-6}
202	4.3×10^{-7}	3.9×10^{-7}	4.3×10^{-7}	ND	4.2×10^{-7}
203	2.4×10^{-6}	2.6×10^{-6}	2.6×10^{-6}	2.3×10^{-6}	2.5×10^{-6}
204	Indeterminable	Indeterminable	3.1×10^{-7}	ND	3.1×10^{-7}
208	3.1×10^{-7}	3.3×10^{-7}	3.1×10^{-7}	ND	3.2×10^{-7}

ND – No data were gathered for this test.

Discussion:

Results obtained from this calculation represent average hydraulic conductivities for the Mancos Shale. These results were obtained from the unweathered zones of the Mancos Shale that underlie the Crescent Junction disposal site. Sources of the ground water appear to be micro to mini fractures and/or bedding planes within the rock formation. The hydraulic conductivities of discrete zones contributing the water were not measured with this method. This method yields average hydraulic conductivities of the portions of the coreholes that are below the fluid level in that borehole.

Conclusion and Recommendations:

Overall, the hydraulic conductivity of the Mancos Shale was determined to be very low at the Crescent Junction site. Based on results of bail testing, and in conjunction with findings of field investigations, the Crescent Junction site appears to be suitable for disposal of the Moab uranium mill tailings and contaminated material. Based on this information, and in conjunction with findings of field investigations, this site is deemed suitable for the intended use.

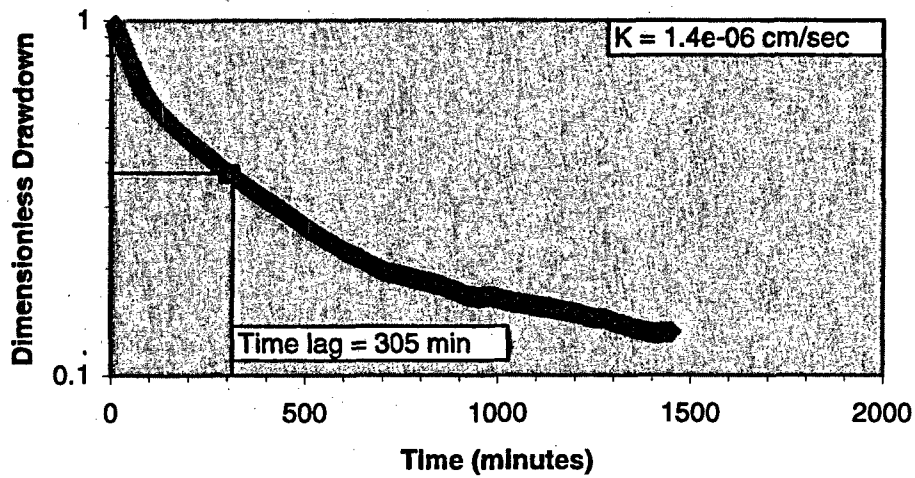
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- Microsoft Excel

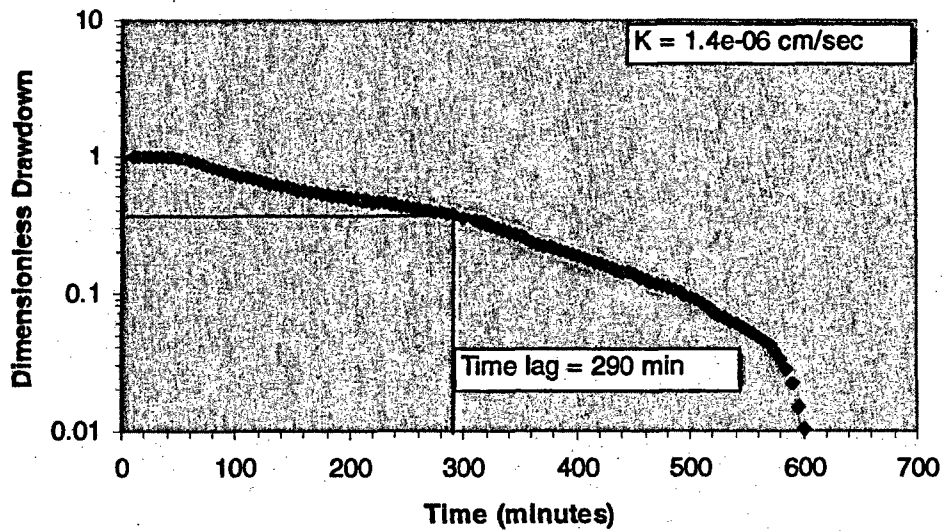
Appendix A

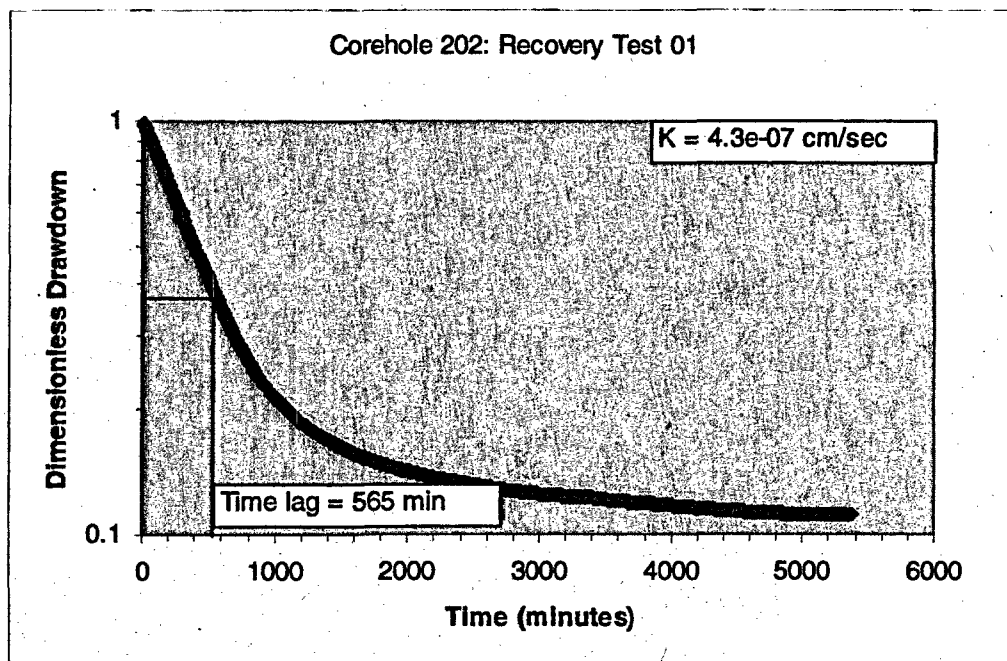
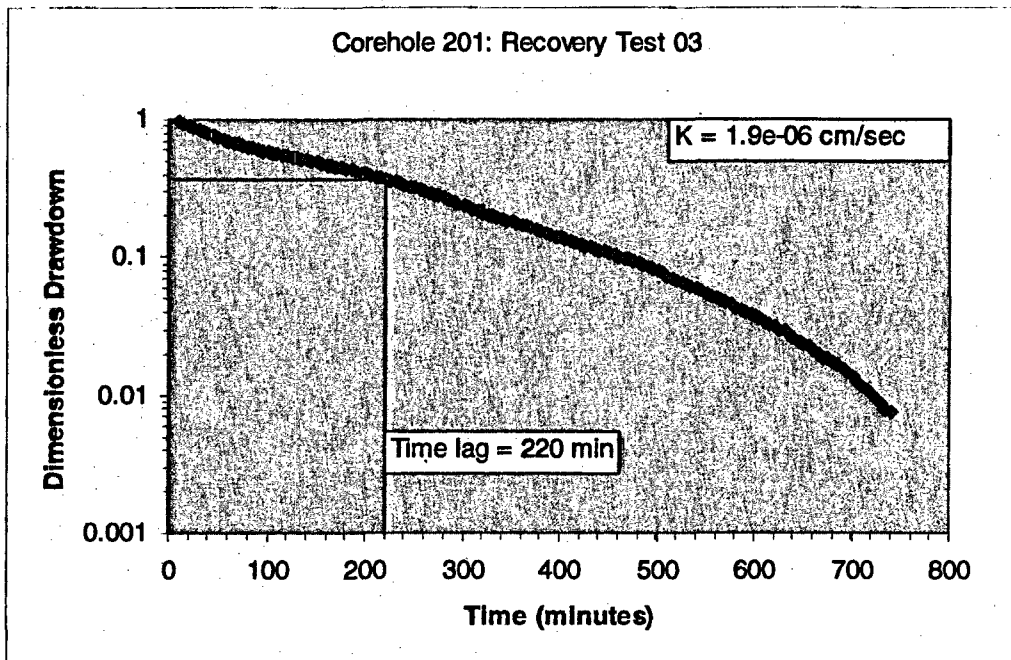
Copies of Packer Testing Raw-Data Sheets and Analysis Sheets

Corehole 201: Recovery Test 01

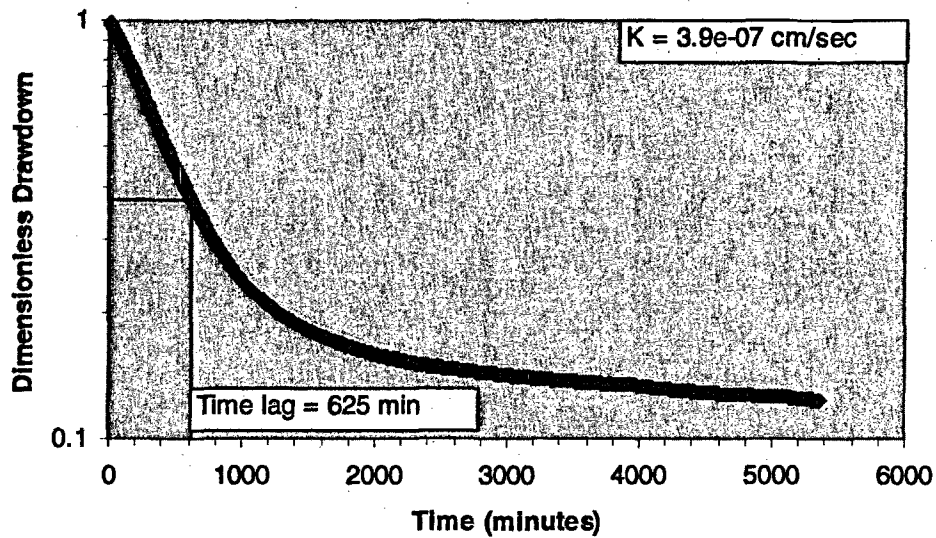


Corehole 201: Recovery Test 02

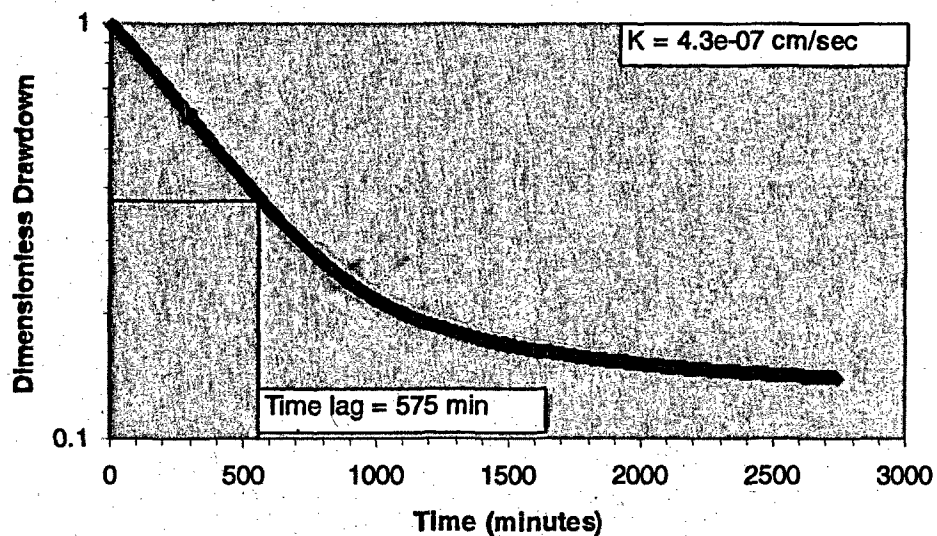




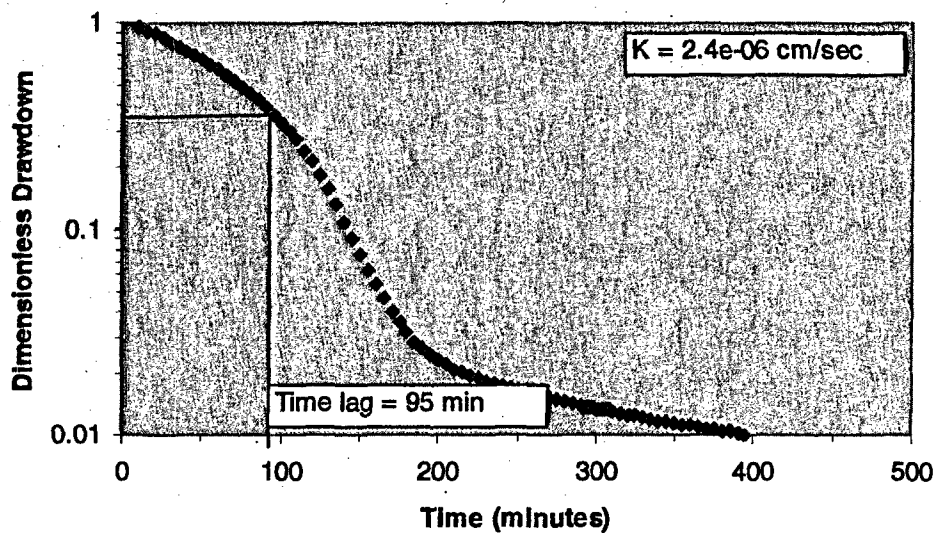
Corehole 202: Recovery Test 02



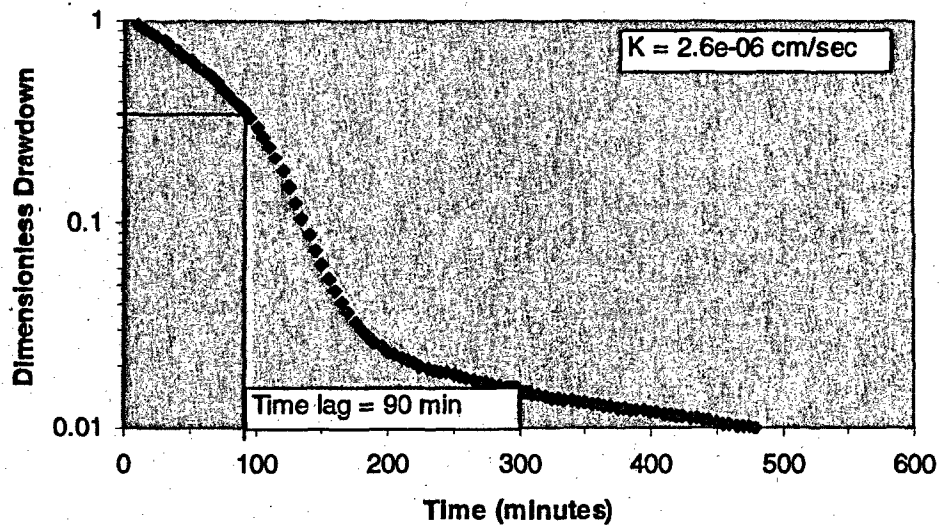
Corehole 202: Recovery Test 03

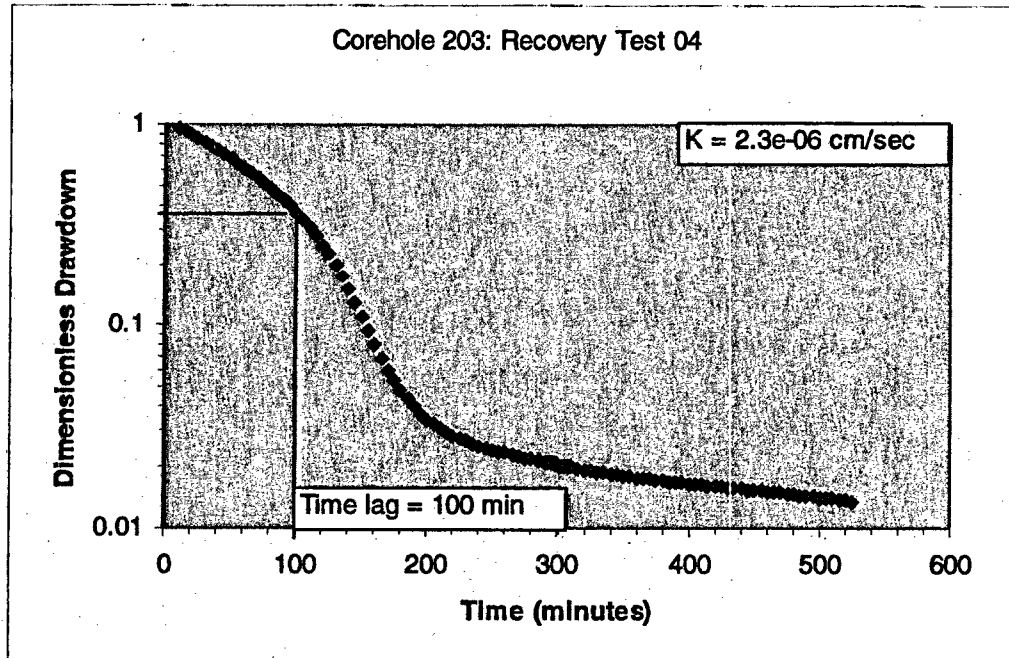
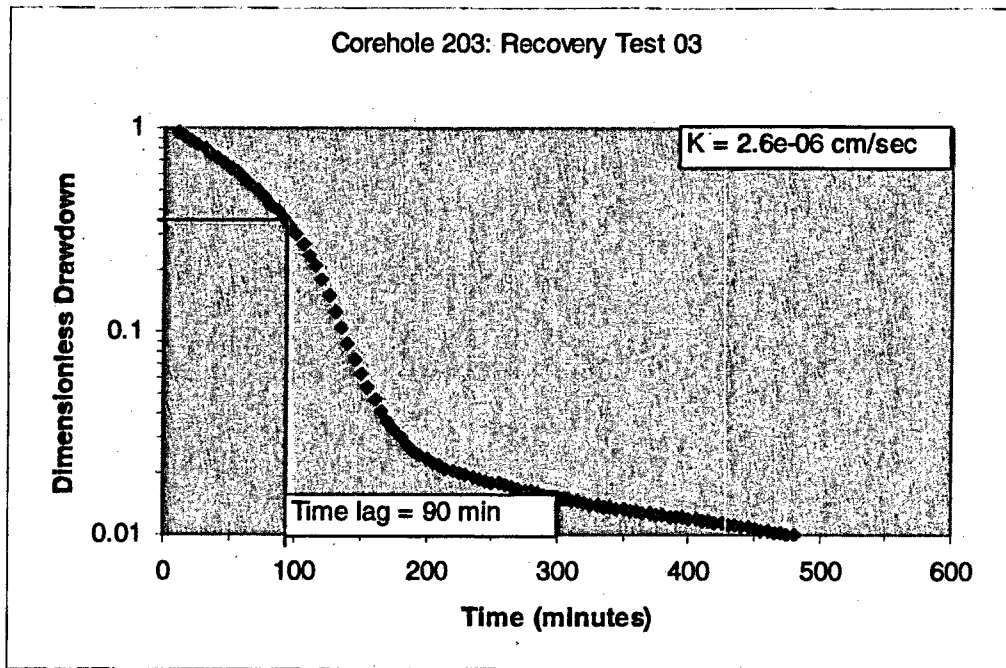


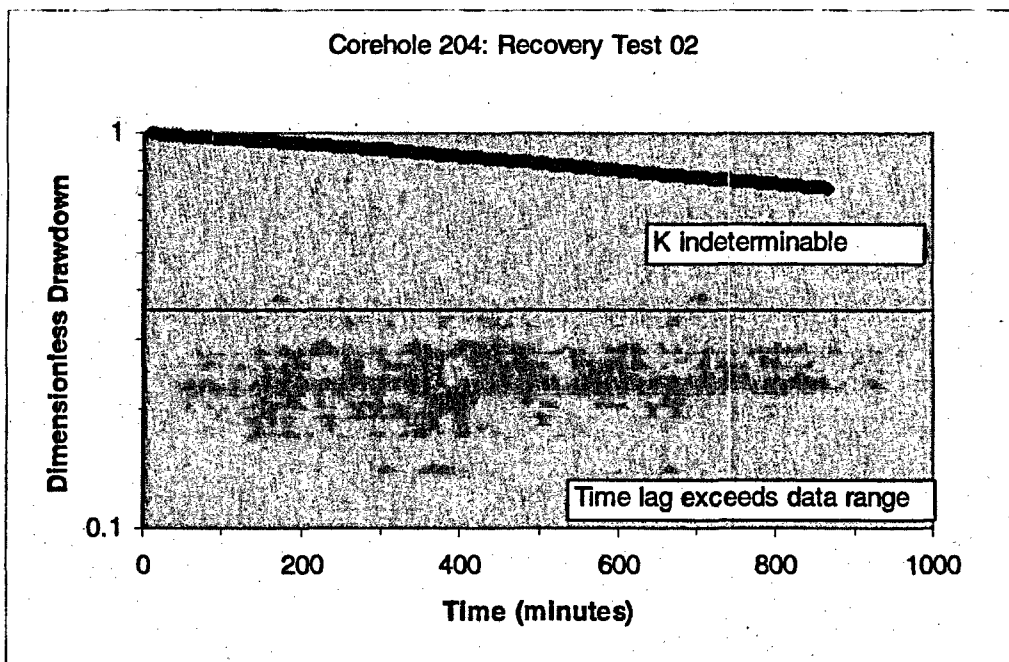
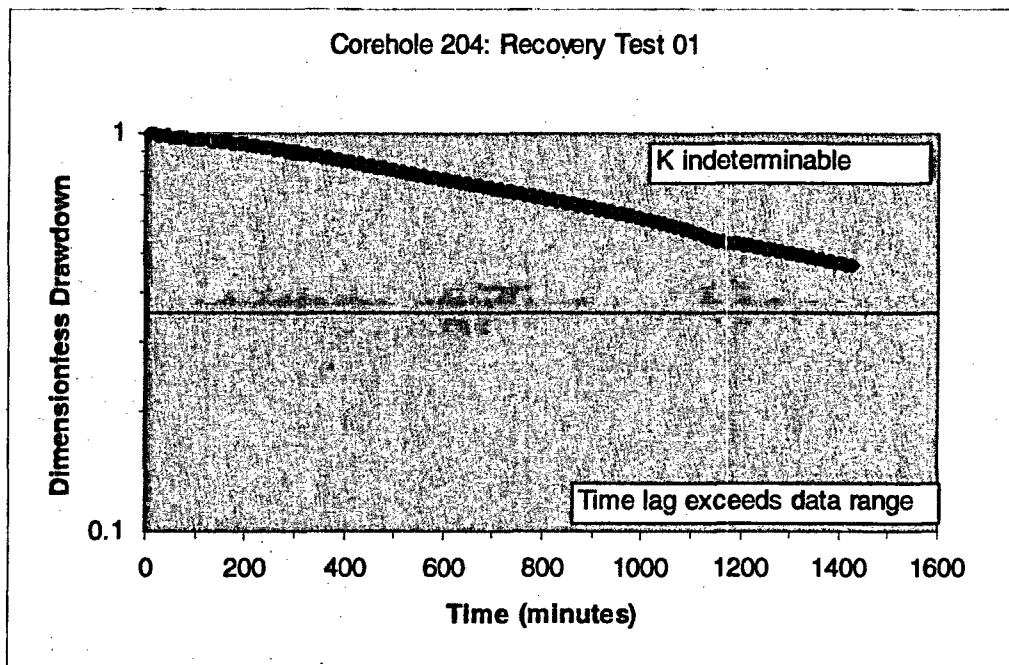
Corehole 203: Recovery Test 01

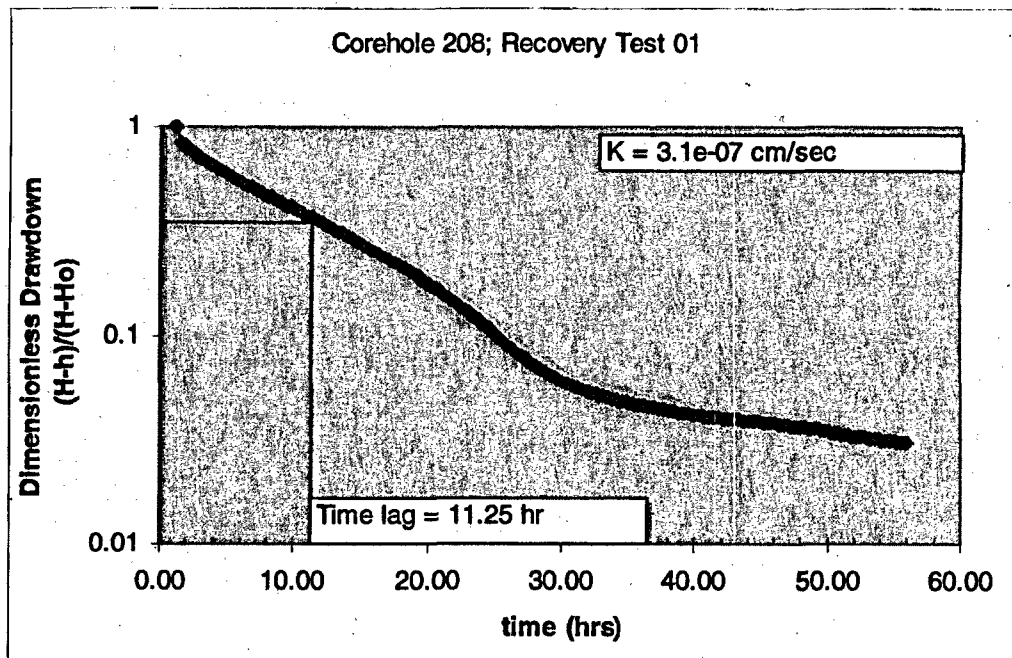
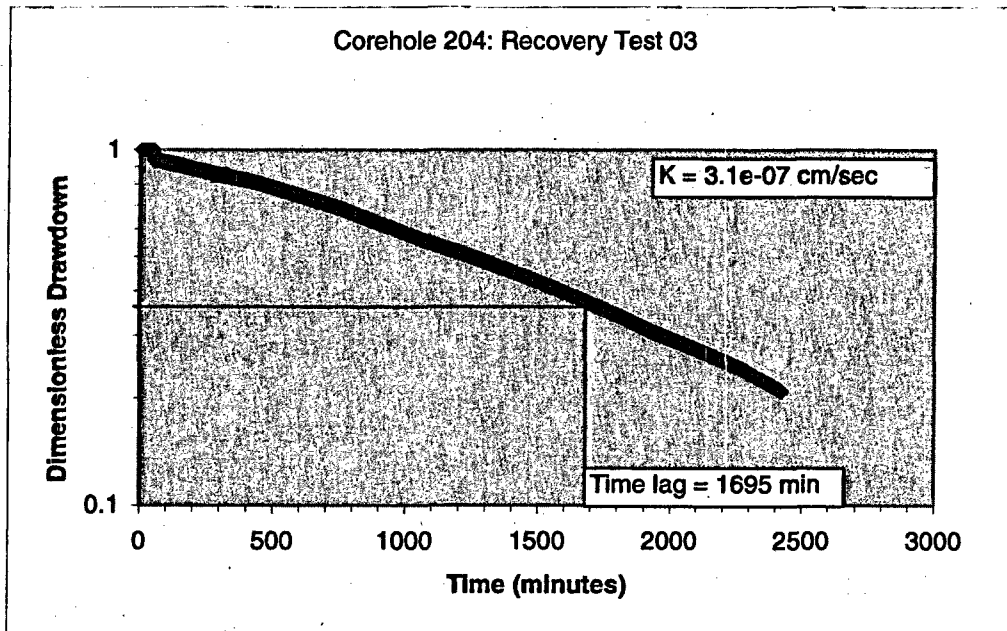


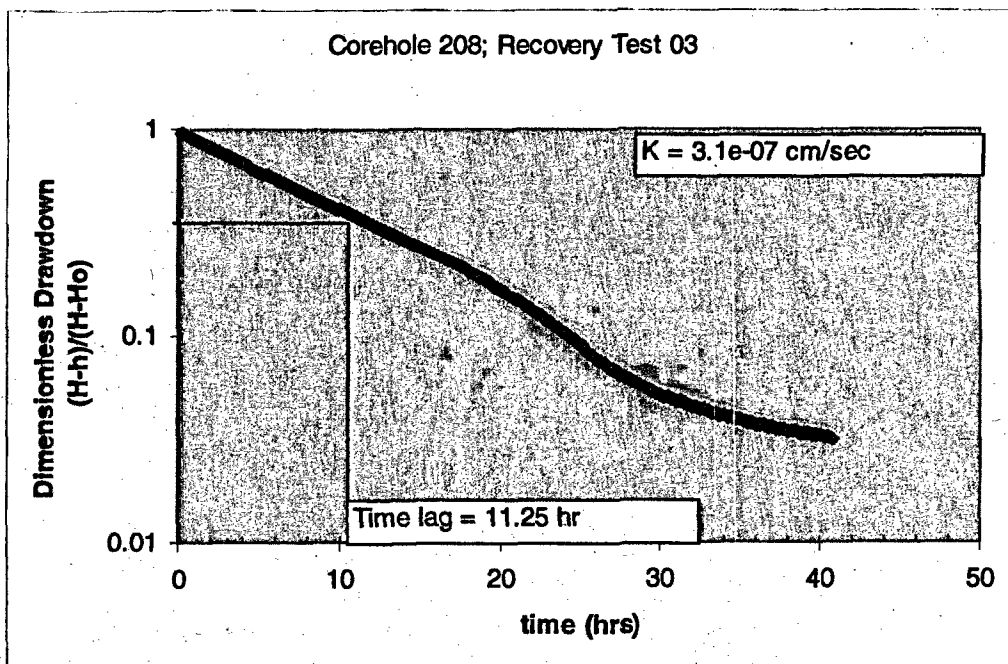
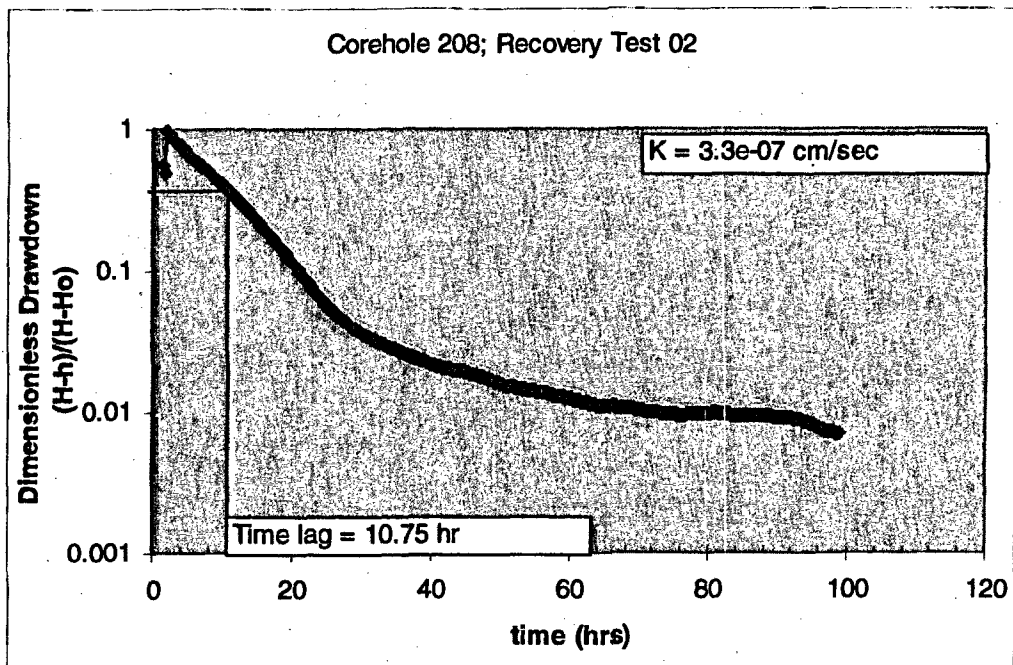
Corehole 203: Recovery Test 02











U.S. Department of Energy—Grand Junction, Colorado

Calculation Cover Sheet

Calc. No.: MOA-02-02-2006-2-06-00 Discipline: Hydrologic Properties No. of Sheets: 7

Project: Moab UMTRA Project

Site: Crescent Junction Disposal Site

Feature: Field Permeability "Packer" Testing

Sources of Data:

Packer testing records obtained at the Crescent Junction site during the field characterization project November 2005 through January 2006.

Sources of Formulae and References:

U.S. Bureau of Reclamation (USBR), 1998. *Engineering Geology Field Manual*, Second Edition, U.S. Department of the Interior, Washington D.C., (Chapter 17 "Water Testing for Permeability" available online: www.usbr.gov/pmts/geology/geolman2/Chapter17.pdf)

Preliminary Calc. ☐

Final Calc. ☐

Supersedes Calc. No.

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Problem Statement:

During November 2005 through January 2006, the U.S. Department of Energy (DOE) contractor S.M. Stoller Corporation completed field permeability "packer" tests at the Crescent Junction disposal site. The objectives of these tests were to:

- Estimate the horizontal hydraulic conductivity of the weathered and unweathered sections of the Mancos Shale that underlie the disposal site.
- Evaluate the hydrogeologic suitability of the proposed disposal site.
- Establish design parameters for the proposed disposal site.
- Help formulate a water resources protection strategy for the proposed disposal site.

Method of Solution:

Packer tests are conducted in a corehole after the hole is cored and flushed with clear water. The method consists of lowering the testing apparatus into the corehole, inflating the packers so that they fit snugly against the wall of the corehole, and then injecting water under pressure into the test interval. The flow of water into the test interval is measured with a flow meter. The flow rate of water into the test interval is measured as a function of the injection pressure. This provides a measure of the hydraulic conductivity of the rock formation.

HQ-wire line core drilling was used to advance three shallow coreholes into the weathered Mancos Shale to a depth of 40 feet (ft) below the ground surface, and ten coreholes into the relatively unweathered Mancos Shale to a depth of 300 ft below the land surface. Corehole logs that describe the lithologic materials encountered during drilling are presented in Calculation MOA-02-03-2006-1-03-00 (in preparation).

Packer test methods are described in the U.S. Bureau of Reclamation Engineering Geology Field Manual (USBR 1998). Several methods are potentially applicable, depending on the zone that is being tested. The zone determinations and packer configurations are defined in Figure 1. According to Figure 1, there are three potential zones in the subsurface and two potential packer configurations. The packer tests for this project were done in all three zones, and both packer configurations were used. A single-packer system was used in the shallow coreholes (0211, 0212, and 0213) and each of the single-packer tests was performed above the water level in zone 1. Dual-packer tests were completed in the deep coreholes (0204 and 0208) in zones 1, 2, and 3, above and below the water table. Figure 2 presents the locations where the packer tests were undertaken. A *Moyno* pump was used to deliver steady, even pressure to the test interval. Totalized flows were read from a mechanical, inline flow meter until they stabilized.

In coreholes 0211, 0212, and 0213, the tests were done in the shallow, weathered-bedrock intervals while the hole was being advanced. Water for coring and washing the selected test interval was obtained from the Thompson Springs municipal water supply system. The single-packer assembly was lowered through the drill rod into the shallow test interval using a wire line packer system (Figure 3). A 10-ft-long test interval was used for each injection test. The packer was inflated to 100 pounds per square inch (lb/in²) to isolate each test interval.

Test intervals 20–30 ft and 30–40 ft below ground surface were selected to evaluate the hydraulic properties of the weathered Mancos Shale. Guidance provided in the Manual (USBR 1998, p.127) recommends that relatively homogeneous but fractured rock (such as the weathered Mancos Shale) can be tested at 1 lb/in² per ft of test-interval depth. Consequently, water was injected at 5-lb/in², 10-lb/in², and again at 5-lb/in² gage pressure at the surface. When combined with the hydrostatic pressure between the pressure gage and the test interval, the total head was less than the critical pressures that could have damaged the formation.

The dual packer tests were done in the deep coreholes and were intended to test representative sections of the competent Mancos Shale. The tests began in the deepest part of the corehole and proceeded

upward until three depth intervals were tested. The test intervals were selected on the basis of visual observations of the rock core retrieved from the corehole, which indicated a stratigraphic contact probably exists between the Prairie Canyon and Blue Gate Members of the Mancos Shale at a depth of approximately 100 ft in corehole 0204 and 110 ft in corehole 0208.

Each test interval was 12 ft in length. Test intervals were chosen to straddle that contact and ascertain if any observable differences exist in the hydraulic conductivity of those units. A test interval was also chosen near the bottom of each corehole. The diameter of each corehole was nominally 3.9 inches. Water for coring and washing the selected test interval was obtained either from the Thompson Springs or the Moab municipal water supply system. Each interval was tested at multiple gauge pressures ranging from 5 to 30 lb/in². Because the flows were very low or nonexistent, a test duration of up to 30 minutes was used whenever practicable. The dual-packer system was inflated to pressures ranging from 230 to 300 lb/in² prior to testing each interval.

Assumptions:

- Injected water flows directly into the test interval without short-circuiting through the packer seal.
- For flows exceeding 4 gallons per minute (gpm), friction losses through the drill pipe follow the Pressure Loss Curve provided by the subcontractor, Layne Geoconstruction.
- Solutions provided in the Manual (USBR 1998) are applicable to the field conditions at the Crescent Junction disposal site.
- The analysis methods presented in the Manual (USBR 1998) are equally valid both above and below the water table.

Calculations:

Calculations are attached in Appendix A. Table 1 provides a summary of the test results for this project.

Discussion:

Table 1 presents a summary of the packer test results. The horizontal hydraulic conductivity values range from 10⁻³ centimeters per second (cm/sec) to less than 10⁻⁷ cm/sec. The hydraulic conductivity of the weathered bedrock is approximately 4 orders of magnitude higher than the unweathered bedrock. Based on the packer tests, the relatively high hydraulic conductivity in the weathered Mancos Shale extends to a depth of at least 40 ft below ground surface. At a depth of 80 to 130 ft below land surface, the hydraulic conductivities are less than 10⁻⁷ cm/sec. The transition between weathered and unweathered bedrock probably correlates to the fracture intensity. Optical televiewer logs prepared for this project suggest that the transition between weathered and unweathered bedrock occurs at a depth of approximately 50 to 60 ft below the surface.

Table 1. Summary of Field-Permeability "Packer" Test Results for the Crescent Junction Site

Test Interval: Hole ID @ Depth (ft)	Calculated Permeability (cm/s) @ Injection Pressure (lb/in ²)				
	Test 1	Test 2	Test 3	Test 4	Test 5
Dual-Packer Tests:					
0204 @ 80 to 92	J 1.3 x 10 ⁻⁸ @ 10	3.9 x 10 ⁻⁷ @ 20	J 9.6 x 10 ⁻⁹ @ 30	6.6 x 10 ⁻⁷ @ 20	J 1.3 x 10 ⁻⁸ @ 10
0204 @ 110 to 122	J 7.5 x 10 ⁻⁹ @ 10	9.1 x 10 ⁻⁹ @ 20	4.2 x 10 ⁻⁷ @ 30	J 9.1 x 10 ⁻⁸ @ 20	J 7.5 x 10 ⁻⁹ @ 10
0204 @ 283 to 295	J 8.9 x 10 ⁻⁹ @ 5	1.2 x 10 ⁻⁶ @ 10	2.6 x 10 ⁻⁶ @ 20	J 1.1 x 10 ⁻⁸ @ 10	J 1.2 x 10 ⁻⁸ @ 5
0208 @ 90 to 102	J 6.0 x 10 ⁻⁹ @ 10	J 7.7 x 10 ⁻⁹ @ 20	J 2.2 x 10 ⁻⁹ @ 30	J 7.7 x 10 ⁻⁹ @ 20	J 6.0 x 10 ⁻⁹ @ 10
0208 @ 121 to 133	J 8.0 x 10 ⁻⁹ @ 10	J 1.4 x 10 ⁻⁸ @ 20	7.5 x 10 ⁻⁷ @ 30	J 1.4 x 10 ⁻⁸ @ 20	J 8.0 x 10 ⁻⁹ @ 10
0208 @ 282 to 294	6.3 x 10 ⁻⁷ @ 5	6.0 x 10 ⁻⁷ @ 10	J 6.0 x 10 ⁻⁹ @ 20	J 5.7 x 10 ⁻⁹ @ 10	2.1 x 10 ⁻⁷ @ 5
Single-Packer Tests:					
0211 @ 20 to 30	1.4 x 10 ⁻³ @ 5	1.3 x 10 ⁻³ @ 5	1.7 x 10 ⁻³ @ 5		
0211 @ 30 to 40	1.4 x 10 ⁻³ @ 5				
0212 @ 20 to 30	1.6 x 10 ⁻³ @ 5	1.8 x 10 ⁻³ @ 10	2.0 x 10 ⁻³ @ 5		
0212 @ 30 to 40	2.5 x 10 ⁻³ @ 5	2.3 x 10 ⁻³ @ 10	2.5 x 10 ⁻³ @ 5		
0213 @ 20 to 30	2.4 x 10 ⁻³ @ 5	2.2 x 10 ⁻³ @ 10	2.2 x 10 ⁻³ @ 5		
0213 @ 30 to 40	2.3 x 10 ⁻³ @ 5	2.6 x 10 ⁻³ @ 10	2.5 x 10 ⁻³ @ 5		

Notes:

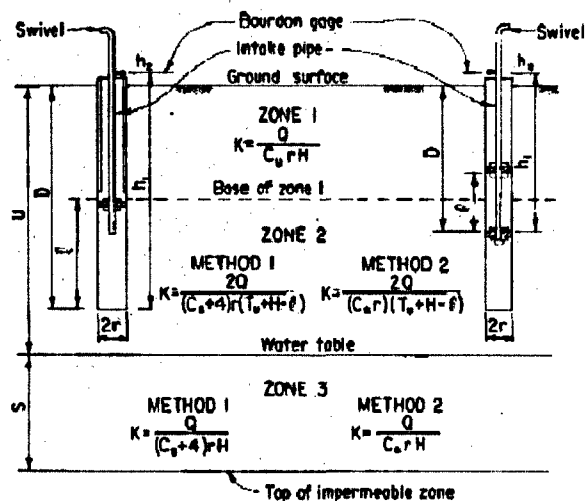
- Gray fields indicate no additional data collected at that test interval.
- J flag represents the quantitation limit for a no-flow test.

Conclusion and Recommendations:

Results from the packer tests illustrate that the hydraulic conductivity of the Mancos Shale at the Crescent Junction disposal site is much lower in the competent bedrock underlying the weathered interval that extends to at least 40 ft beneath the land surface. Below the weathered zone, the hydraulic conductivity of the Mancos Shale decreases by approximately 4 orders of magnitude.

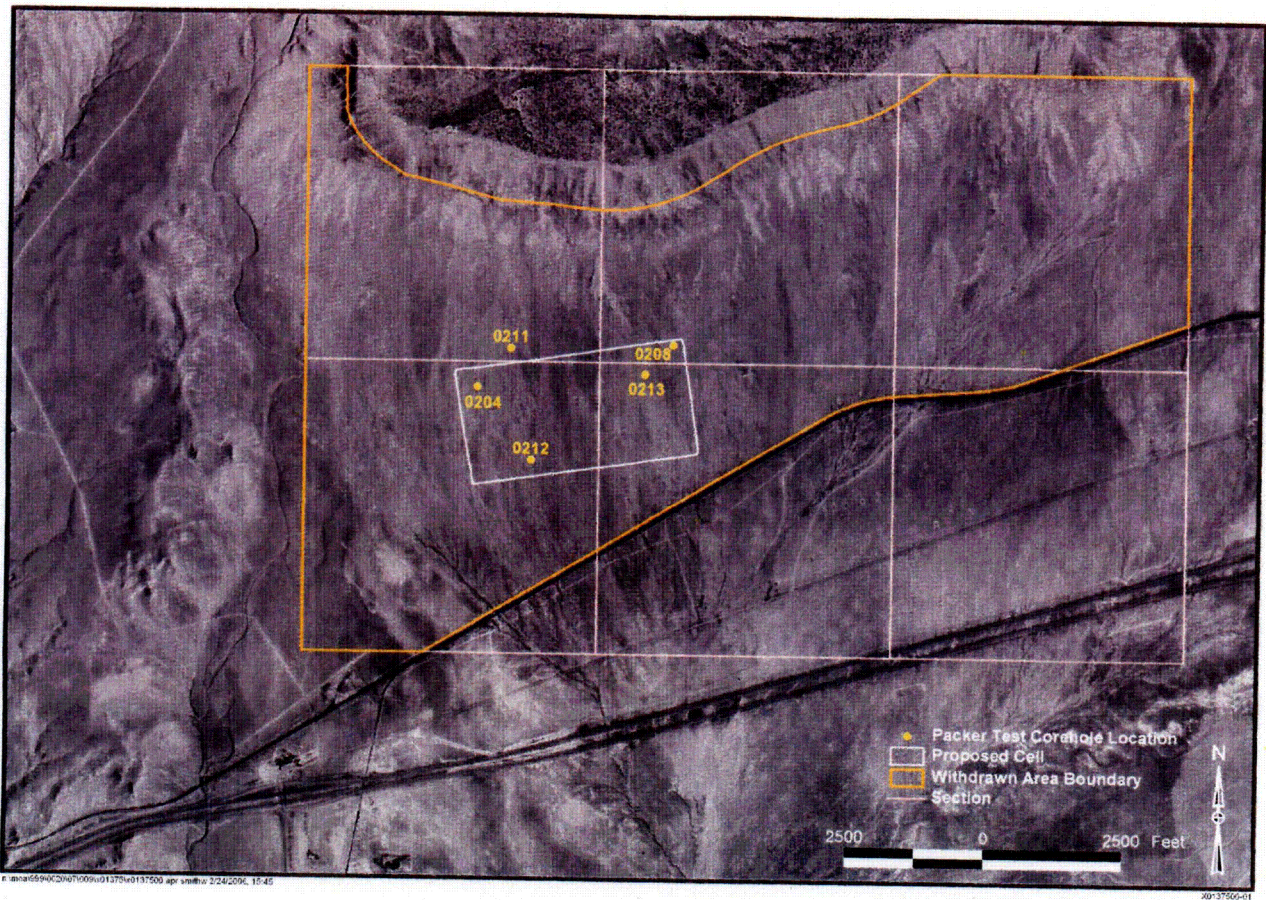
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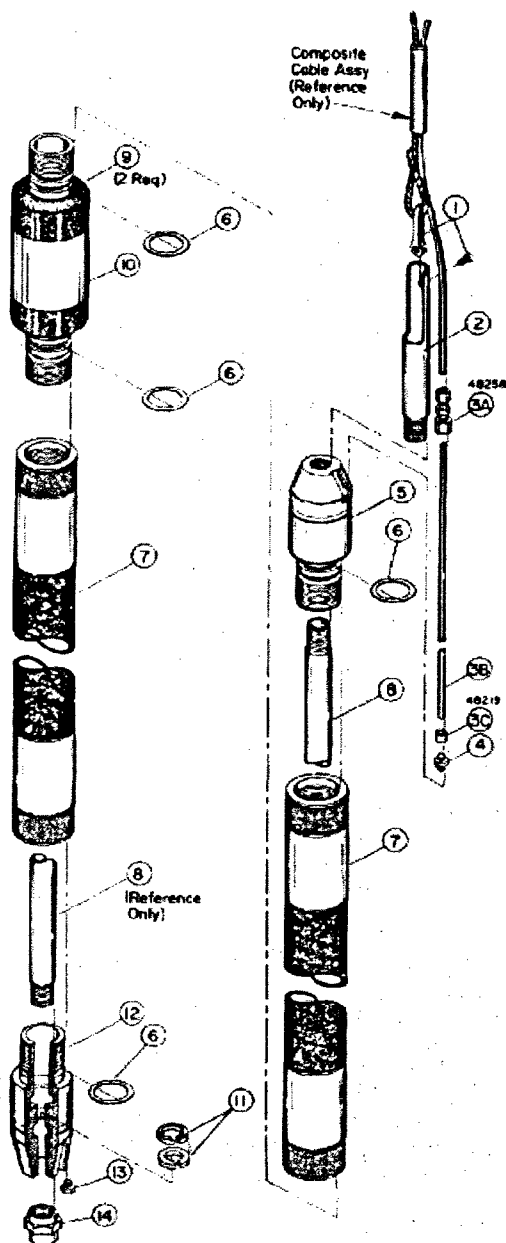
- Not applicable



K = coefficient of permeability, feet per second under a unit gradient
 Q = steady flow into well, ft^3/s
 $H = h_1 + h_2 - L$ = effective head, ft
 h_1 (above water table) = distance between Bourdon gage and bottom of hole for method 1 or distance between gage and upper surface of lower packer for method 2, ft
 h_2 (below water table) = distance between gage and water table, ft
 h_3 = applied pressure at gage, $1 \text{ lb/in}^2 = 2.307 \text{ ft}$ of water
 L = head loss in pipe due to friction, ft; ignore head loss for $Q < 4 \text{ gal/min}$ in $1\frac{1}{2}$ -inch pipe; use length of pipe between gage and top of test section for computations
 $X = \frac{U}{S} (100)$ = percent of unsaturated stratum
 l = length of test section, ft
 r = radius of test hole, ft
 C_u = conductivity coefficient for unsaturated materials with partially penetrating cylindrical test wells
 C_s = conductivity coefficient for semi-spherical flow in saturated materials through partially penetrating cylindrical test wells
 U = thickness of unsaturated material, ft
 S = thickness of saturated material, ft
 $T_u = U - D + H$ = distance from water surface in well to water table, ft
 T_s = distance from ground surface to bottom of test section, ft
 a = surface area of test section, ft^2 ; area of wall plus area of bottom for method 1; area of wall for method 2
Limitations:
 $Q/a \leq 0.10$, $S \geq 5l$, $l \geq 10r$, thickness of each packer must be $\geq 10r$ in method 2

Figure 1. Illustration of Potential Packer Test Configurations, Solution Methods, and Explanation of Mathematical Symbols (modified after Bureau of Reclamation 1998, Figure 17-5)



Wireline Packer

HQ Wireline Packer Type II

1-14	48228	HQ Packer Assembly Type II	1
1	44018	Shackle	1
2	48239	Riser Tube	1
3	48218	Inflation Tube Jumper	1
4	44004	Adapter	1
5	48230	Fixed Head	1
6	48231	O-Ring	4
7	48232	Gland Element	2
8	48233	Center Tube	1
9	48235	Union Ring	2
10	48234	Gland Union	1
11	48237	Seal	2
12	48236	Sliding Head	1
13	44034	Plug	1
14	48238	Connector	1

Figure 3. Schematic Diagram of Single Wire Line Packer System Used on the Crescent Junction Project

Appendix A

Copies of Packer Testing Raw-Data Sheets and Analysis Sheets

Stoller

RECORD COPY

established 1959

Packer-Test Record

Page 1 of 3

Project Name: Crescent Junction Characterization

Date: 11/21/05

Field Representative: M. Kautsky Borehole No. 211 Total Depth: 30 ft.

Depth to Water (TOC): ± 120 ft. Borehole Cleaned? Yes ☒ No ☐ Date: 11-21-05

Test Interval (BGL): from 20 to 30 ft. Swivel/Elbow Height (AGL) 5'

Conductor Pipe, Type and Size: HQ

Time	Gauge Pressure	Flow Meter Reading
12:17 ^{mm} <u>12:19</u>	5 psi ^{mm} <u>5 psi</u>	<u>34356</u>
<u>12:21</u>	<u>5 psi</u>	<u>34376</u> > 12 gpm
<u>12:23</u>	<u>5 psi</u>	<u>34400</u> > 12½ gpm
<u>12:24</u>	<u>5 psi</u>	<u>34425</u> > 15 gpm
<u>12:25</u>	<u>5 psi</u>	<u>34440</u> > 16 gpm
<u>12:28</u>	<u>5 psi</u>	<u>34456</u> > 16.2 gpm
<u>12:29</u>	<u>5 psi</u>	<u>34504.5</u> > 22.5 "
<u>12:30</u>	<u>5 psi</u>	<u>34527</u> > 19.5 "
^{mm} 12:32 <u>12:31</u>	<u>5 psi</u>	<u>34546.5</u> > 22 "
<u>12:33</u>	<u>5 psi</u>	<u>34568.5</u> > 22.2
<u>12:35</u>	<u>5 psi</u>	<u>34613</u> > 22.7
		<u>34658.5</u>

Packer-Test Record

Page 2 of 3

Project Name: Crescent Junction Characterization Date: 11-21-05

Field Representative: M. Kautsky Borehole No. 211 Total Depth: 30 ft

Depth to Water (TOC): 12.0 ± Borehole Cleaned? Yes X No Date:

Test Interval (BGL): from 20 to 30 ft. Swivel/Elbow Height (AGL) 5 ft.

Conductor Pipe, Type and Size: HQ

Time	Gauge Pressure	Flow Meter Reading
<u>12:40</u>	<u>10 psi</u>	<u>34723</u>
<u>12:42</u>	<u>10 psi</u>	<u>34764</u> } 20 gpm
<u>12:43</u>	<u>10 psi</u>	<u>34790</u> } 26 gpm
<u>12:44</u>	<u>10 psi</u>	<u>448 34816</u> } 26 gpm
<u>12:45</u>	<u>10 psi</u>	<u>34842</u> } 26 gpm
<u>12:46</u>	<u>10 psi</u>	<u>34870</u> } 28 gpm
<u>12:48</u>	<u>10 psi</u>	<u>34923</u> } 26.5 gpm
<u>Ran out of water @ 12:48</u>		
<u>14:08</u>	<u>10 psi</u>	<u>35000</u> } 23.5 gpm
<u>14:09</u>	<u>10 psi</u>	<u>35023.5</u> } 22 gpm
<u>14:10</u>	<u>10 psi</u>	<u>35045.5</u> } 20.5 gpm
<u>14:11</u>	<u>10 psi</u>	<u>35066</u> } 21.5 gpm
<u>14:12</u>	<u>10 psi</u>	<u>35087.5</u> } 20.5 gpm
<u>14:13</u>	<u>10 psi</u>	<u>35108</u> } 22 gpm
<u>14:14</u>	<u>10 psi</u>	<u>35130</u> } 22 gpm
<u>14:15</u>	<u>10 psi</u>	<u>35152</u> } 22 gpm
<u>14:16</u>	<u>10 psi</u>	<u>35174</u> } 22 gpm

end of 10 psi test

Packer-Test Record

Page 3 of 3

Project Name: Crescent Junction Characterization Date: 11-21-05

Field Representative: M. Kautsky Borehole No. 211 Total Depth: 30

Depth to Water (TOC): 120 ± Borehole Cleaned? Yes X No Date: 11-21-05

Test Interval (BGL): from 20 to 30 ft. Swivel/Elbow Height (AGL) 5 ft

Conductor Pipe, Type and Size: HQ / HX

Time	Gauge Pressure	Flow Meter Reading
<u>14:19</u>	<u>5 psi</u>	<u>35235</u> ^{Flow (gpm)} <u>> 21 gpm</u>
<u>14:20</u>	<u>5 psi</u>	<u>35256</u> <u>> 22 "</u>
<u>14:21</u>	<u>5 psi</u>	<u>35278</u> <u>> 21 gpm</u>
<u>14:22</u>	<u>5 psi</u>	<u>35299</u> <u>> 21.5 gpm</u>
<u>14:24</u>	<u>5 psi</u>	<u>35342</u> <u>> 20.5 gpm</u>
<u>14:25</u>	<u>5 psi</u>	<u>35362.5</u> <u>> 21.5 gpm</u>
<u>14:26</u>	<u>5 psi</u>	<u>35384</u> <u>> 22 gpm</u>
<u>14:27</u>	<u>5 psi</u>	<u>35406</u> <u>> 19 gpm</u>
<u>14:28</u>	<u>5 psi</u>	<u>35425</u> <u>> 21 gpm</u>
<u>14:29</u>	<u>5 psi</u>	<u>35446</u> <u>> 22</u>
<u> </u>	<u> </u>	<u>35468</u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>

JOB NAME Crescent Junction

PREPARED: M. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

BOREHOLE : 211

Depth : 20-30 ft

 Pressure (h_z) : 5 psi (11.6 ft)

Unsaturated Zone Calculation:

Definitions:

 L = length of test section

 $T_u = U - D + H$
 U = Thickness of Unsaturated Material

 D = distance from ground surface to bottom of test section

 $H = h_1 + h_z - L$
 L = head loss ; ignore if $Q < 4 \text{ gpm}$
 $X = \frac{H}{T_u} (100)$; percent unsaturated material

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

 $L = 10 \text{ ft}$
 $T_u = U - D + H = 120 \text{ ft} - 30 \text{ ft} + 44.5 \text{ ft} = 134.5 \text{ ft}$
 $\frac{T_u}{L} = \frac{134.5 \text{ ft}}{10 \text{ ft}} = \boxed{13.4}$
 $H = h_1 + h_z - L = 35 \text{ ft} + 11.6 \text{ ft} - 2.1 \text{ ft} = 44.5 \text{ ft}$
 $X = \frac{H}{T_u} (100) = \frac{44.5 \text{ ft}}{134.5 \text{ ft}} (100) = \boxed{33}$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

1-30-06

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 211
Depth : 20-30 ft
Pressure (h_w) : 11.6 ft
(5 psi)

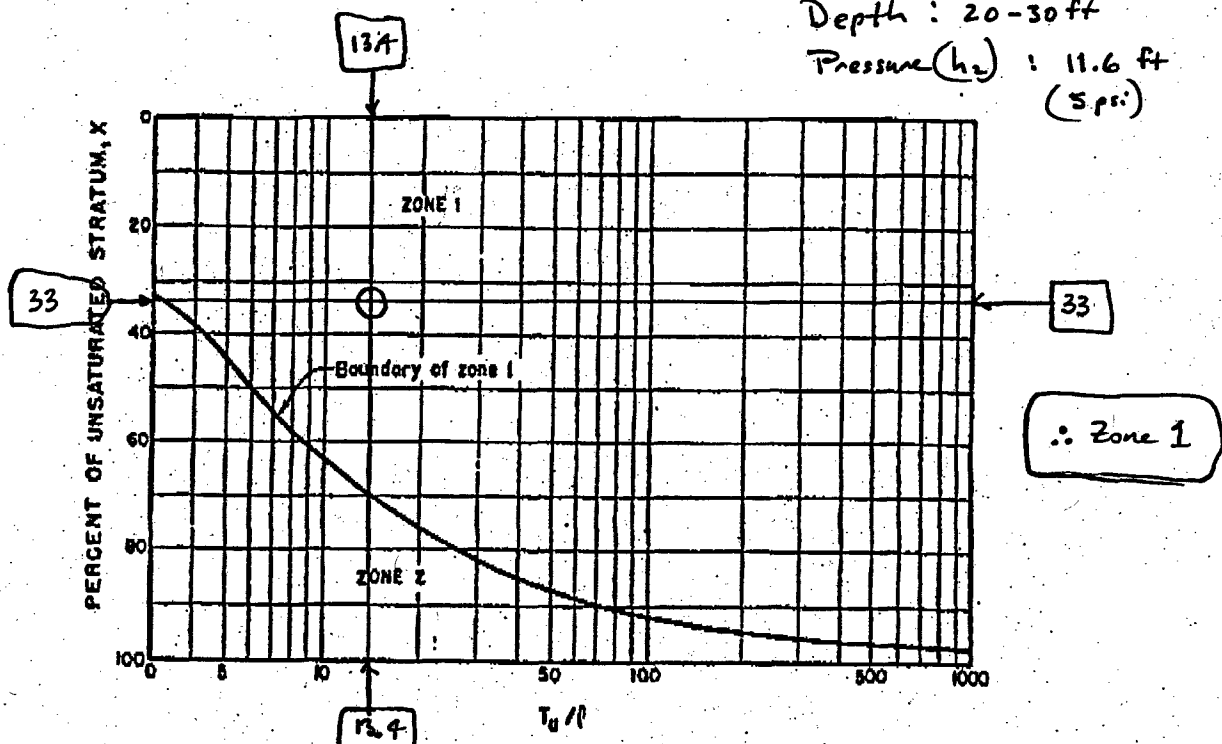
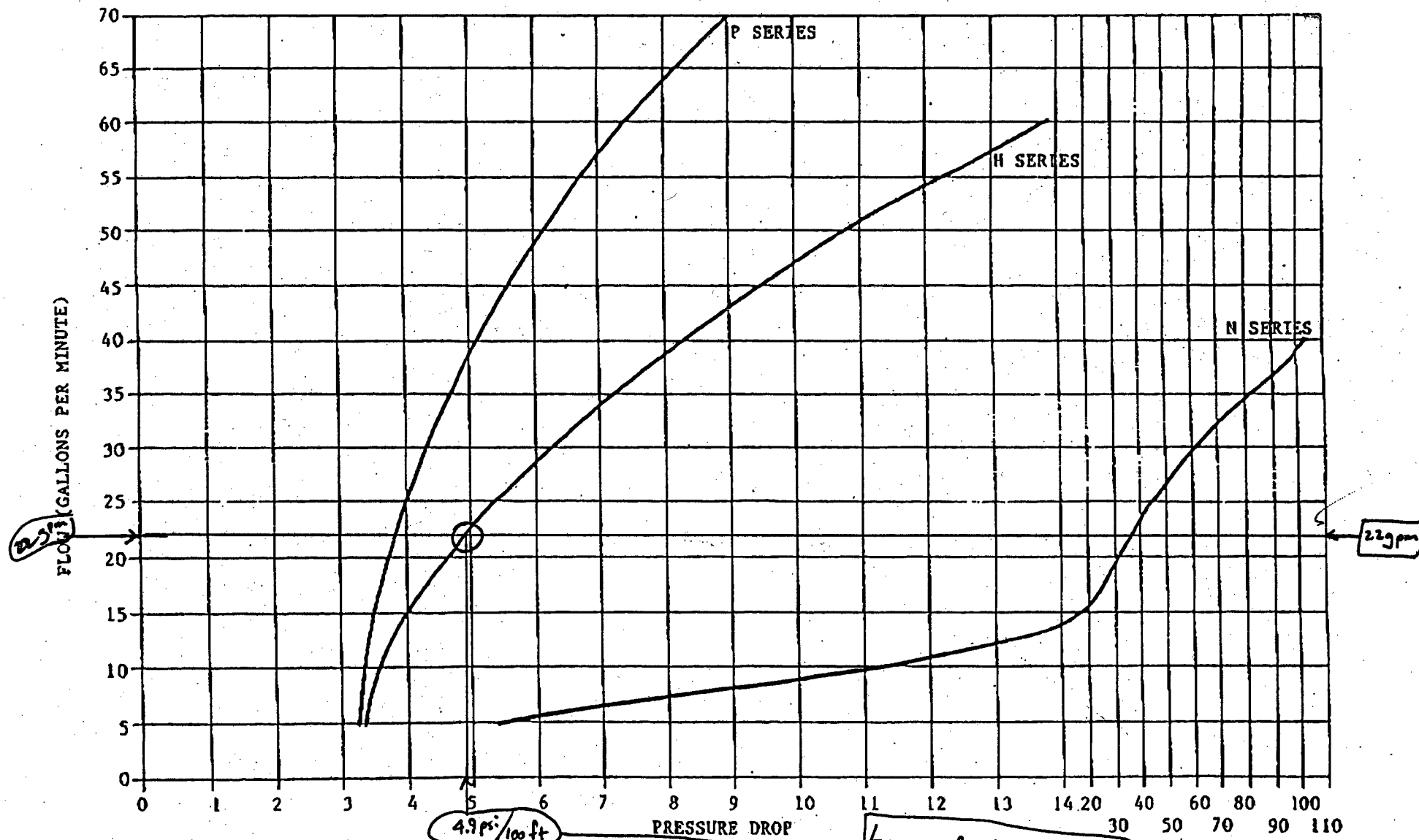


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 13.4$$

$$X = 33$$

PRESSURE LOSS CURVE



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From: WIRELINE TYPE II service manual, Bont Lanyear.

Borehole: 211
Depth: 20-30 ft
Pressure: 11.6 ft.
(5 psi)

Stoller

PACKER TEST SET-UP SHEET

Zone 1

JOB NO: _____

DATE: 1-30-06

JOB NAME: Crescent Junction Site

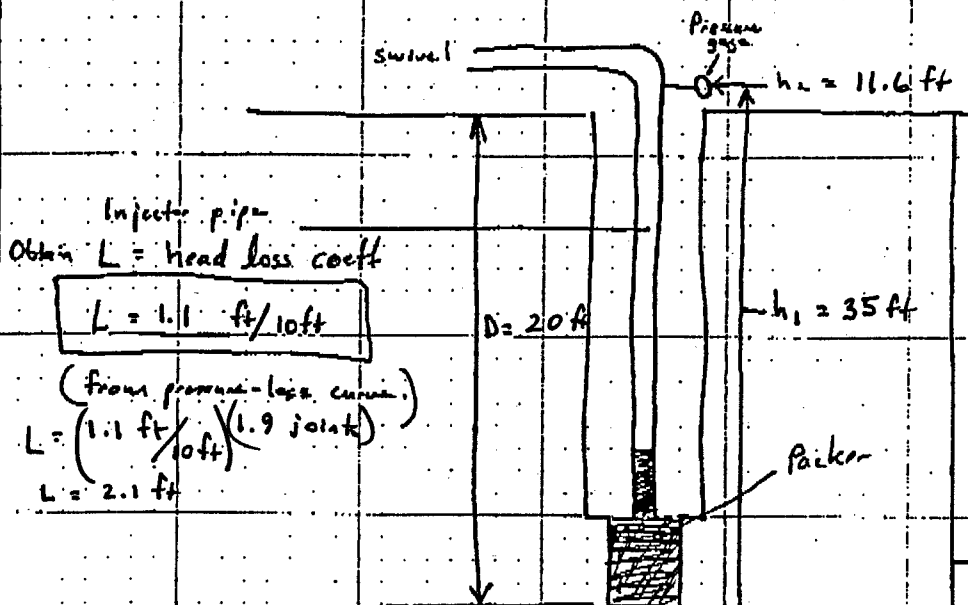
PREPARED: Mark Kautsky

REVIEWED: Bonehala 211

SHEET NO: 1 OF 1

Depth 20-30 ft

pressure (42) = 5 psi



Injector p.p.
Obtain L = head loss coeff

$$L = 1.1 \text{ ft/10ft}$$

(from previous test curve.)
 $L = (1.1 \text{ ft/10ft}) (1.9 \text{ joints})$
 $L = 2.1 \text{ ft}$

$$H = h_1 + h_2 - L$$

$$= 35 \text{ ft} + 11.6 \text{ ft} - 2.1 \text{ ft}$$

$$H = 44.5 \text{ ft}$$

Obtain C_u

$$C_u = 150$$

(From Fig 17.7 USBR)

$$\frac{H}{h} = \frac{52.8 \text{ ft}}{0.16 \text{ ft}} = 330$$

$$\frac{l}{H} = \frac{10 \text{ ft}}{44.5 \text{ ft}} = 0.22$$

Calculate K :

Method 1,
Zone 1,
USBR

$$K = \frac{Q}{C_u \cdot h \cdot H} = \frac{(22 \text{ gal/min}) (1440 \text{ min/d}) (1 \text{ ft}^3/7.48 \text{ gal})}{(150) (0.16 \text{ ft}) (44.5 \text{ ft})}$$

$$K = 4.0 \text{ ft/day}$$

$$K = 1.4 \times 10^{-3} \text{ cm/sec}$$

WATER TESTING FOR PERMEABILITY

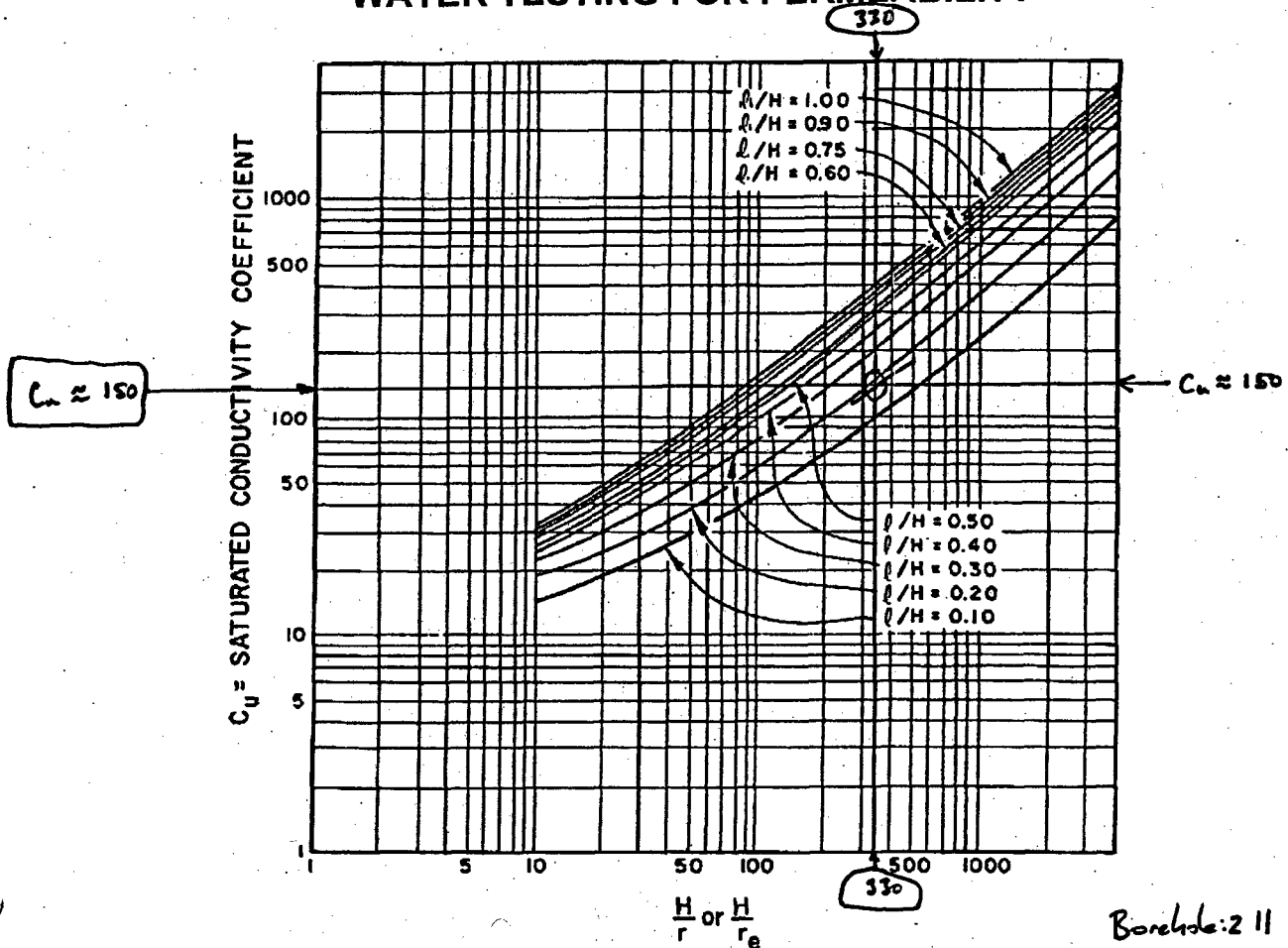


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Borehole: 2 1/2
Depth: 20-30 ft
Pressure: 11.6 ft

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

Stoller

DATE 1-23-06
 PROJECT: Crescent Junction
 PREPARED: M. Kautsky
 REVIEWED:
 SHEET NO. OF

PACKER TEST ANALYSIS

BOREHOLE : 211

Depth : 20-30 ft

Unsaturated Zone Calculation:

Pressure (h_2) : 23.1 ft (10 psi)

Definitions:

L = length of test section

$$T_u = U - D + H$$

U = Thickness of Unsaturated Material

D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

L = head loss ; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) ; \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10 \text{ ft}$$

$$T_u = U - D + H = 120 \text{ ft} - 30 \text{ ft} + 55.3 \text{ ft} = \boxed{145.3}$$

$$\frac{T_u}{L} = \frac{145.3 \text{ ft}}{10 \text{ ft}} = \boxed{14.5}$$

$$H = h_1 + h_2 - L = \boxed{54.9 \text{ ft}}$$

$$X = \frac{H}{T_u} (100) = \frac{54.9 \text{ ft}}{145.3 \text{ ft}} (100) = \boxed{38}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

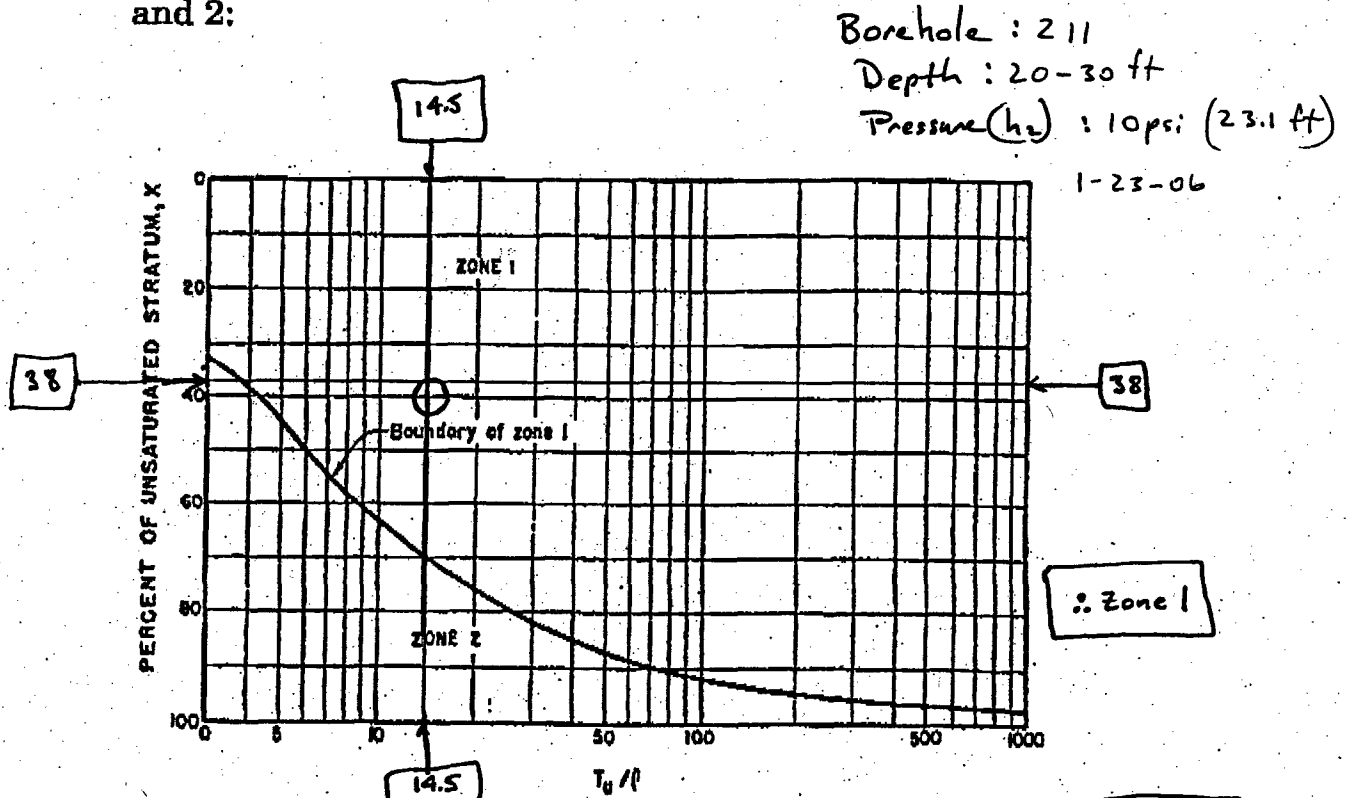


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 14.5$$

$$X = 38$$

Stoller

PACKER TEST SET-UP SHEET

Zone 1

JOB NO: _____

DATE: 1-30-06

JOB NAME: Crescent Junction Site

PREPARED: Mark Kautsky

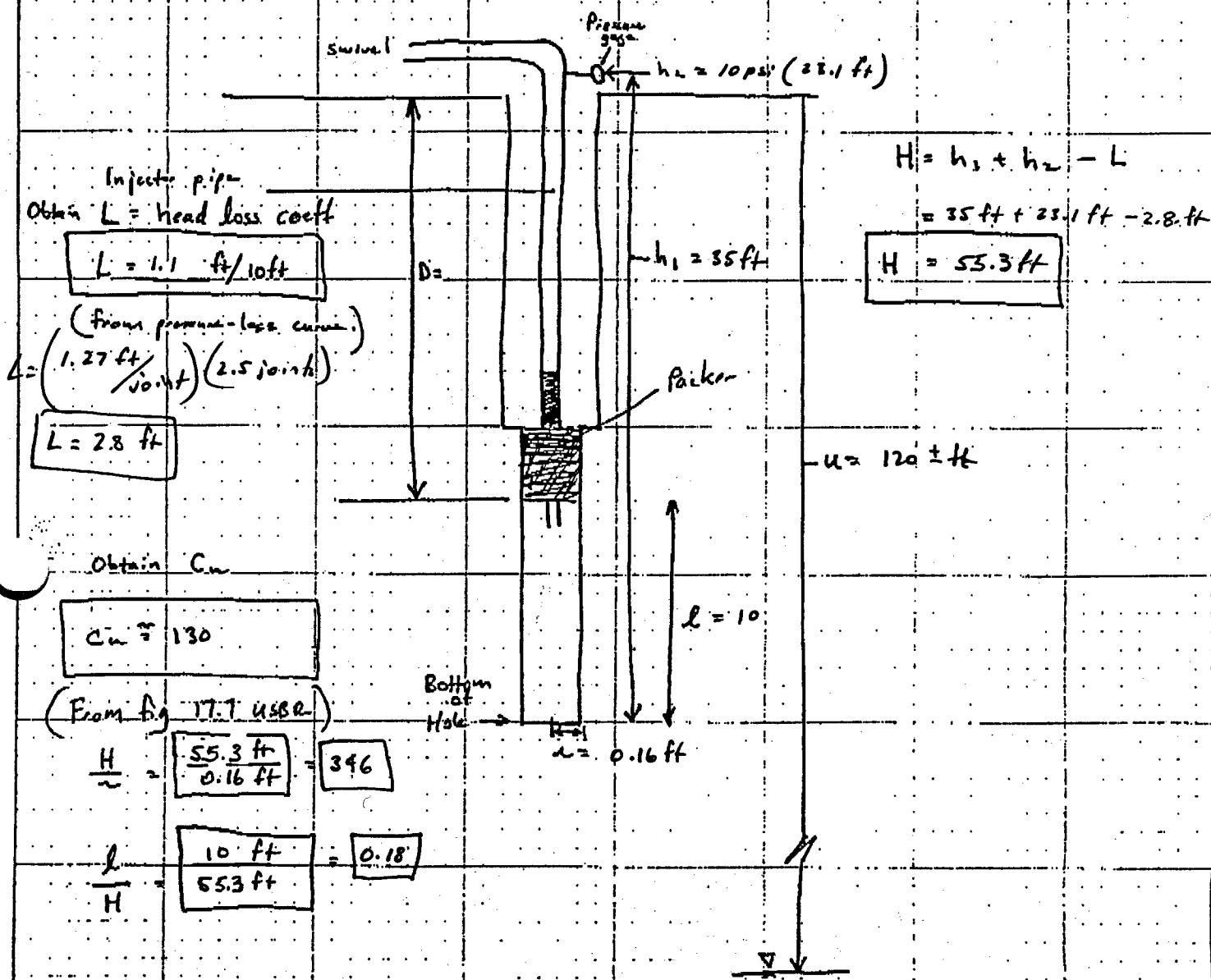
REVIEWED: _____

SHEET NO: 1 OF 1

Borehole 211

Depth 20-30 ft

Pressure 10 psi



Inject. pipe
Obtain L = head loss coeff

$$L = 1.1 \text{ ft/10ft}$$

(From pressure-loss curve)

$$L = (1.27 \text{ ft/joint}) (2.5 \text{ joints})$$

$$L = 2.8 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$= 35 \text{ ft} + 23.1 \text{ ft} - 2.8 \text{ ft}$$

$$H = 55.3 \text{ ft}$$

Obtain C_u

$$C_u \approx 130$$

(From Fig. 17.7 USBR)

$$\frac{H}{l} = \frac{55.3 \text{ ft}}{0.16 \text{ ft}} = 346$$

$$\frac{l}{H} = \frac{10 \text{ ft}}{55.3 \text{ ft}} = 0.18$$

Calculate K :

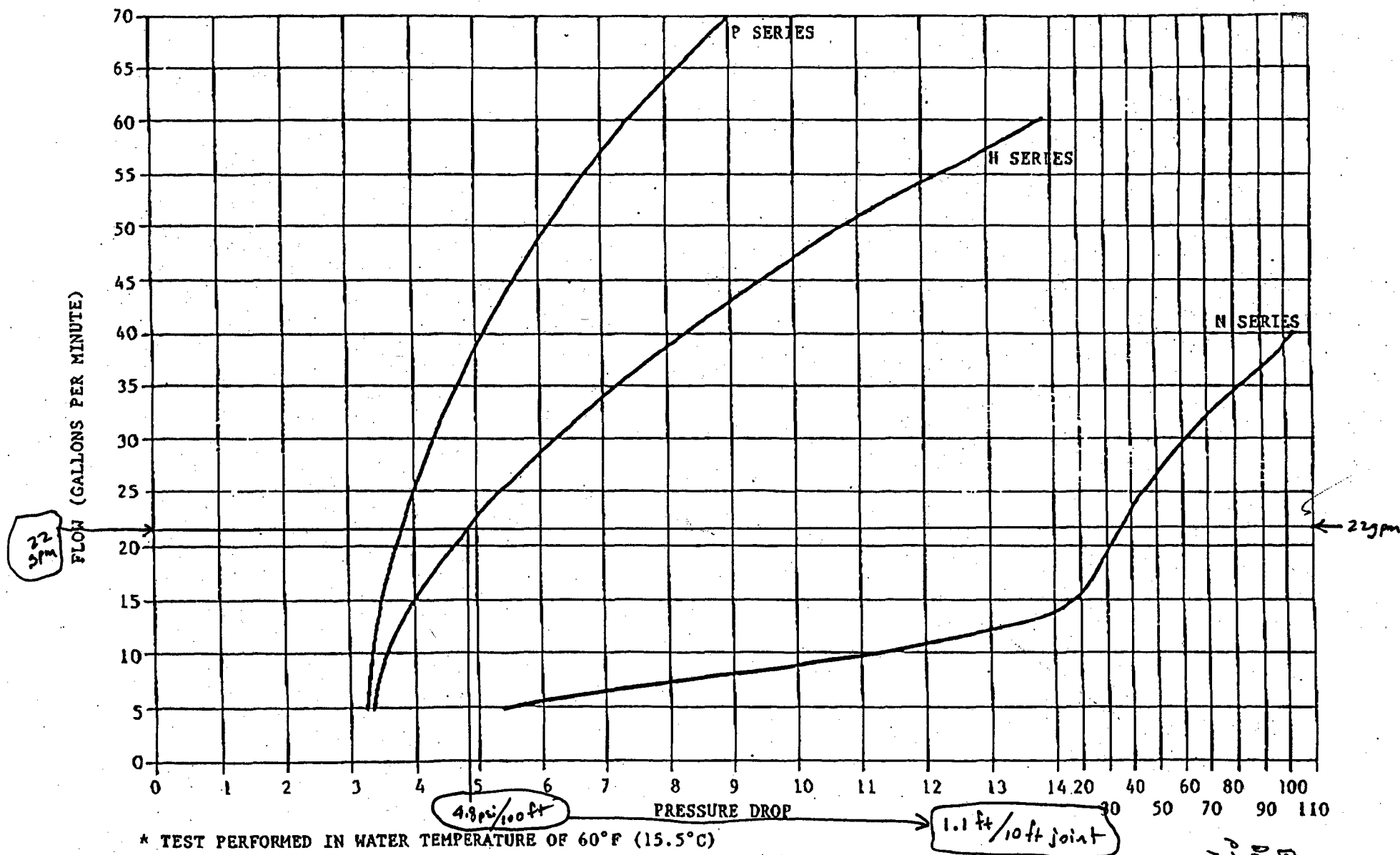
Method 1,
Zone 1,
USBR

$$K = \frac{Q}{C_u \cdot H} = \frac{\left(\frac{22 \text{ gal}}{\text{min}}\right) \left(\frac{1440 \text{ min}}{\text{day}}\right) \left(\frac{\text{ft}^3}{7.48 \text{ gal}}\right)}{(130) (0.16 \text{ ft}) (55.3 \text{ ft})}$$

$$K = 3.7 \text{ ft/day}$$

$$K = 1.3 \times 10^{-3} \text{ cm/sec}$$

PRESSURE LOSS CURVE



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From : WIRELINE TYPE II service manual, Boat Longyear.

Boat Longyear 211
Depth 20-30 ft
Pressure 10 psi
1-30-06

WATER TESTING FOR PERMEABILITY

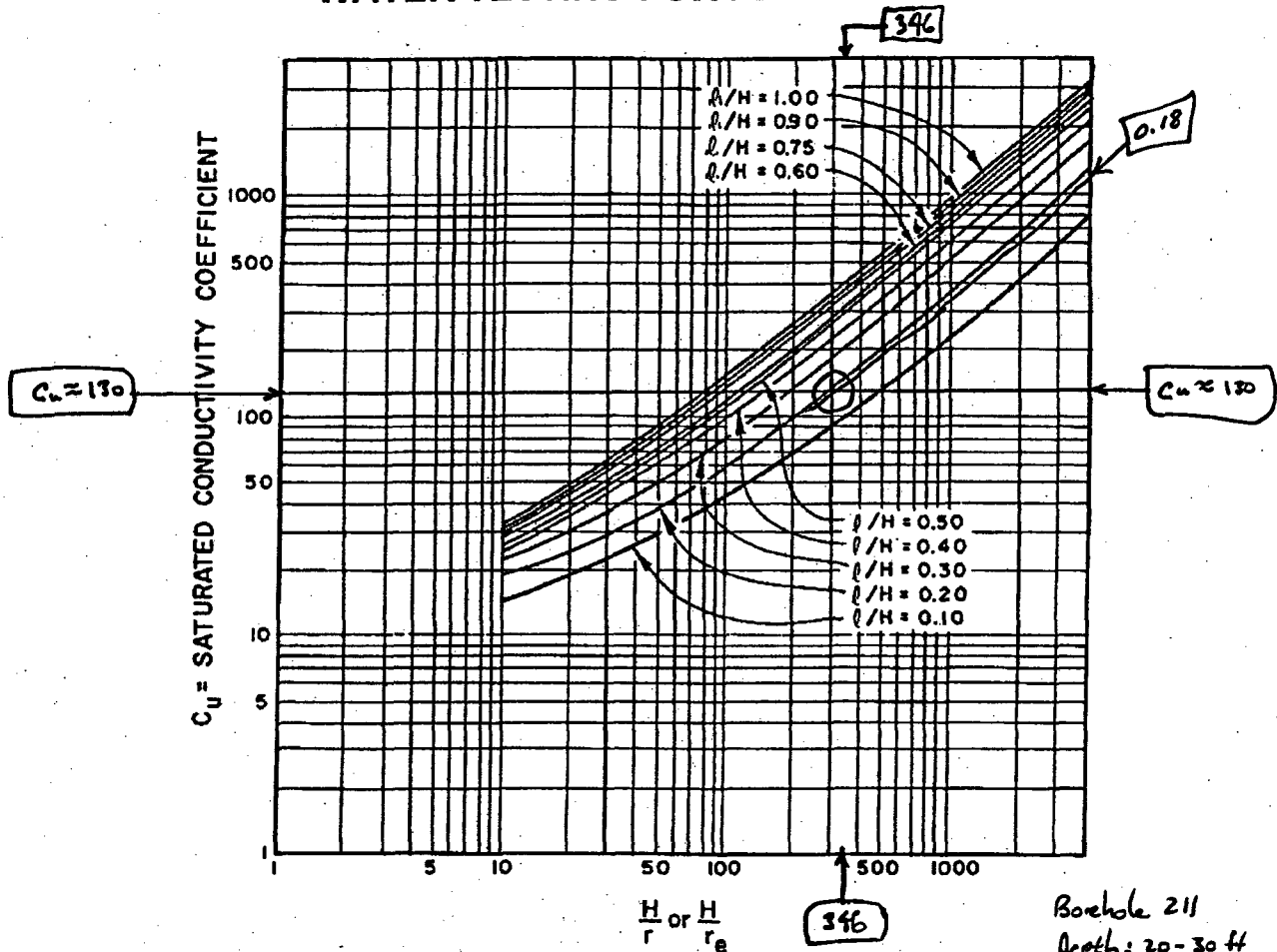


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

Stoller

JOB NO. _____ DATE 1-23-06

JOB NAME: Crescent Junction

PREPARED: M. Kautsky REVIEWED: _____

SHEET NO. _____ OF _____

PACKER TEST ANALYSES

BOREHOLE: 211

Depth: 20-30 ft

Pressure (hr): 5 psi (retest)

Unsaturated Zone Calculation:

Definitions: L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100); \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10$$

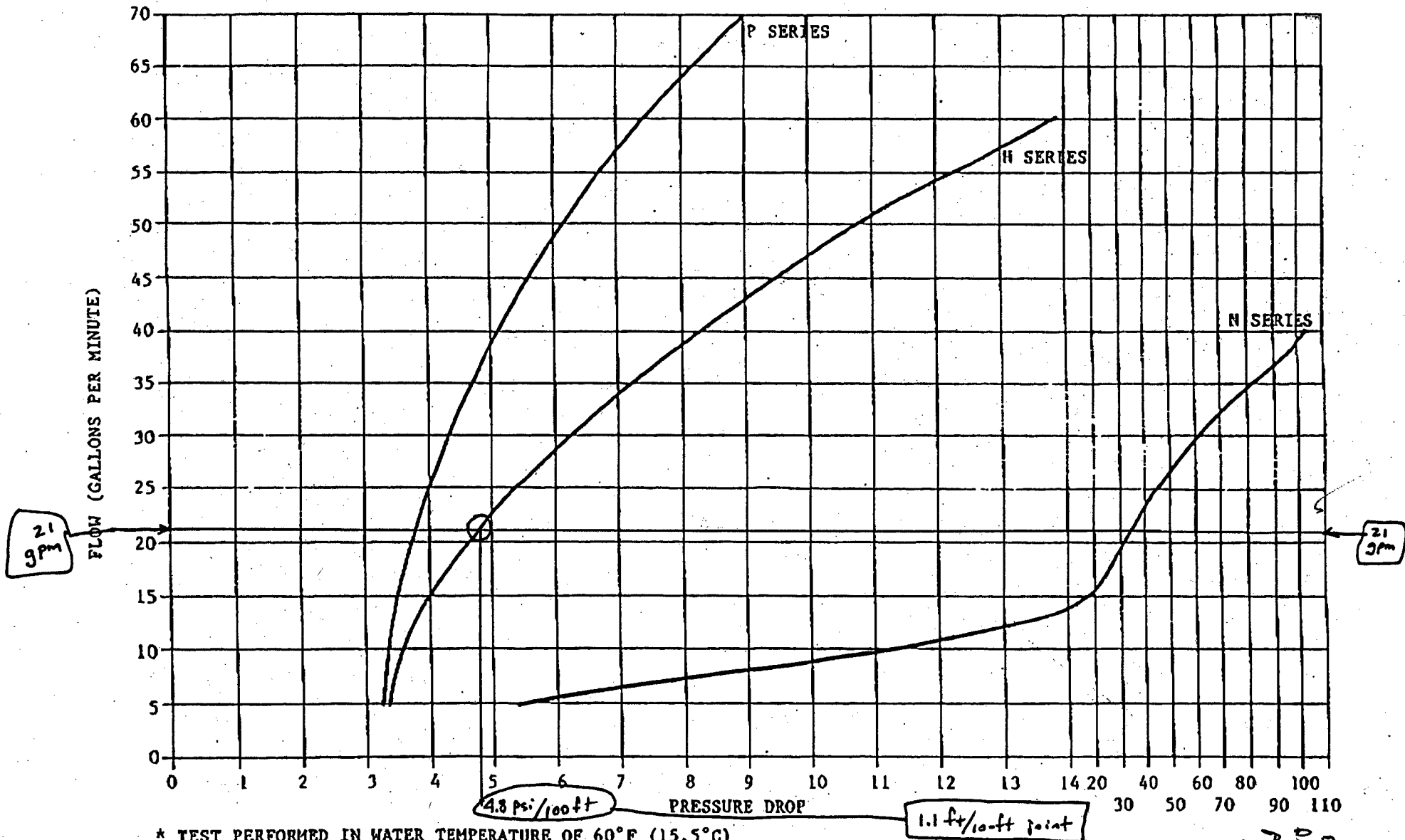
$$T_u = U - D + H = (120 - 30 + 43.8) \text{ ft} = 134 \text{ ft}$$

$$\frac{T_u}{L} = \frac{134 \text{ ft}}{10 \text{ ft}} = \boxed{13.4}$$

$$H = h_1 + h_2 - L = 43.8 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{43.8 \text{ ft}}{134 \text{ ft}} = \boxed{0.33} = \boxed{33\%}$$

PRESSURE LOSS CURVE



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From : WIRELINE TYPE II service manual, Boat Langyear.

Boat 211
Depth 20-30 ft
Pressure 5 PSI (about)
1-30-06

WATER TESTING FOR PERMEABILITY

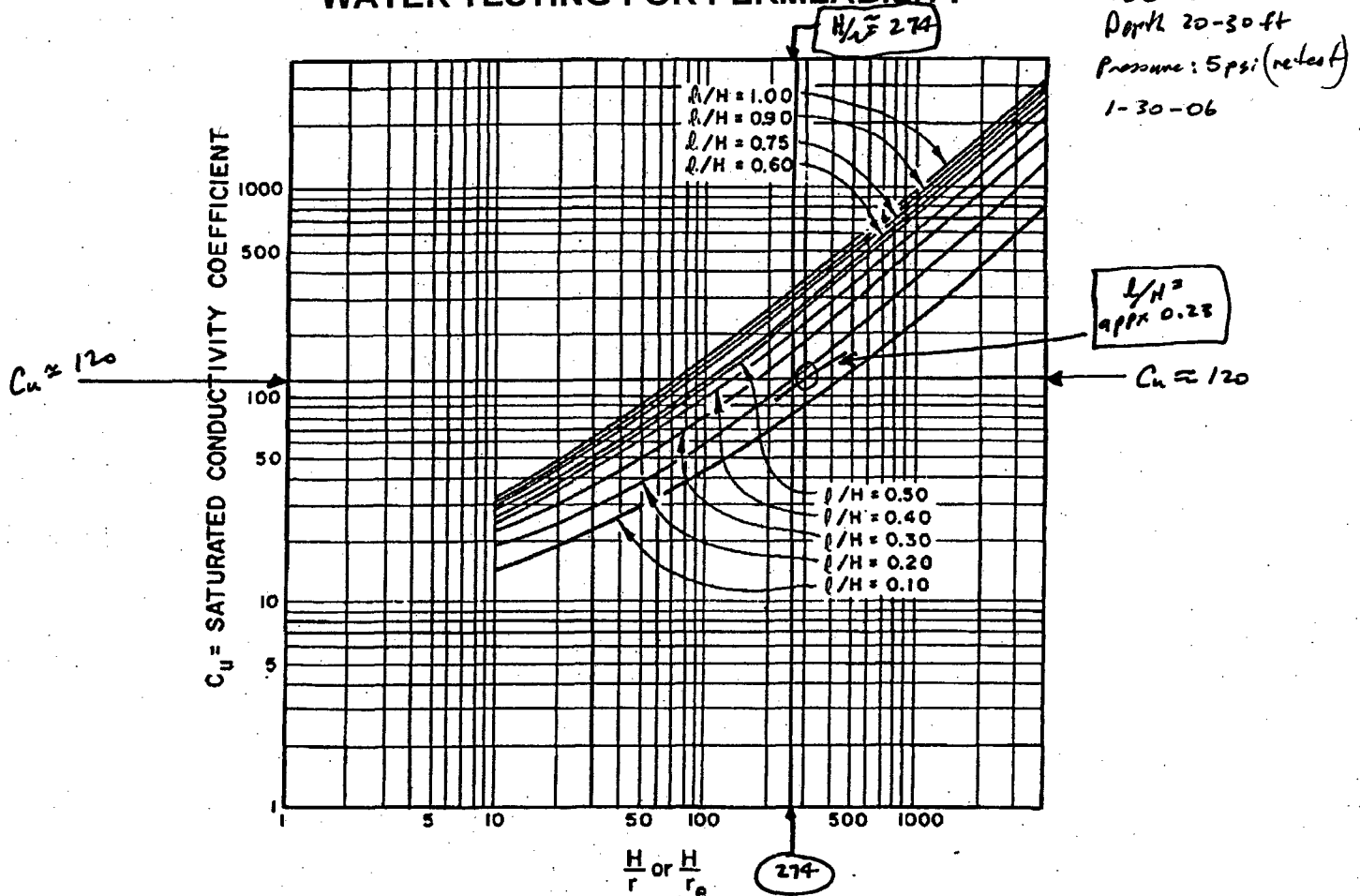


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

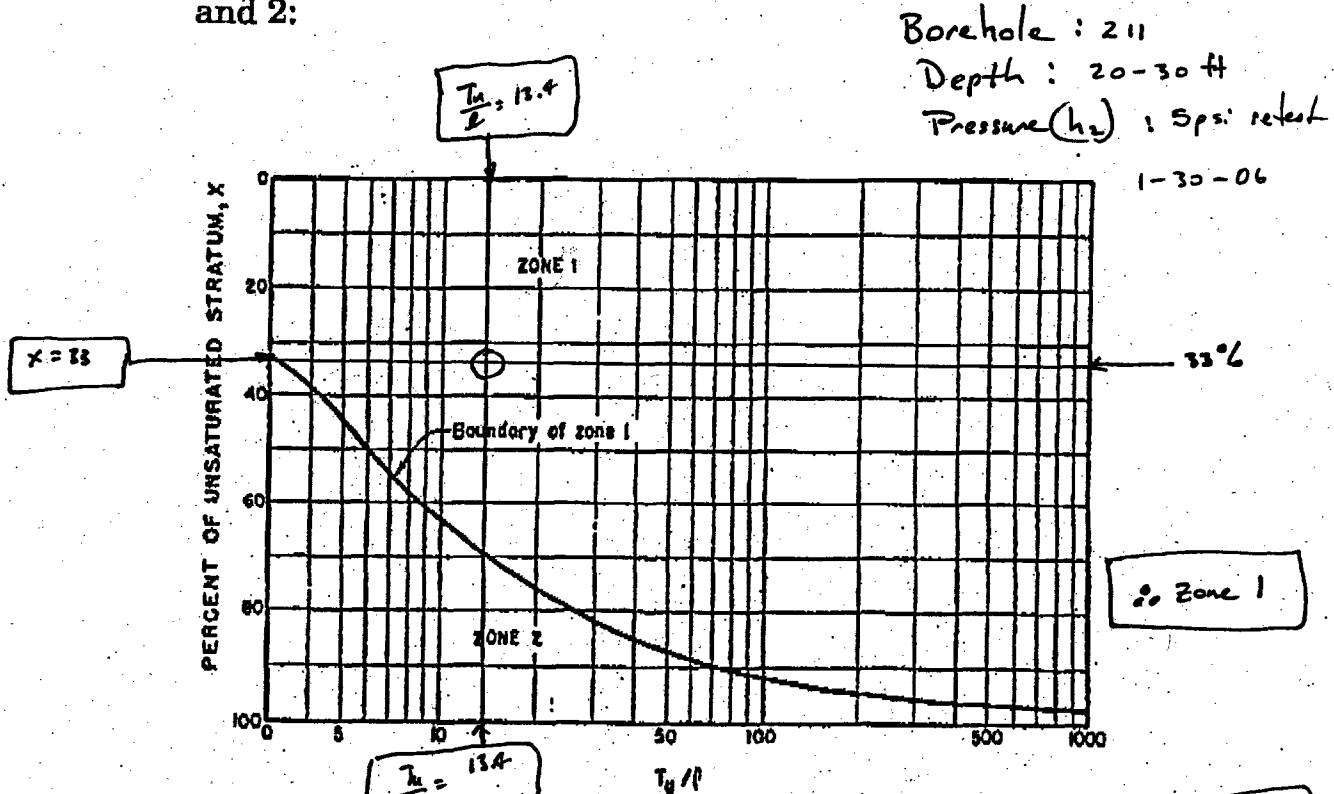


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 13.4$$

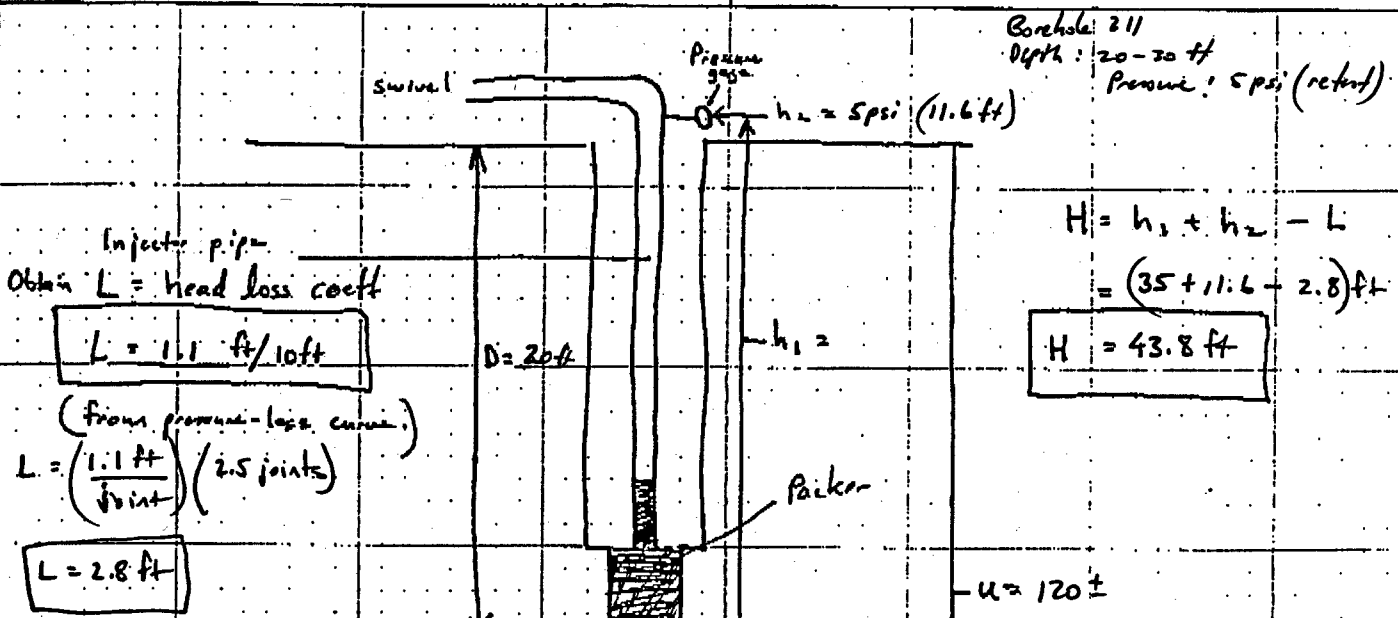
$$x = 33$$

Stoller

PACKER TEST SET-UP SHEET

Zone 1

JOB NO: _____ DATE: 1-30-06
 JOB NAME: Crescent Junction Site
 PREPARED: Mark Kautsky REVIEWED: _____
 SHEET NO: 1 OF _____



Injector p.p. =
 Obtain $L = \text{head loss coeff}$

$$L = 1.1 \text{ ft/10ft}$$

(From pressure-loss curve)

$$L = \left(\frac{1.1 \text{ ft}}{10 \text{ ft}} \right) (2.5 \text{ joints})$$

$$L = 2.8 \text{ ft}$$

Obtain C_u

$$C_u \approx 120$$

(From Fig. 17.7 USBR)

$$\frac{H}{l} = \frac{43.8 \text{ ft}}{0.16 \text{ ft}} = 274$$

$$\frac{l}{H} = \frac{10 \text{ ft}}{43.8 \text{ ft}} = 0.23$$

Calculate K :

Method 1,
 Zone 1,
 USBR

$$K = \frac{Q}{C_u \cdot l \cdot H} = \frac{\left(\frac{21 \text{ gal}}{\text{min}} \right) \left(\frac{1440 \text{ min}}{\text{day}} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(120) (0.16 \text{ ft}) (43.8 \text{ ft})}$$

$$K = 4.8 \text{ ft/d}$$

$$K = 1.7 \times 10^{-3} \text{ cm/s}$$

Packer-Test Record

Page 1 of 1

Project Name: Crescent Junction Characterization Date: 11-22-05

Field Representative: Mark Kautsky Borehole No. 211 Total Depth: 40 ft

Depth to Water (TOC): 120 ± Borehole Cleaned? Yes X No Date: 11-22-05

Test Interval (BGL): from 30 to 40 ft. Swivel/Elbow Height (AGL) 5 ft.

Conductor Pipe, Type and Size: HX pipe / Ack Board Packers ^{wireline Type II} in fltd to 100 psi

Time	Gauge Pressure	Flow Meter Reading <u>Flow (gpm)</u>
<u>09:05</u>	<u>5 PSI</u>	<u>35515</u> > 12.5 gpm
<u>09:06</u>	<u>5 PSI</u>	<u>35527.5</u> > 16
<u>09:07</u>	<u>5 PSI</u>	<u>35543.5</u> > 17
<u>09:08</u>	<u>5 PSI</u>	<u>35560.5</u> > 21
<u>09:09</u>	<u>5 PSI</u>	<u>35581.5</u> > 24
<u>09:10</u>	<u>5 PSI</u>	<u>35605.5</u> > 25
<u>09:11</u>	<u>5 PSI</u>	<u>35630.5</u> > 25.5
<u>09:12</u>	<u>5 PSI</u>	<u>35656</u> > 24.5
<u>09:13</u>	<u>5 PSI</u>	<u>35680.5</u> > 26.5
<u>09:14</u>	<u>5 PSI</u>	<u>35707</u> > 26
<u>09:15</u>	<u>5 PSI</u>	<u>35733</u> > 26
<u>09:16</u>	<u>5 PSI</u>	<u>35759</u> > 26
<u>09:17</u>	<u>5 PSI</u>	<u>35785</u>

Stoller

DATE 1-23-06

JOB NAME: Crescent Junction

PREPARED: M. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

BOREHOLE: 211

Depth: 30-40 ft

Pressure (h_2): 5 psi 11.6 ft

Unsaturated Zone Calculation:

Definitions:

 L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) ; \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10 \text{ ft}$$

$$T_u = U - D + H = 120 - 30 + 52.1 = 142.1 \text{ ft}$$

$$\frac{T_u}{L} = \frac{142.1 \text{ ft}}{10 \text{ ft}} = \boxed{14.2}$$

$$H = h_1 + h_2 - L = 52.1 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{52.1 \text{ ft}}{142.1 \text{ ft}} (100) = \boxed{37\%}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

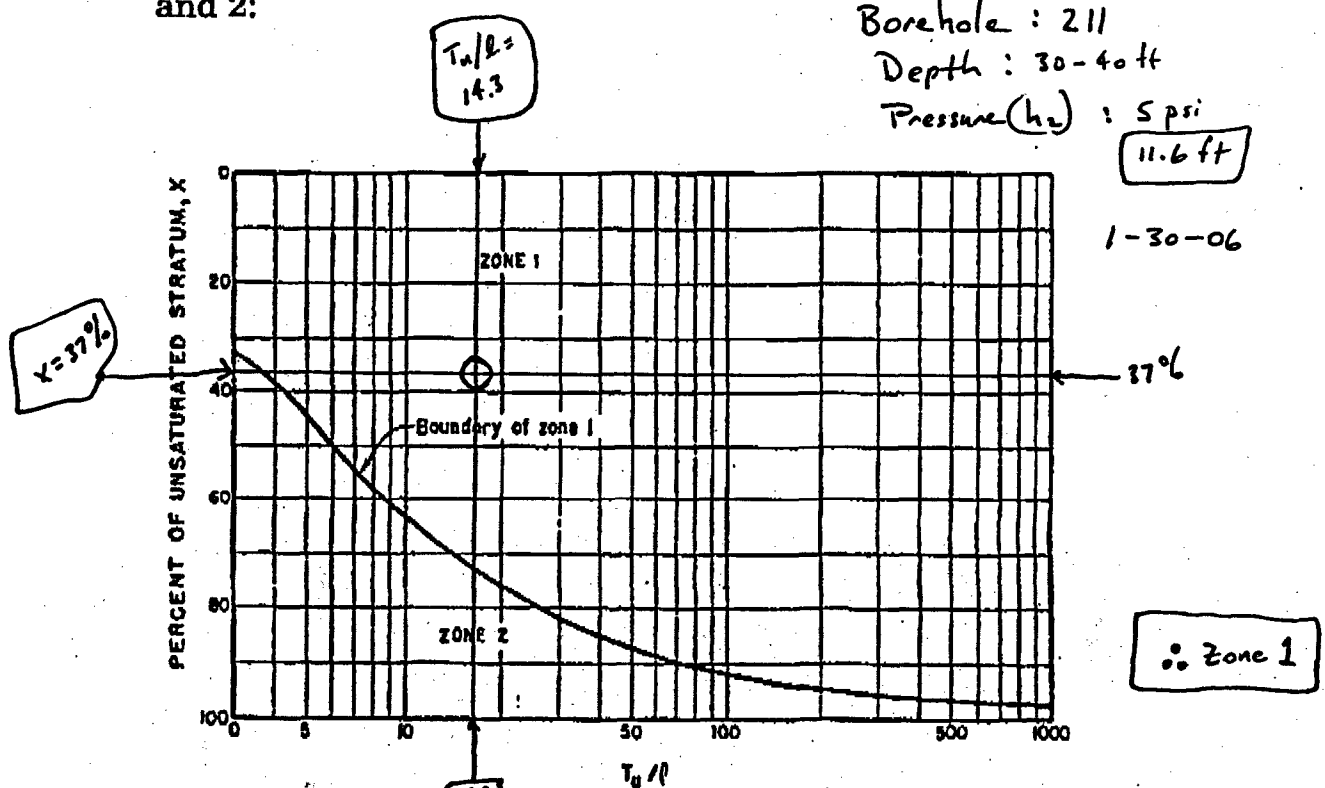


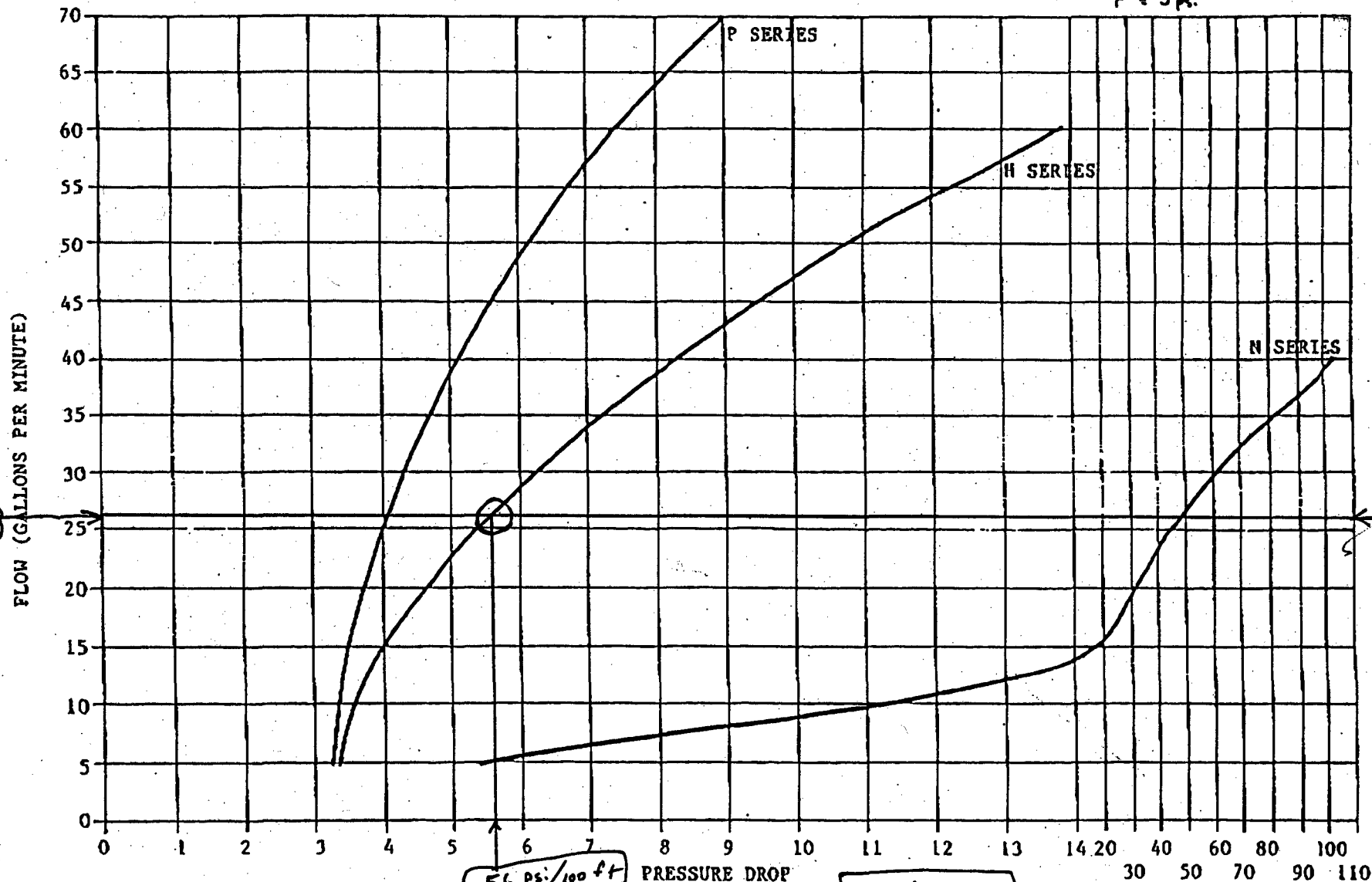
Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 14.3$$

$$X = 37\%$$

PRESSURE LOSS CURVE

Borehole 211
Depth 30-40 ft
P = 5 psi



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From: WIRELINE TYPE II service manual, Borehole 211

Borehole 211
Depth: 30-40 ft.
Pressure: 5 psi
1-30-06

Stoller

PACKER TEST SET-UP SHEET

Zone 1

JOB NO: _____

DATE: 1-30-06

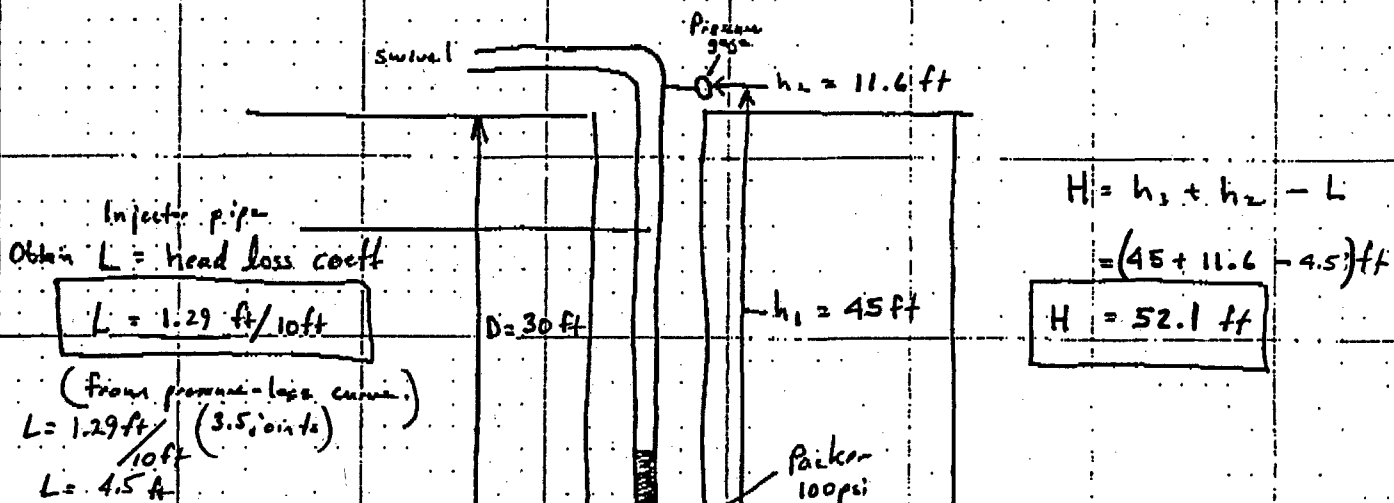
JOB NAME: Crescent Junction Site

PREPARED: Mark Kautsky

REVIEWED: _____

SHEET NO: 1 OF _____

Control 211
Depth 30-40 ft
pressure: 5 psi



Obtain C_u

$C_u \approx 150$

(From Fig. 17.7 USBR)

$$\frac{H}{l} = \frac{52.1 \text{ ft}}{0.16 \text{ ft}} = 326$$

$$\frac{l}{H} = \frac{10 \text{ ft}}{52.1 \text{ ft}} = 0.19$$

Calculate K :

Method 1,
Zone 1,
USBR

$$K = \frac{Q}{C_u \cdot H} = \frac{\left(\frac{26 \text{ gal}}{\text{min}}\right) \left(\frac{1440 \text{ min}}{\text{d}}\right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}}\right)}{(150) (0.16 \text{ ft}) (52.1 \text{ ft})}$$

$$K = 4.0 \text{ ft/d}$$

$$K = 1.4 \times 10^{-3} \text{ cm/sec}$$

WATER TESTING FOR PERMEABILITY

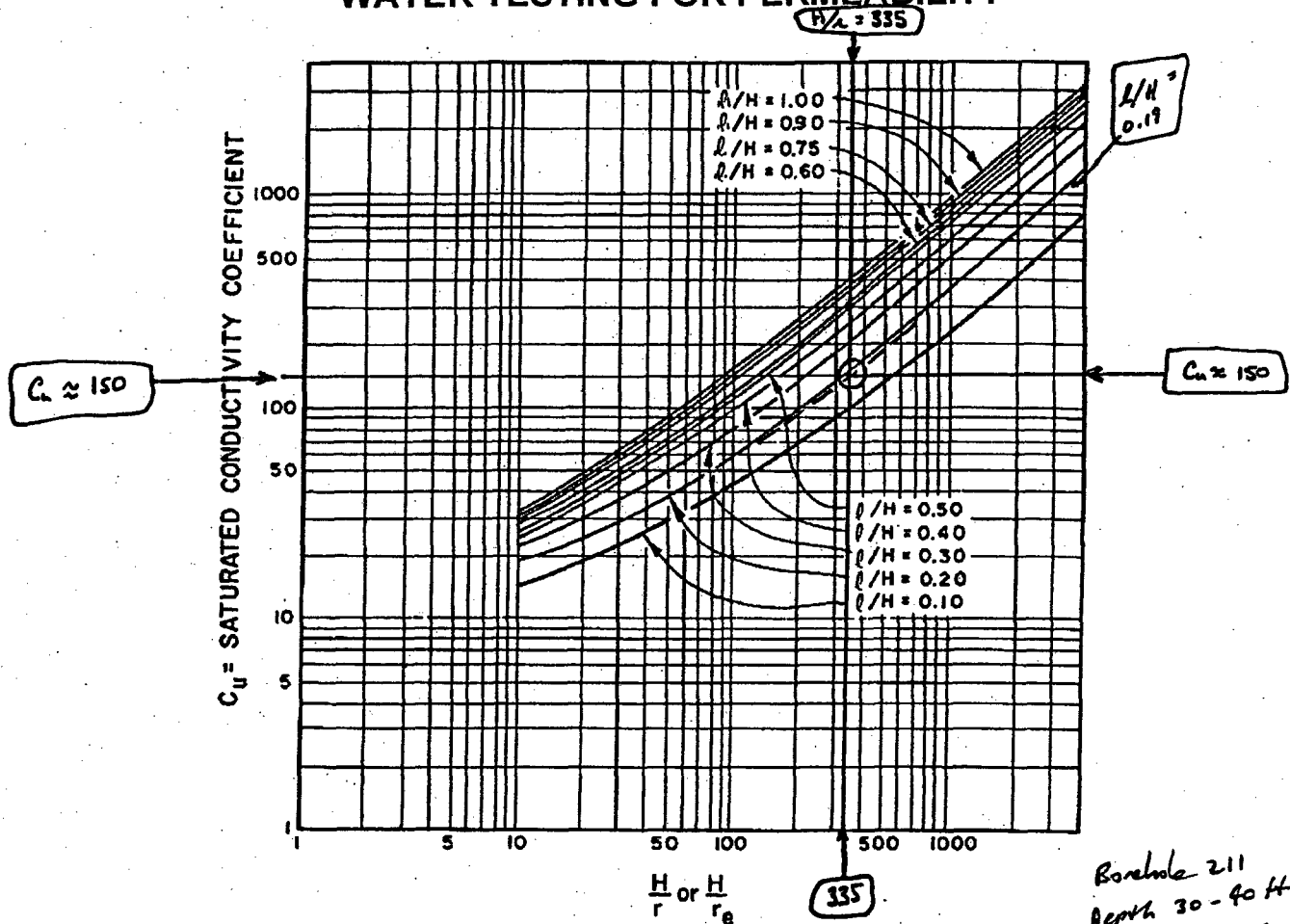


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2) (0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

Stoller

Packer-Test Record

Project Name: Crescent Junction Characterization Date: 11-23-05

Field Representative: M. Kautsky Borehole No. 212 Total Depth: 30 ft

Depth to Water (TOC): 120 ± Borehole Cleaned? Yes ☒ No ☐ Date: 11-23-05

Test Interval (BGL): from 20 to 30 ft. Swivel/Elbow Height (AGL) 5

Conductor Pipe, Type and Size: Hx

A-25

Stoller

RECORD COPY

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Packer-Test Record

Page 2 of 3

Project Name: Crescent Junction Characterisation Date: 11-23-05

Field Representative: M. Kautsky Borehole No. 212 Total Depth: 30 ft

Depth to Water (TOC): 120⁺ Borehole Cleaned? Yes X No Date: 11-23-05

Test Interval (BGL): from 20 to 30 ft. Swivel/Elbow Height (AGL) 5 ft.

Conductor Pipe, Type and Size: HX

Time	Gauge Pressure	Flow Meter Reading
<u>0845</u>	<u>10PSI</u>	<u>36170</u> > 25
<u>0846</u>	<u>10PSI</u>	<u>36195</u> > 26
<u>0847</u>	<u>10PSI</u>	<u>36221</u> > 28
<u>0848</u>	<u>10PSI</u>	<u>36249</u> > 28
<u>0849</u>	<u>10PSI</u>	<u>36277</u> > 28
<u>0850</u>	<u>10PSI</u>	<u>36305</u> > 27
<u>0851</u>	<u>10PSI</u>	<u>36332</u> > 28
<u>0852</u>	<u>10PSI</u>	<u>36360</u> > 28
<u>0853</u>	<u>10PSI</u>	<u>36388</u>
<u> </u>	<u> </u>	<u>final Avg Q = 28 gpm</u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>
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Stoller

Packer-Test Record

Project Name: Crescent Junction Characterisation Date: 11-23-05

Field Representative: M. Kentsky Borehole No. 212 Total Depth: 30

Depth to Water (TOC): 120± Borehole Cleaned? Yes X No Date: 11-23-05

Test Interval (BGL): from 20 to 30 ft. Swivel/Elbow Height (AGL) 5 ft.

Conductor Pipe, Type and Size: 1 1/2".

A-27

Stoller

ALPAC

DATE 1-23-06

JOB NAME Crescent Junction

PREPARED: H. Kautsky

REVIEWED:

SHEET NO: OF

Packer Test Analysis

BOREHOLE: 212

Depth: 20-30 ft

Pressure (h_2): 5 psi

Unsaturated Zone Calculation:

Definitions: L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100); \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10 \text{ ft}$$

$$T_u = U - D + H = 120 \text{ ft} - 20 \text{ ft} + 43.8 \text{ ft} = 143.8 \text{ ft}$$

$$\frac{T_u}{L} = \frac{143.8 \text{ ft}}{10 \text{ ft}} = \boxed{14.4}$$

$$H = h_1 + h_2 - L = 43.8 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{43.8 \text{ ft}}{143.8 \text{ ft}} (100) = \boxed{30}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 212
Depth : 20-30 ft.
Pressure (h_2) : 5 psi

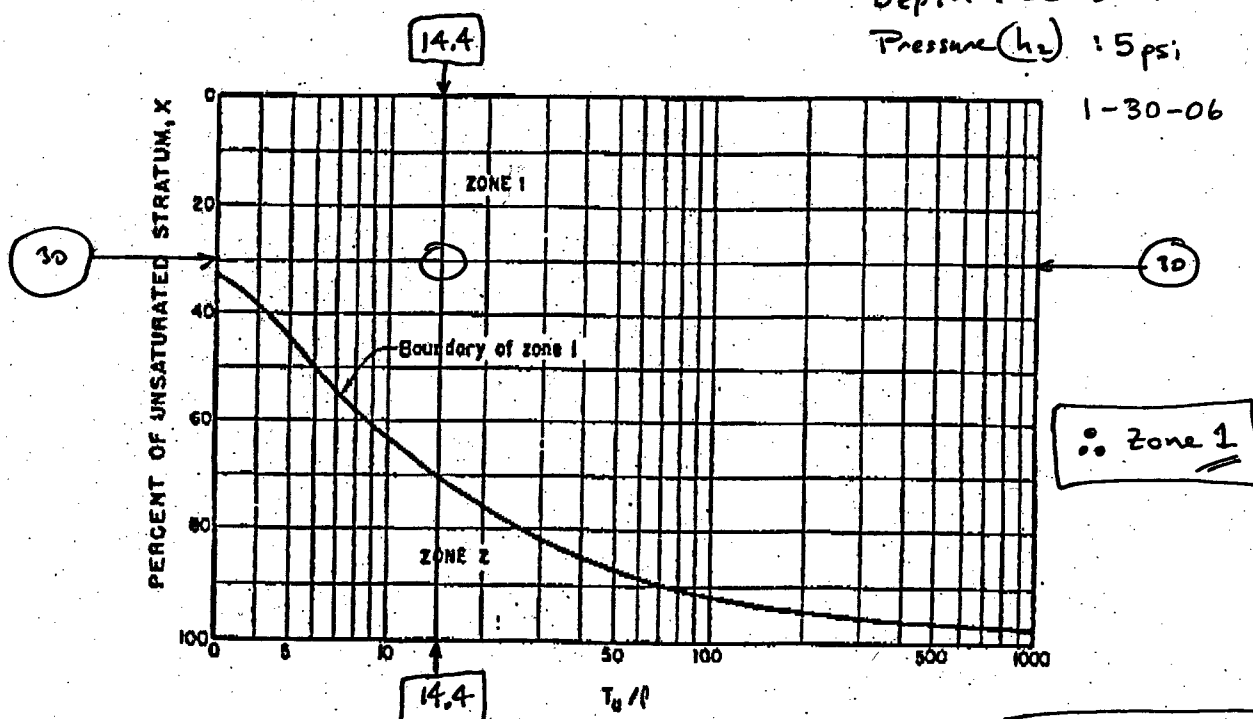


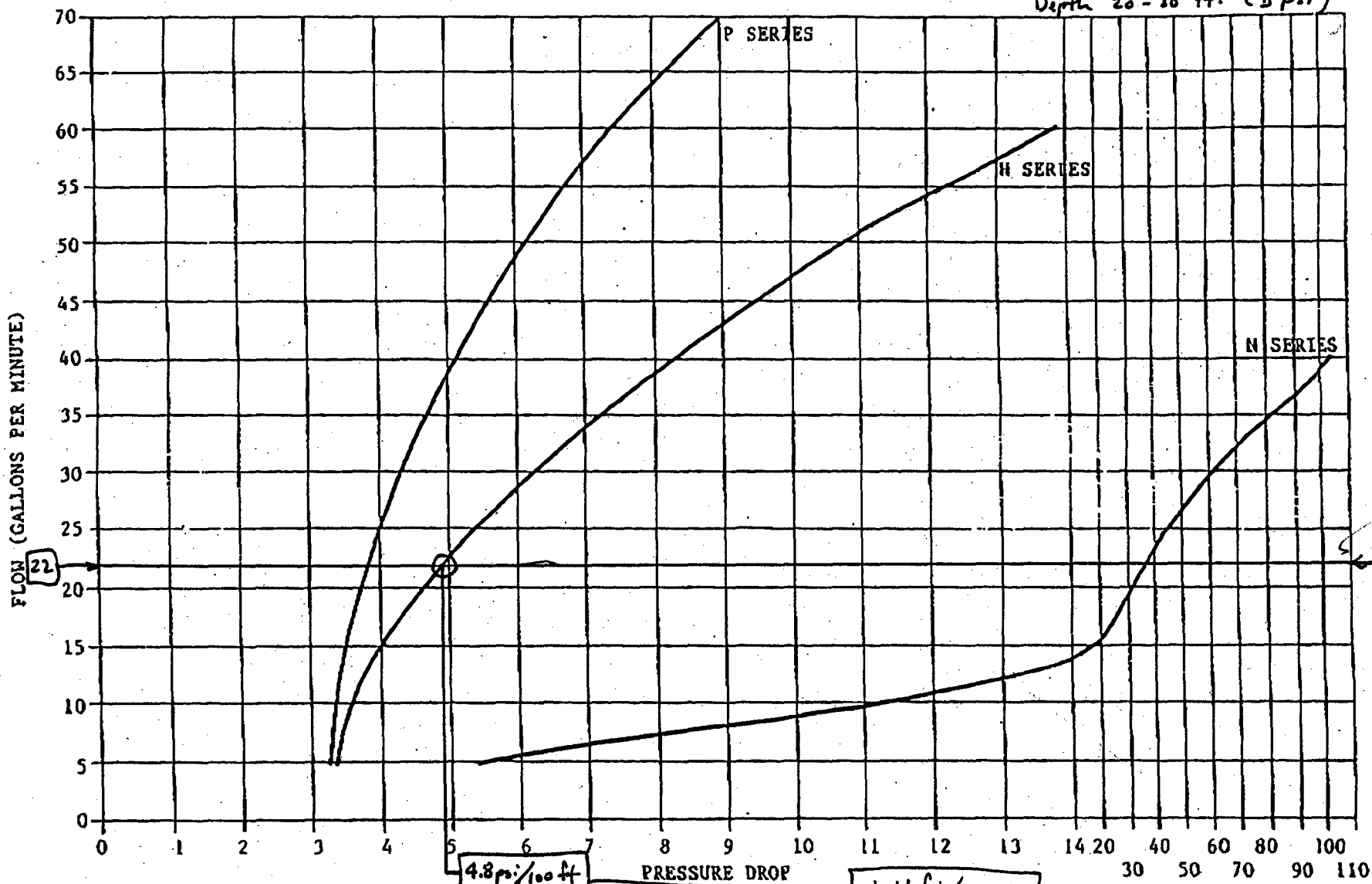
Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 14.4$$

$$X = 30$$

PRESSURE LOSS CURVE

1-30-06
Borehole 212
Depth 20-30 ft. (5 psi)



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From: WIRELINE TYPE II service manual, Borehole Loggers.

A-30

22 gpm

WATER TESTING FOR PERMEABILITY

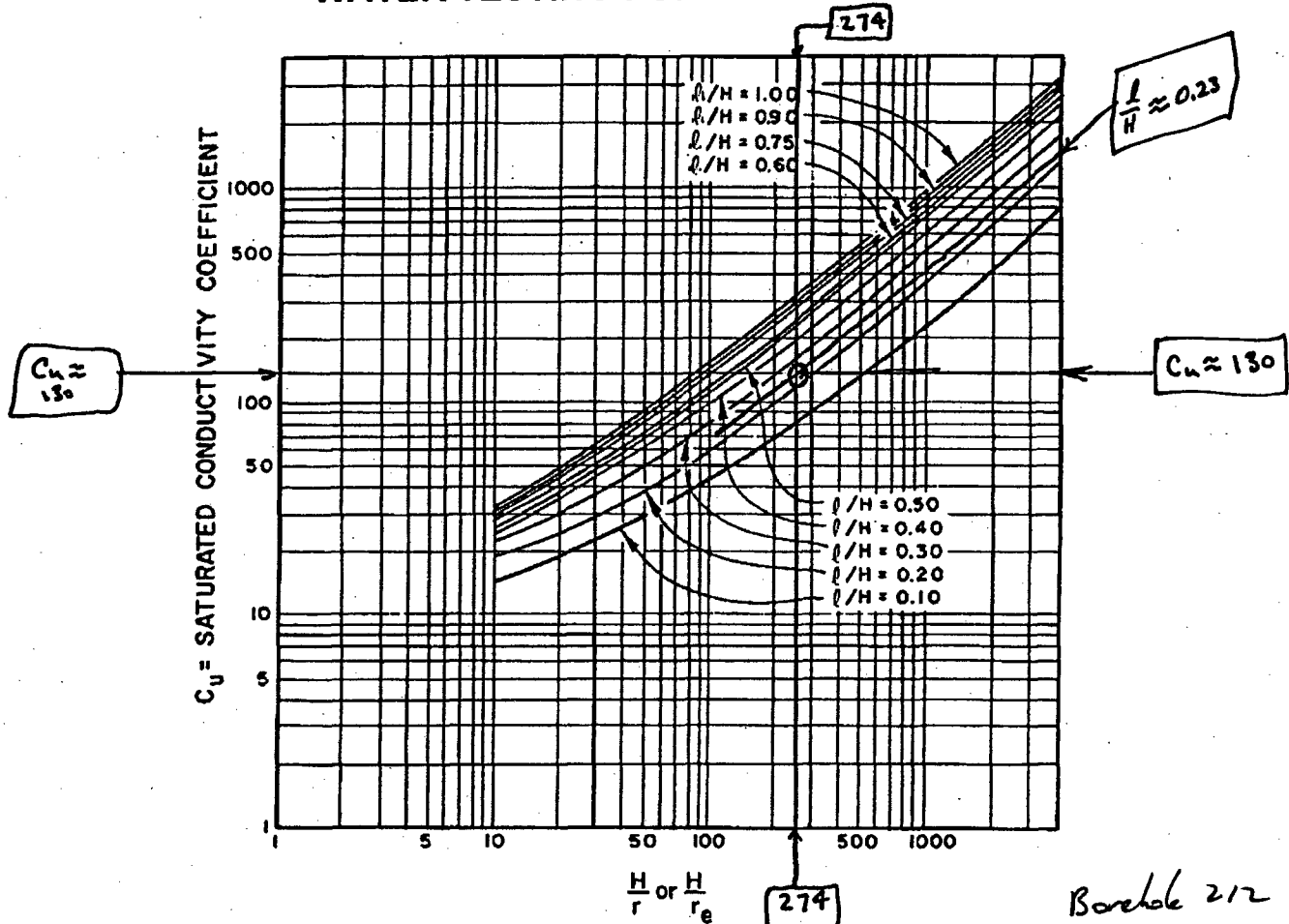


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

Packer Test Set-up Sheet

JOB No:

DATE: 1-30-06

JOB NAME: Crescent Junction Site

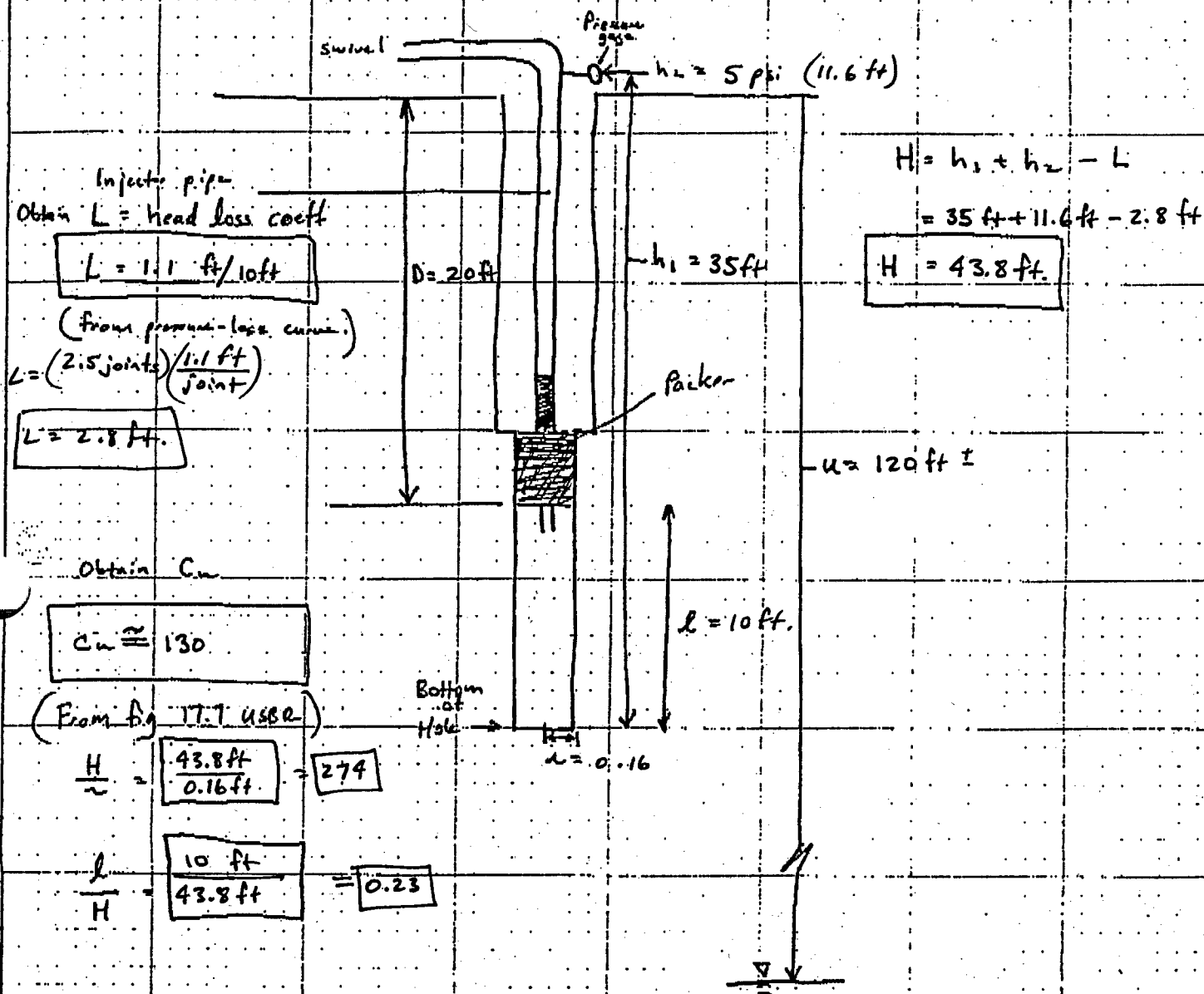
PREPARED: Mark Kautsky REVIEWED:

SHEET NO.: 1 OF 1 depth: 20-30 ft
pressure: 5 psi

Borehole 212

depth: 20-30 ft

Решение: 5 р. 50 к.



Calculate K :

Method 1,
Zone 1,
USBR

$$K = \frac{Q}{C_u \cdot H} = \frac{\left(\frac{22 \text{ gal}}{\text{min}}\right) \left(\frac{1440 \text{ min}}{\text{day}}\right) \left(\frac{\text{ft}^3}{7.48 \text{ gal}}\right)}{(130) (0.16 \text{ ft}) (43.8 \text{ ft})}$$

$$K = 4.6 \text{ ft/day}$$
$$K = 1.6 \times 10^{-3} \text{ cm/s}$$

Stoller

DATE 1-23-06

JOB NAME Crescent Junction

PREPARED: H. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

BOREHOLE: 212

Depth: 20-30 ft.

Pressure (h_2): 10 psi

Unsaturated Zone Calculation:

Definitions:

 L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4$ gpm

$$X = \frac{H}{T_u} (100) \text{ ; percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10 \text{ ft}$$

$$T_u = U - D + H = (120 - 20 + 54.7) \text{ ft} = 154.7 \text{ ft}$$

$$\frac{T_u}{L} = \frac{154.7 \text{ ft}}{10 \text{ ft}} = \boxed{15.5}$$

$$H = h_1 + h_2 - L = 59.7 \text{ ft} + 23.1 \text{ ft} - 3.4 \text{ ft} = 54.7 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{54.7 \text{ ft}}{154.7 \text{ ft}} (100) = \boxed{35}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

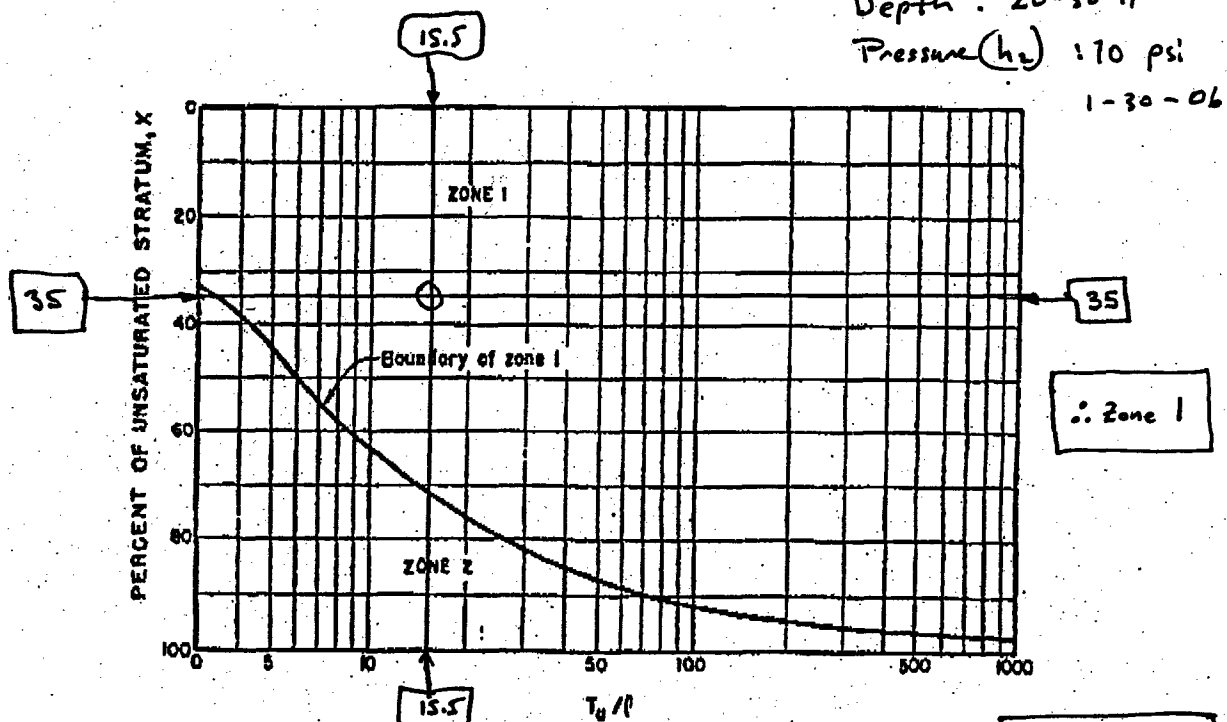


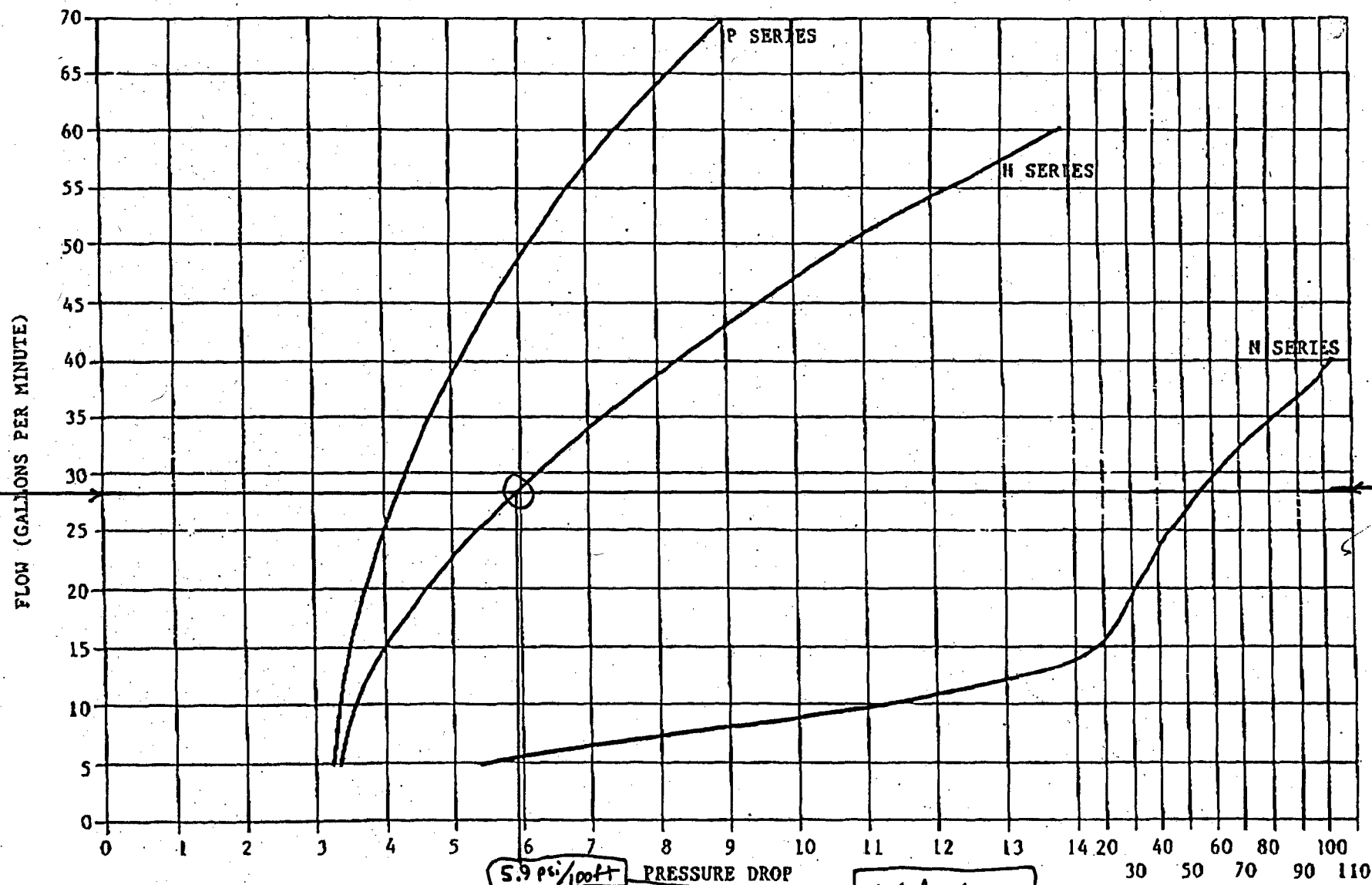
Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 15.5$$

$$X = 35$$

PRESSURE LOSS CURVE

Borehole 212
Depth 20-30 ft
Pressure: 10 psi (23.1 ft)



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From: WIRELINE TYPE II service manual, Bont Lanyear.

F-001

T-115 P.28/32

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A-35

From-LAYNE CHRISTENSEN

JUL-25-05 04:21PM

WATER TESTING FOR PERMEABILITY

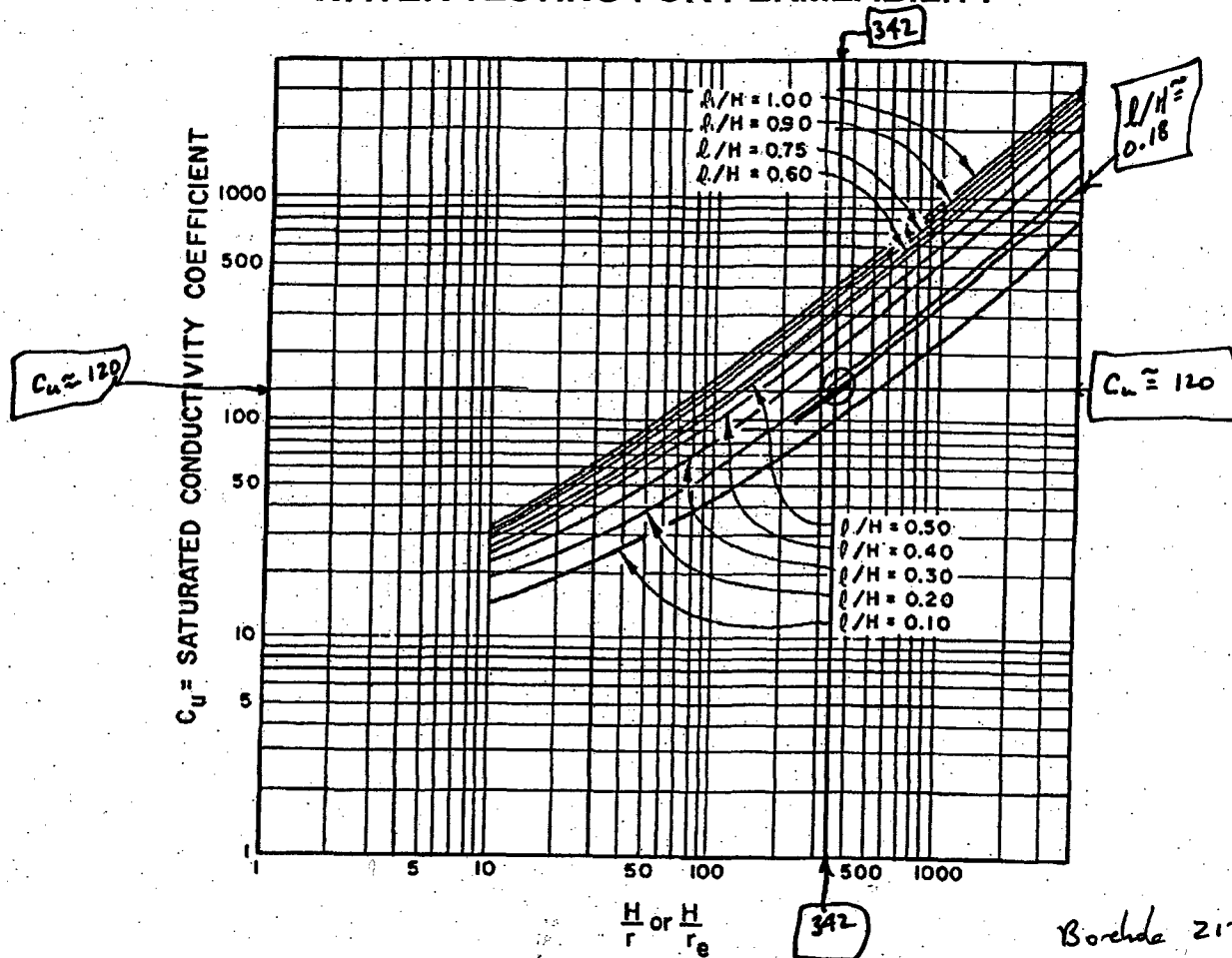


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

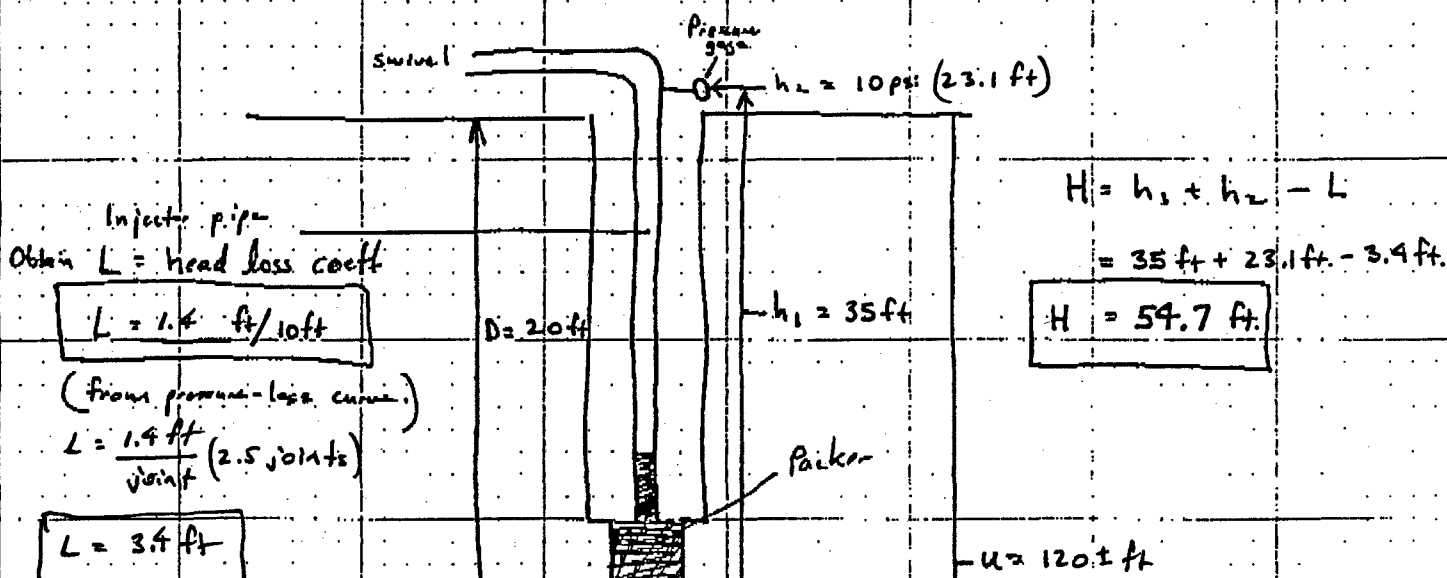
If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

Stoller

PACKER TEST SET-UP SHEET

JOB NO.: _____ DATE: 1-30-06
 JOB NAME: Crescent Junction Site
 PREPARED: Mark Kautsky REVIEWED: _____
 SHEET NO.: 1 OF 1 Borehole: 212
 Depth: 20-30 ft.
 Pressure: 10 psi



Obtain C_u

$$C_u \approx 120$$

(From Fig. 17.7 USBR)

$$\frac{H}{u} = \frac{54.7 \text{ ft}}{120 \text{ ft}} = 0.456$$

$$\frac{h}{H} = \frac{10 \text{ ft}}{54.7 \text{ ft}} = 0.18$$

Calculate K :

Method 1,
Zone 1,
USBR

$$K = \frac{Q}{C_u u H} = \frac{\left(\frac{28 \text{ gal}}{\text{min}}\right) \left(\frac{1440 \text{ min}}{\text{day}}\right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}}\right)}{(120) (0.16 \text{ ft}) (54.7 \text{ ft})}$$

$$K = 5.1 \text{ ft/day}$$

$$K = 1.8 \times 10^{-3} \text{ cm/sec}$$

Stoller

PACKER TEST SET-UP SHEET

JOB NO: _____

DATE: 1-30-06

JOB NAME: Crescent Junction Site

PREPARED: Mark Kantsky

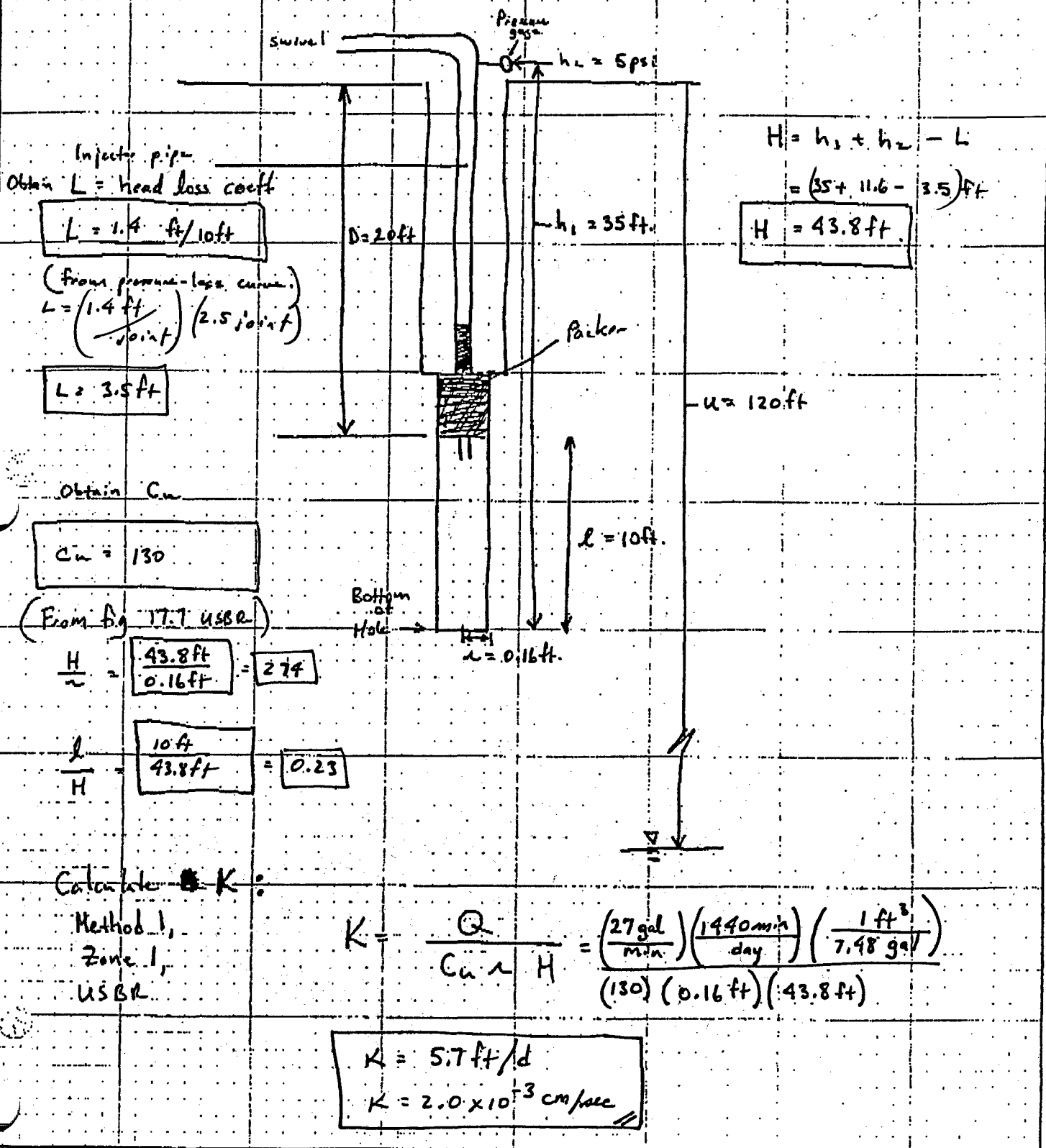
REVIEWED: _____

SHEET NO: 1 OF _____

Borehole 212

Test Interval 20-30ft

pressure 1.5 psi (retest)



Packer-Test Record

Page 1 of 2

Project Name: Crescent Junction Characterization Date: 11-30-05

Field Representative: M. Kautsky Borehole No.: 212 Total Depth: 40ft

Depth to Water (TOC): 120 ± Borehole Cleaned? Yes X No Date: 11-30-05

Test Interval (BGL): from 30 to 40 ft. Swivel/Elbow Height (AGL) 5ft

Conductor Pipe, Type, and Size: H₄ / ~~X~~ H₂

Time	Gauge Pressure	Flow Meter Reading	Flow
12:28	5 psi	36689	1
12:29	5 psi	36708	19 gpm
12:30	5 psi	36727	19 gpm
12:31	8 psi	36747	20 gpm
12:33	5 psi	36802	
12:34	5 psi	36840	38 gpm
12:35	5 psi	36878	38 gpm
12:36	5 psi	36913	35 gpm
12:37	5 psi	36947	34 gpm
12:38	5 psi	36977	30 gpm
12:39	5 psi	37004	27 gpm
12:40	5 psi 4	37023	19 gpm
12:41	5 psi 3	37035	12 gpm
12:42	5 psi 0	37043	8 gpm
	Ran out of water.		

Reset pressure ↓

Packer-Test Record

Page 2 of 2

Project Name: Crescent Junction Characterization

Date: 11-30-05

Field Representative: Mark Kautsky

Borehole No.: 212

Total Depth: 40 ft.

Depth to Water (TOC): 120.1

Borehole Cleaned? Yes X No

Date: 11-30-05

Test Interval (BGL): from 30 to 40 ft. Swivel/Elbow Height (AGL) 5 ft.

Conductor Pipe, Type, and Size: Hx/Ha

Time	Gauge Pressure	Flow Meter Reading
14:30	5 psi	37102
14:31	5 psi	37135
14:32	5 psi	37171
14:33	5 psi	37208
14:34	5 psi	37244
14:35	5 psi	37282
14:36	5 psi	37320
14:37	5 psi	37358
14:38	10 psi	37400
14:39	10 psi	37442
14:40	10 psi	37485
14:41	10 psi	37528
14:42	10 psi	37571
14:43	5 psi	37610
14:44	5 psi	37648
14:45	5 psi	37686
14:46	5 psi	37637722
14:47	5 psi	37760

Stoller

JOB NO. _____ DATE 1-23-06

JOB NAME Crescent Junction

PREPARED: M. Kautsky

REVIEWED: _____

SHEET NO. _____ OF _____

Packer Test Analysis

BOREHOLE : 212

Depth : 30-40 ft.

Pressure (h_1) : 5 psi (11.6 ft)

Unsaturated Zone Calculation:

Definitions:

 L = length of test section $T_u = u + D + H$ u = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section $H = h_1 + h_2 - L$ L = head loss ; ignore if $Q < 4 \text{ gpm}$ $X = \frac{H}{T_u} (100)$; percent unsaturated material

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10 \text{ ft}$$

$$T_u = u + D + H = 120 - 30 + 50.3 = 140.3$$

$$\frac{T_u}{L} = \frac{140.3 \text{ ft}}{10 \text{ ft}} = \boxed{14}$$

$$H = h_1 + h_2 - L = 50.3 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{50.3 \text{ ft}}{140.3 \text{ ft}} (100) = \boxed{36}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

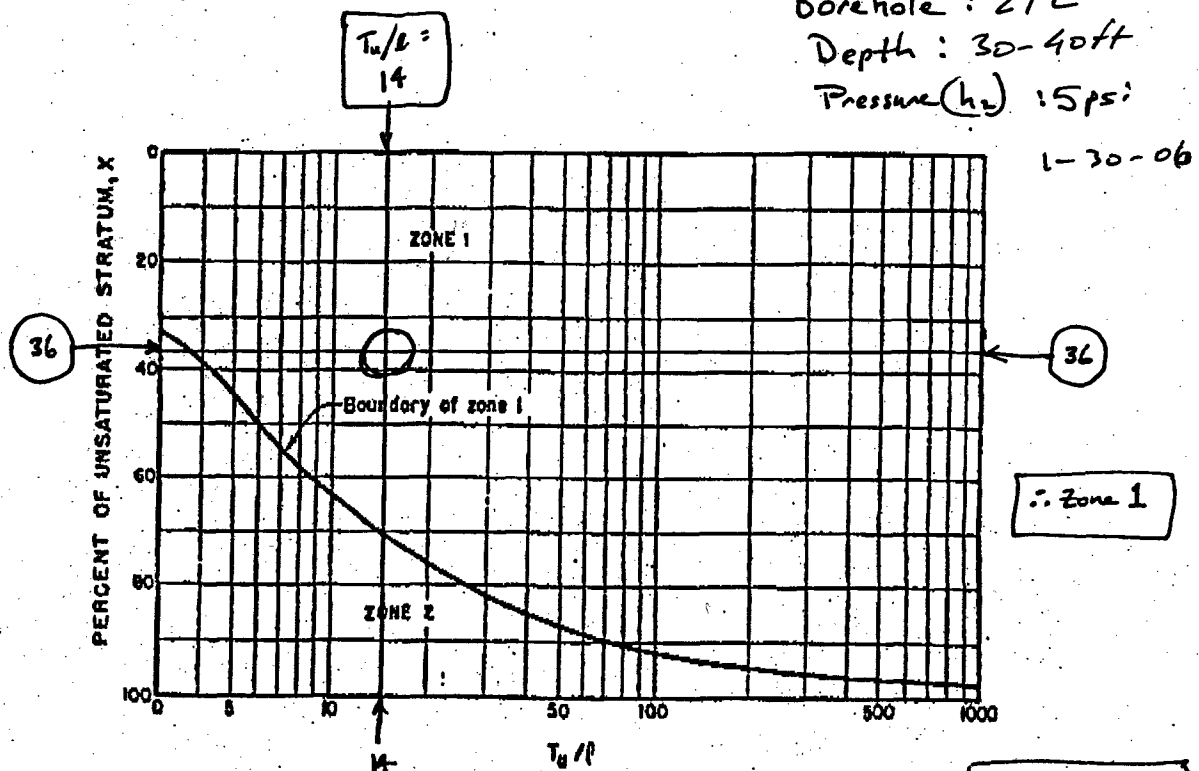
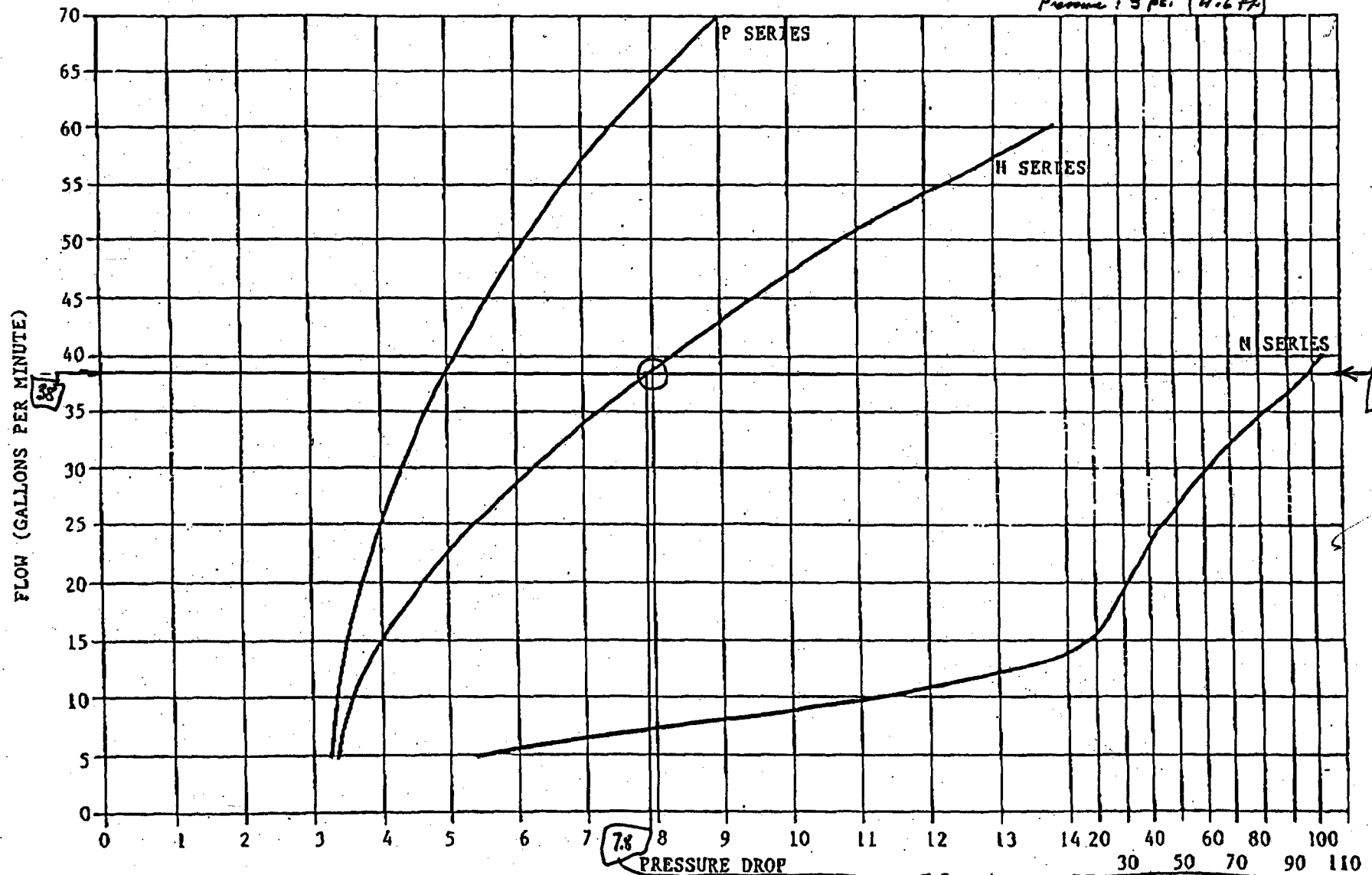


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

PRESSURE LOSS CURVE

1-30-06
Borehole 212
Interval 30-40 ft.
Pressure: 5 psi (4.6 ft)



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

$$7.8 \text{ psi}/100 \text{ ft} = 1.8 \text{ ft}/10\text{-ft joint}$$

From: WIRELINE TYPE II service manual, Becht Longyear.

F-001

T-115 P.29/32

8019741018

A-43

From-LAYNE CHRISTENSEN

Jul-25-05 04:21pm

WATER TESTING FOR PERMEABILITY

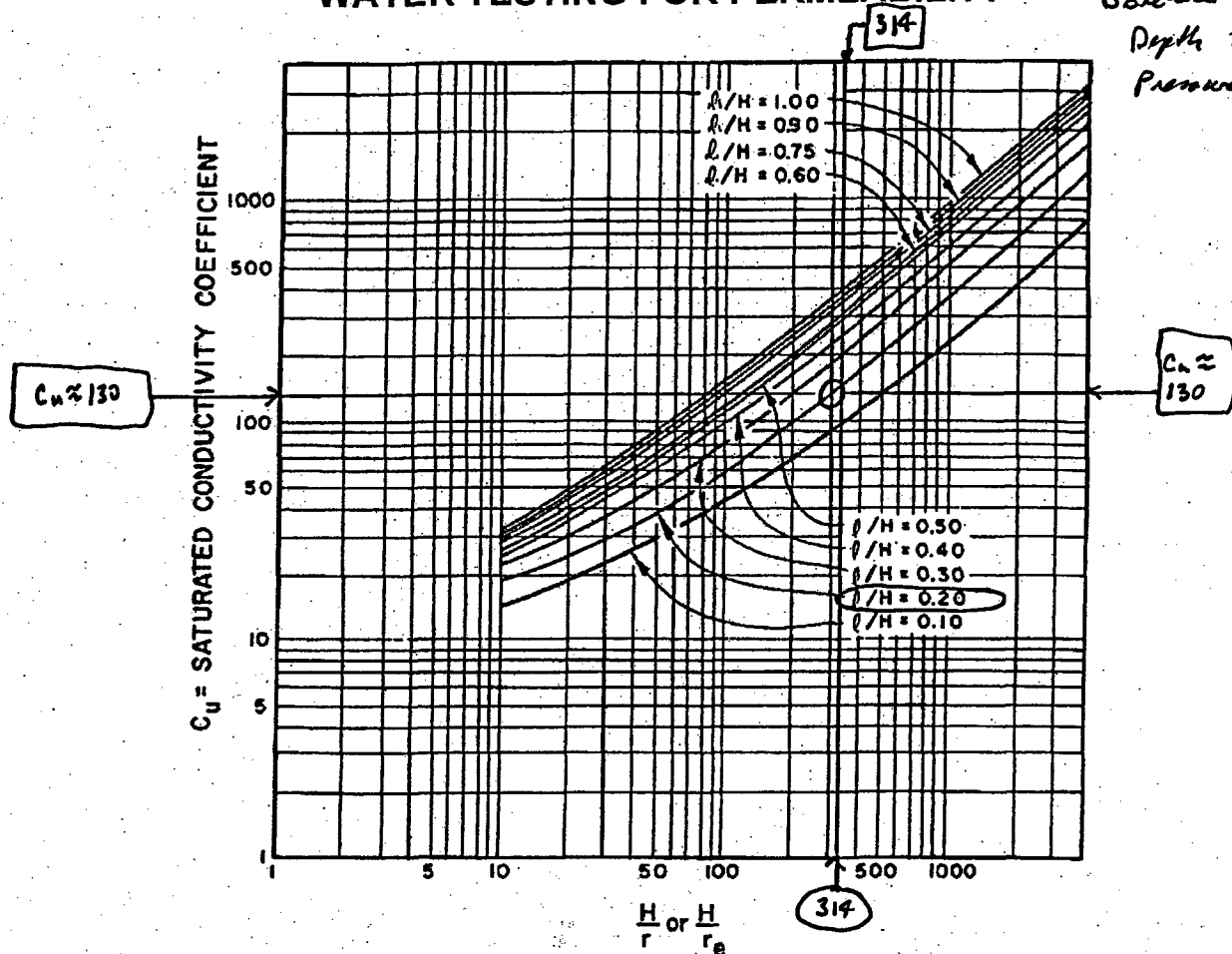


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

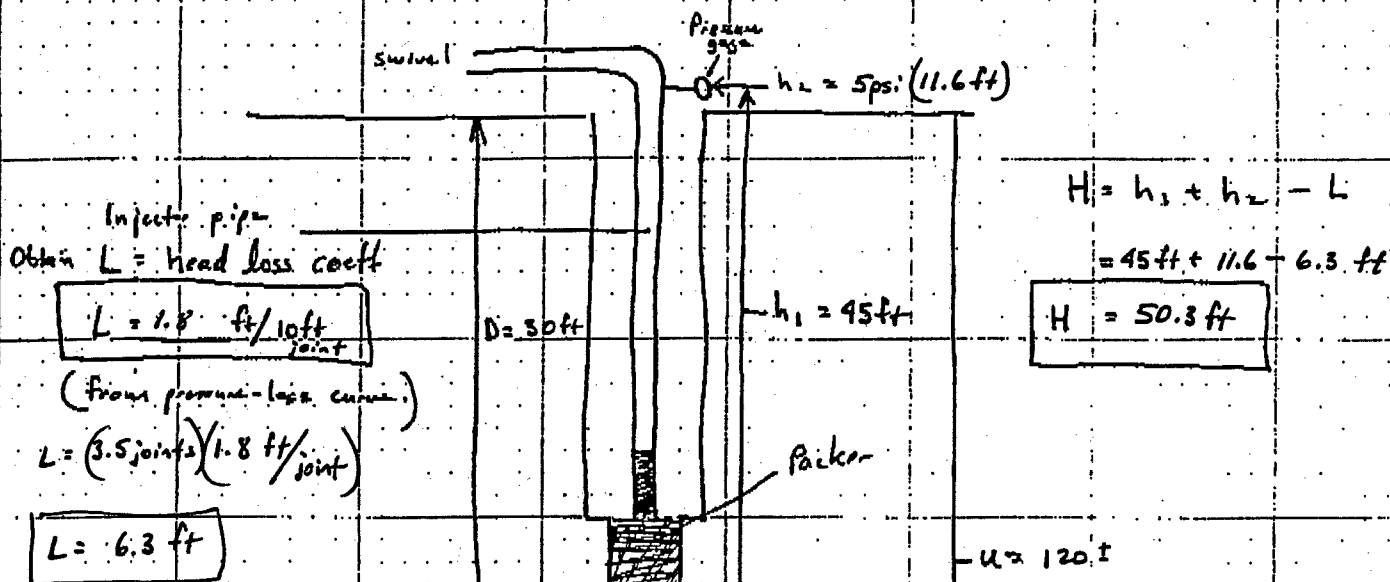
If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

Stoller

PACKER TEST SET-UP SHEET

JOB NO.: _____ DATE: 1-30-06
 JOB NAME: Crescent Junction Site
 PREPARED: Mark Kautsky REVIEWED: _____
 SHEET NO.: 1 OF 1
 Borehole 212
 Depth 30-40 ft.
 Pressure: 5psi (11.6 ft)



Inject: p.p.
 Obtain $L = \text{head loss coeff}$

$$L = 1.8 \text{ ft}/10\text{ ft joint}$$

(From pressure-loss curve)

$$L = (3.5\text{ joints}) (1.8 \text{ ft}/\text{joint})$$

$$L = 6.3 \text{ ft}$$

Obtain C_u

$$C_u \approx 130$$

(From Fig. 17.7 USBR)

$$\frac{H}{L} = \frac{50.3\text{ ft}}{0.16\text{ ft}} = 314$$

$$\frac{l}{H} = \frac{10\text{ ft}}{50.3\text{ ft}} = 0.20$$

Calculate K :

Method 1,
 Zone 1,
 USBR

$$K = \frac{Q}{C_u \cdot L \cdot H} = \frac{\left(\frac{38\text{ gal}}{\text{min}}\right) \left(\frac{1440\text{ min}}{\text{d}}\right) \left(\frac{\text{ft}^3}{7.48\text{ gal}}\right)}{(130) (0.16\text{ ft}) (50.3\text{ ft})}$$

$$K = 7 \text{ ft}/\text{day}$$

$$K = 2.5 \times 10^{-3} \text{ cm}/\text{sec}$$

Stoller

JOB NO.

DATE 1-23-06

JOB NAME Crescent Junction

PREPARED: H. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

BOREHOLE : 212

Depth : 30-40 ft.

Pressure (h_w) : 10 psi (23.1 ft)

Unsaturated Zone Calculation:

Definitions:

 L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss ; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) ; \text{percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10 \text{ ft.}$$

$$T_u = U - D + H = 120 \text{ ft} - 30 \text{ ft} + 60.7 \text{ ft} = 150.7 \text{ ft}$$

$$\frac{T_u}{L} = \frac{150.7 \text{ ft}}{10 \text{ ft}} = \boxed{15.1}$$

$$H = h_1 + h_2 - L = 60.7 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{60.7 \text{ ft}}{150.7 \text{ ft}} (100) = \boxed{40}$$

WATER TESTING FOR PERMEABILITY

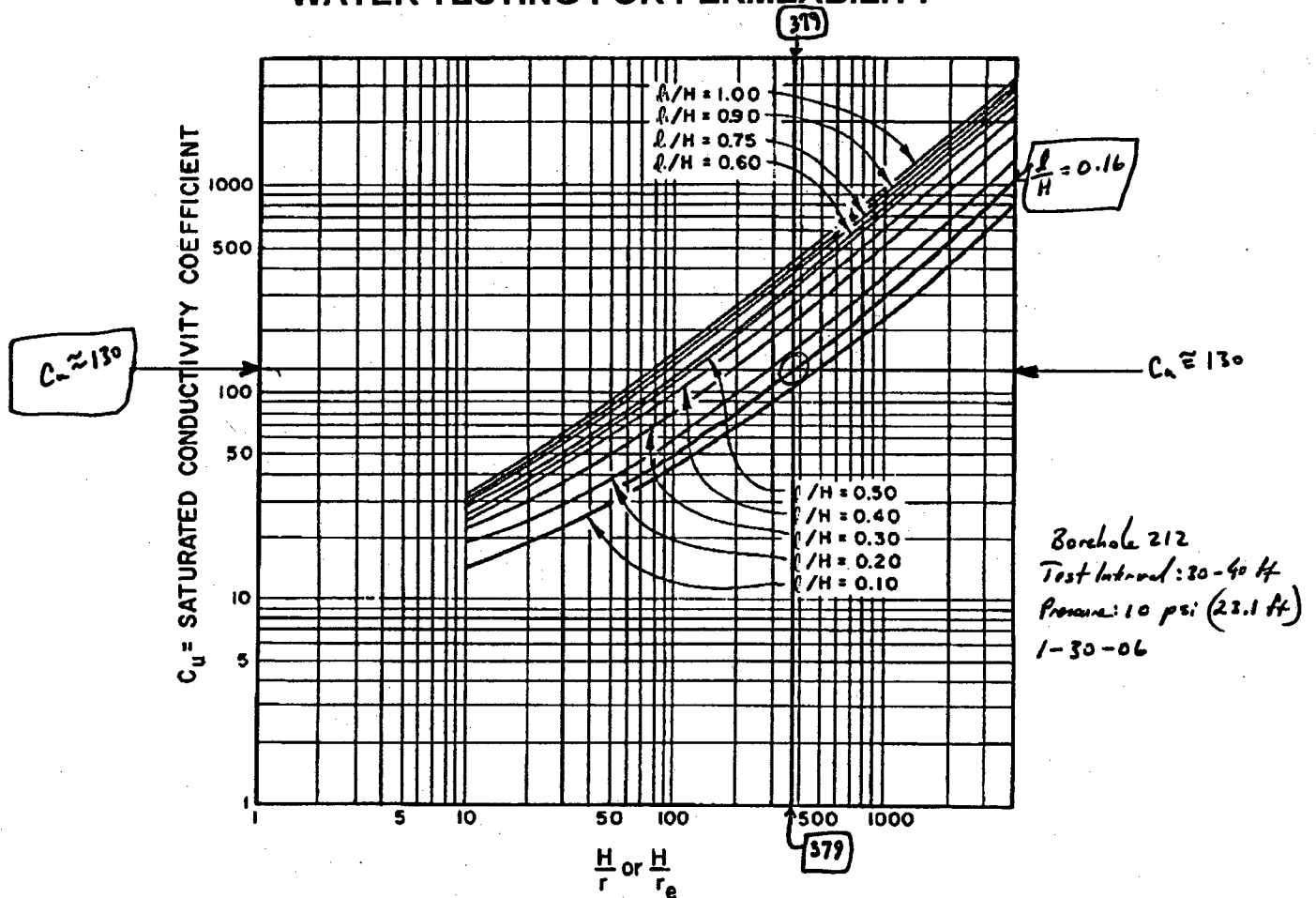


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

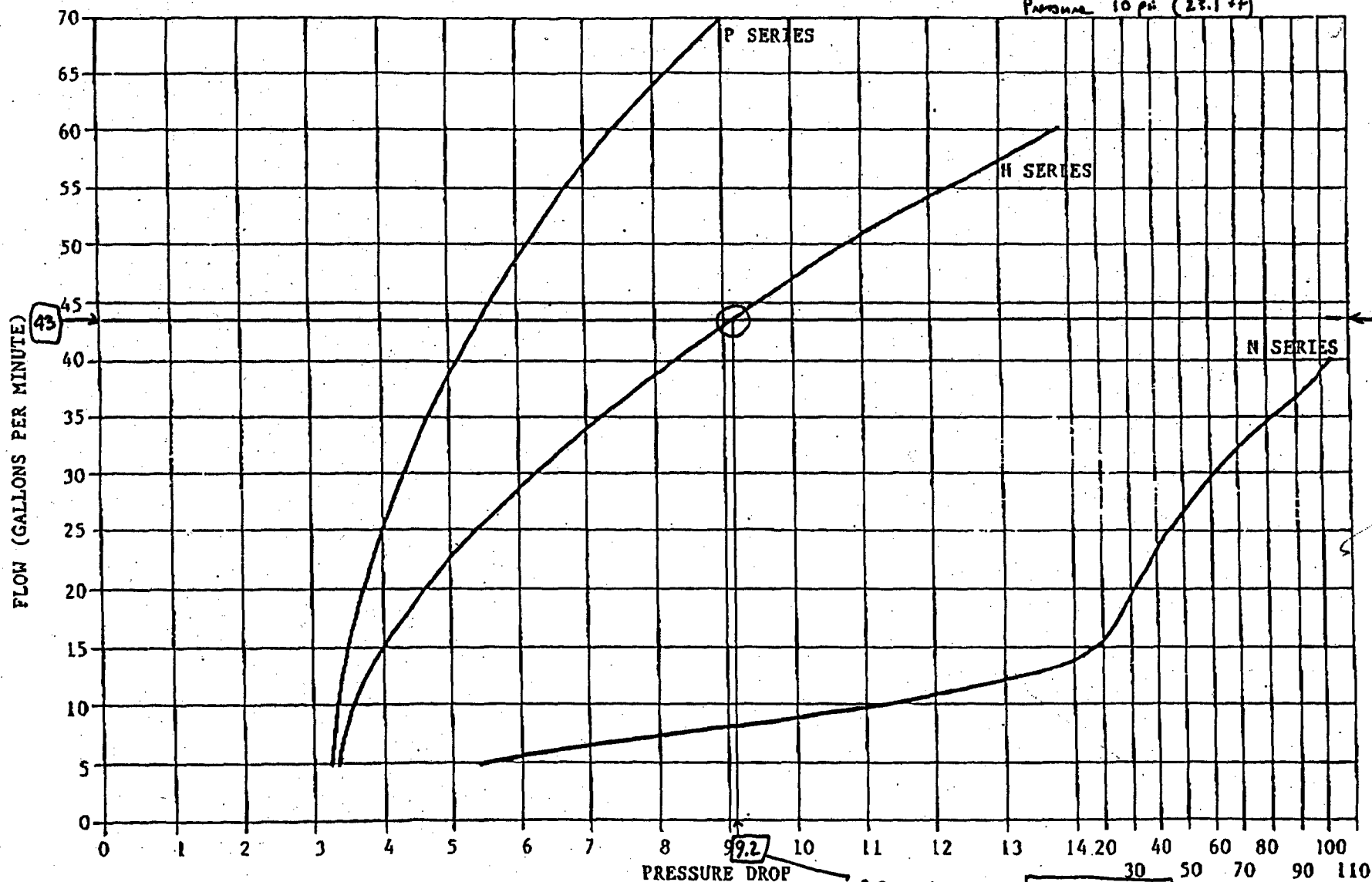
Given: U , l , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

PRESSURE LOSS CURVE

1-30-06
Borehole 212
Test Interval 30-40 ft.
Pressure 10 psi (23.1 ft)



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From : WIRELINE TYPE II service manual, Borehole 212.

T-115 P.28/32 F-001

8019741018

A-48

From-LAYNE CHRISTENSEN

JUL-25-05 04:21pm

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

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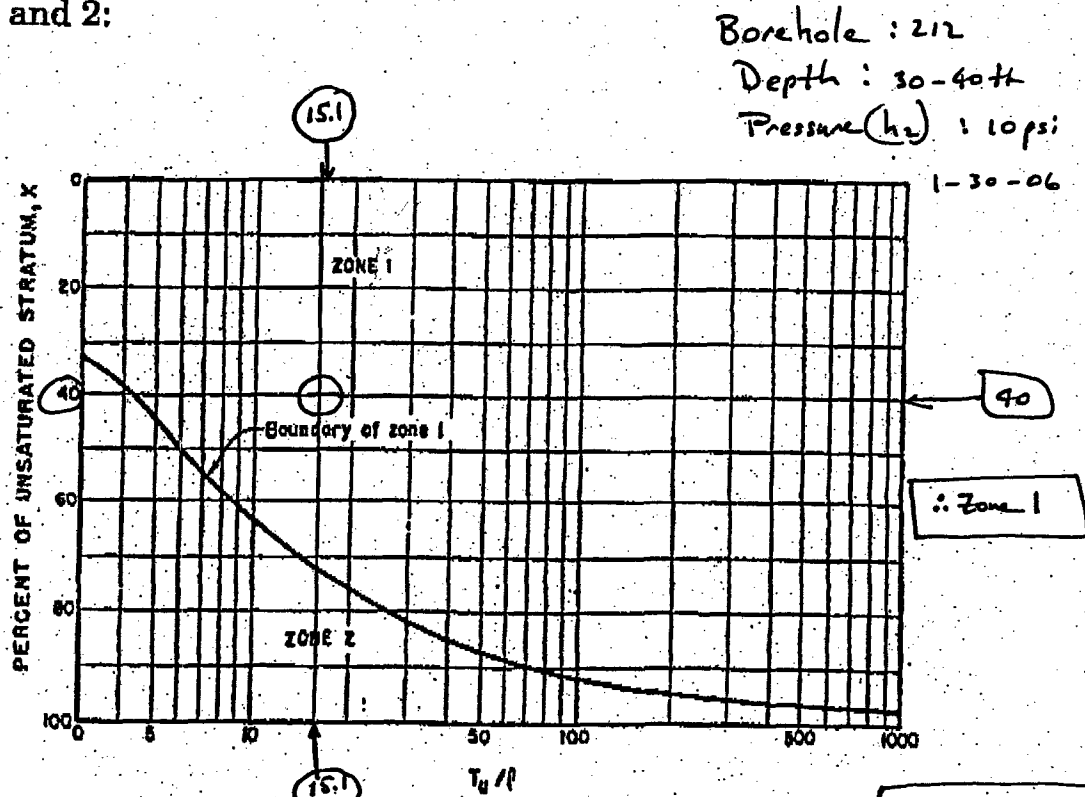


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{e} = 15.1$$

$$X = 40$$

Stoller

PACKER TEST SET-UP SHEET

JOB NO: _____

DATE: 1-30-06

JOB NAME: Crescent Junction Site

PREPARED: Mark Kautsky

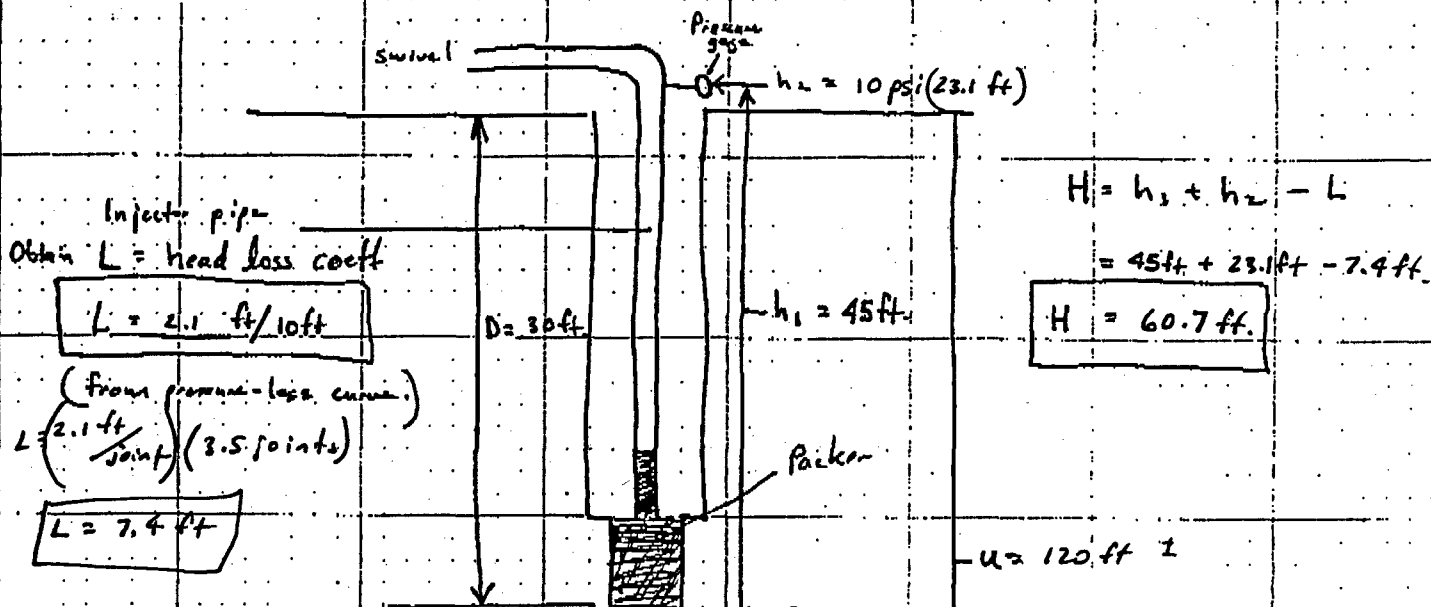
REVIEWED: _____

SHEET NO: 1 OF _____

Borehole 212

Test Interval 30-40 ft.

Pressure 10 psi (23.1 ft)



Injecter pipe
Obtain L = head loss coeff

$$L = 2.1 \text{ ft/10ft}$$

(From pressure-loss curve)
 $L = 2.1 \text{ ft/joint} (3.5 \text{ joints})$

$$L = 7.4 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$= 45 \text{ ft} + 23.1 \text{ ft} - 7.4 \text{ ft}$$

$$H = 60.7 \text{ ft}$$

Obtain C_u

$$C_u = 130$$

(From Fig 17.7 USBR)

$$\frac{H}{l} = \frac{60.7 \text{ ft}}{0.16} = 379$$

$$\frac{l}{H} = \frac{10 \text{ ft}}{60.7 \text{ ft}} = 0.16$$

Calculate K :

Method 1,
Zone 1,
USBR

$$K = \frac{Q}{C_u \cdot l \cdot H} ; K = \frac{\left(\frac{43 \text{ gal}}{\text{min}}\right) \left(\frac{1440 \text{ min}}{\text{d}}\right) \left(\frac{\text{ft}^3}{7.48 \text{ gal}}\right)}{(130) (0.16 \text{ ft}) (60.7 \text{ ft})}$$

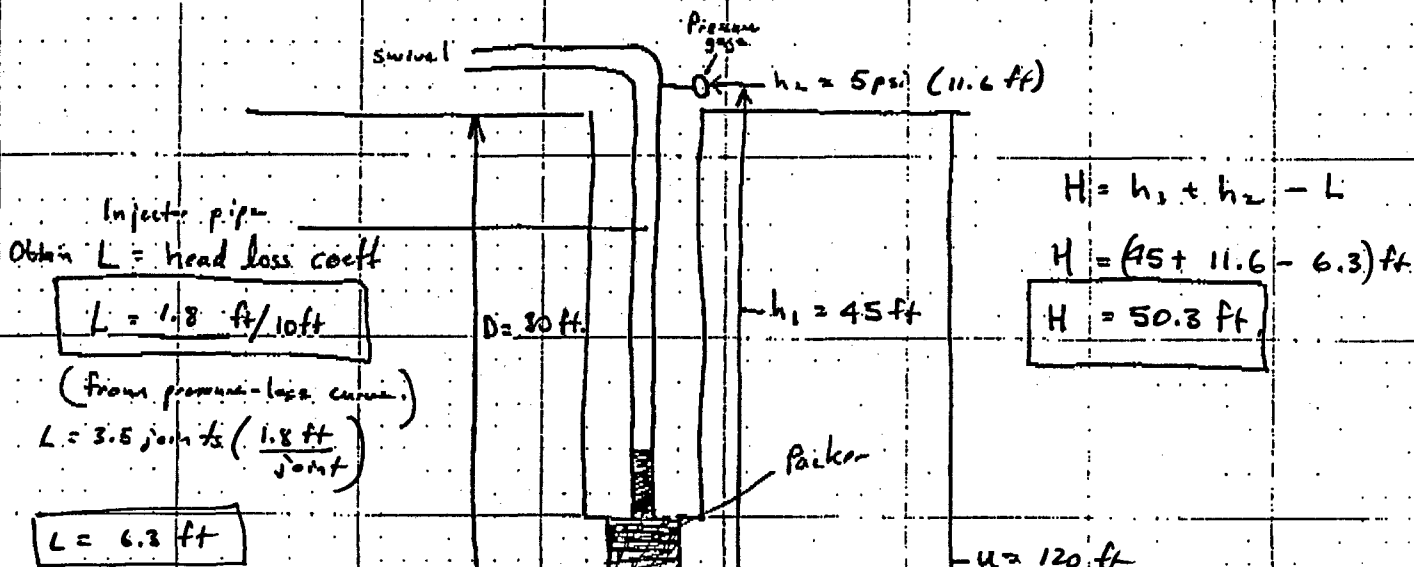
$$K = 6.5 \text{ ft/d}$$

$$K = 2.3 \times 10^{-3} \text{ cm/s}$$

Stoller

PACKER TEST SET-UP SHEET

JOB NO: _____ DATE: 1-30-06
 JOB NAME: Crescent Junction Site
 PREPARED: Mark Kautsky REVIEWED: _____
 SHEET NO: 1 OF 1 Borehole 212
Depth 30-40 ft
pressure: 5 psi (retest)



Obtain C_u
 $C_u \approx 130$
 (From Fig. 17.7 USBR)
 $\frac{H}{l} = \frac{50.3 \text{ ft}}{0.16 \text{ ft}} = 314$
 $\frac{l}{H} = \frac{10 \text{ ft}}{50.3 \text{ ft}} = 0.20$

Calculate K :

Method 1,
 Zone 1,
 USBR

$$K = \frac{Q}{C_u \cdot l \cdot H} = \frac{\left(\frac{38 \text{ gal}}{\text{min}}\right) \left(\frac{1440 \text{ min}}{\text{d}}\right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}}\right)}{(130) (0.16 \text{ ft}) (50.3 \text{ ft})}$$

$$K = 7.0 \text{ ft/day}$$

$$K = 2.5 \times 10^{-3} \text{ cm/s}$$

Packer-Test Record

Page 1 of 2

Project Name: Crescent Junction Characterization Date: 12-1-05

Field Representative: Mark Kautsky Borehole No.: 213 Total Depth: 30 ft

Depth to Water (TOC): 120[±] ft. Borehole Cleaned? Yes X No Date: 12-1-05

Test Interval (BGL): from 20 to 30 ft. ft. Swivel/Elbow Height (AGL) 6 ft.

Conductor Pipe, Type, and Size: HQ/HX

Time	Gauge Pressure	Flow Meter Reading
13:01	5 psi	37784.7
13:02	5 psi	37786.3
13:04	5 psi	37792.8
13:05	5 psi	37800.5
13:06	5 psi	37811.0
13:07	5 psi	37825.0
13:08	5 psi	37842.5
13:09	5 psi	37863.3
13:10	5 psi	37887.6
13:11	5 psi	37915.0
13:12	5 psi	37944.0
13:13	5 psi	37974.3
13:14	5 psi	38005.0
13:15	5 psi	38036.5 31.5 gpm
13:16	5 psi	38068.5 32 gpm
13:17	5 psi	38100.5 32 gpm
13:18	5 psi	38132.5 32 gpm

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RECORD COPY

established 1959

Packer-Test Record

Page 2 of 2

Project Name: Crescent Jct. Characterization Date: 12-1-05

Field Representative: Mark Kautsky Borehole No.: 213 Total Depth: 30

Depth to Water (TOC): 120⁺ Borehole Cleaned? Yes X No Date: 12-1-05

Test Interval (BGL): from 20 to 30 ft. Swivel/Elbow Height (AGL) 6 ft.

Conductor Pipe, Type, and Size: 10 1/4" X

Time	Gauge Pressure	Flow Meter Reading
13:20	10 psi	38203.0
13:21	10 psi	38243.0 40 gpm
13:22	10 psi	38283.0 40 gpm
13:23	10 psi	38323.0 40 gpm
X X	X X	X X X
13:24	5 psi	38 out of water.
15:09	5 psi	38409
15:10	5 psi	38439 30 gpm
15:11	5 psi	38468 29 gpm
15:12	5 psi	38497 29 gpm
15:13	5 psi	38527 30 gpm
15:14	5 psi	38557 30 gpm
15:15	5 psi	38587 30 gpm
	end of test Corhole 213 20-30 ft.	
	MHC	

Stoller

ALP

DATE: 1-23-06

JOB NAME: Crescent Junction

PREPARED: H. Kautsky

REVIEWED:

SHEET NO: OF

PACKER TEST ANALYSIS

BOREHOLE: 213

Depth: 20-30 ft

Pressure (h_w): 5 psi 11.6 ft

Unsaturated Zone Calculation:

Definitions: L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) = \text{percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10 \text{ ft}$$

$$T_u = U - D + H = 120 \text{ ft} - 20 + 43.7 \text{ ft} = 143.7 \text{ ft}$$

$$\frac{T_u}{L} = \frac{143.7 \text{ ft}}{10 \text{ ft}} = \boxed{14.4}$$

$$H = h_1 + h_2 - L = 36 \text{ ft} + 11.6 \text{ ft} - 3.9 \text{ ft} = 43.7 \text{ ft}$$

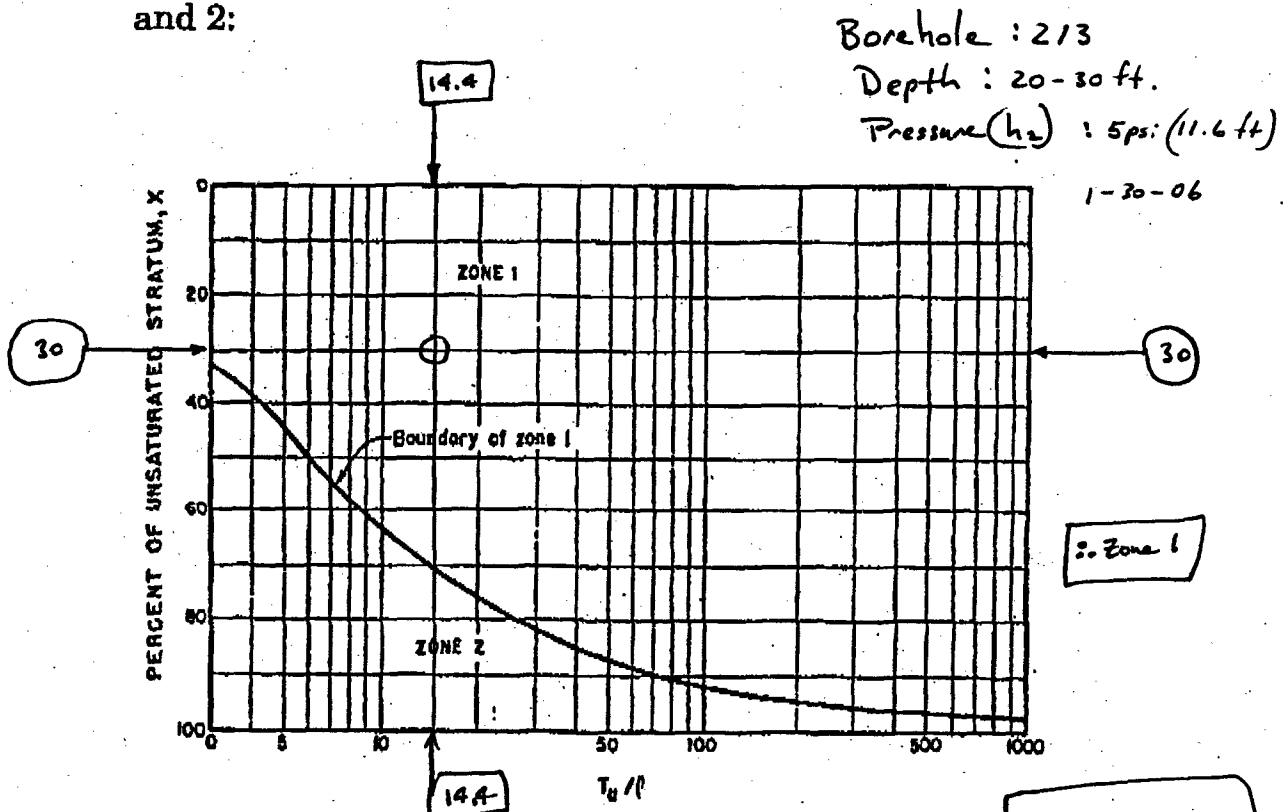
$$X = \frac{H}{T_u} (100) = \frac{43.7 \text{ ft}}{143.7 \text{ ft}} (100) = \boxed{30}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

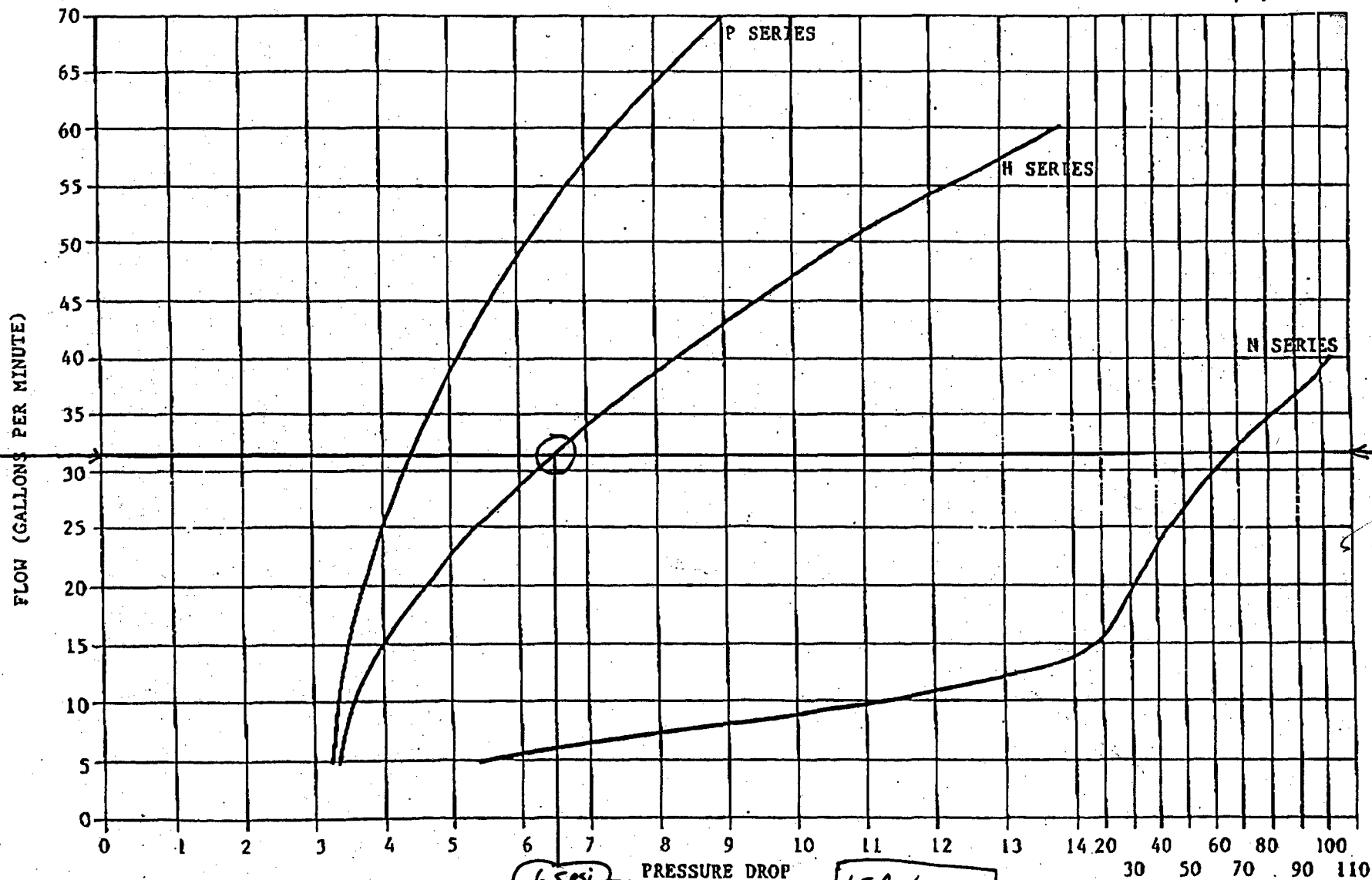


$$\frac{T_u}{l} = 14.4$$

$$X = 30$$

PRESSURE LOSS CURVE

Borehole 213
Depth: 20-30 ft
Pressure: 5 psi 1-30-06



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From: WIRELINE TYPE II service manual, Borehole Loggear.

WATER TESTING FOR PERMEABILITY

Borehole 213
Depth 20-30 ft.
Pressure: 5 psi

1-30-06

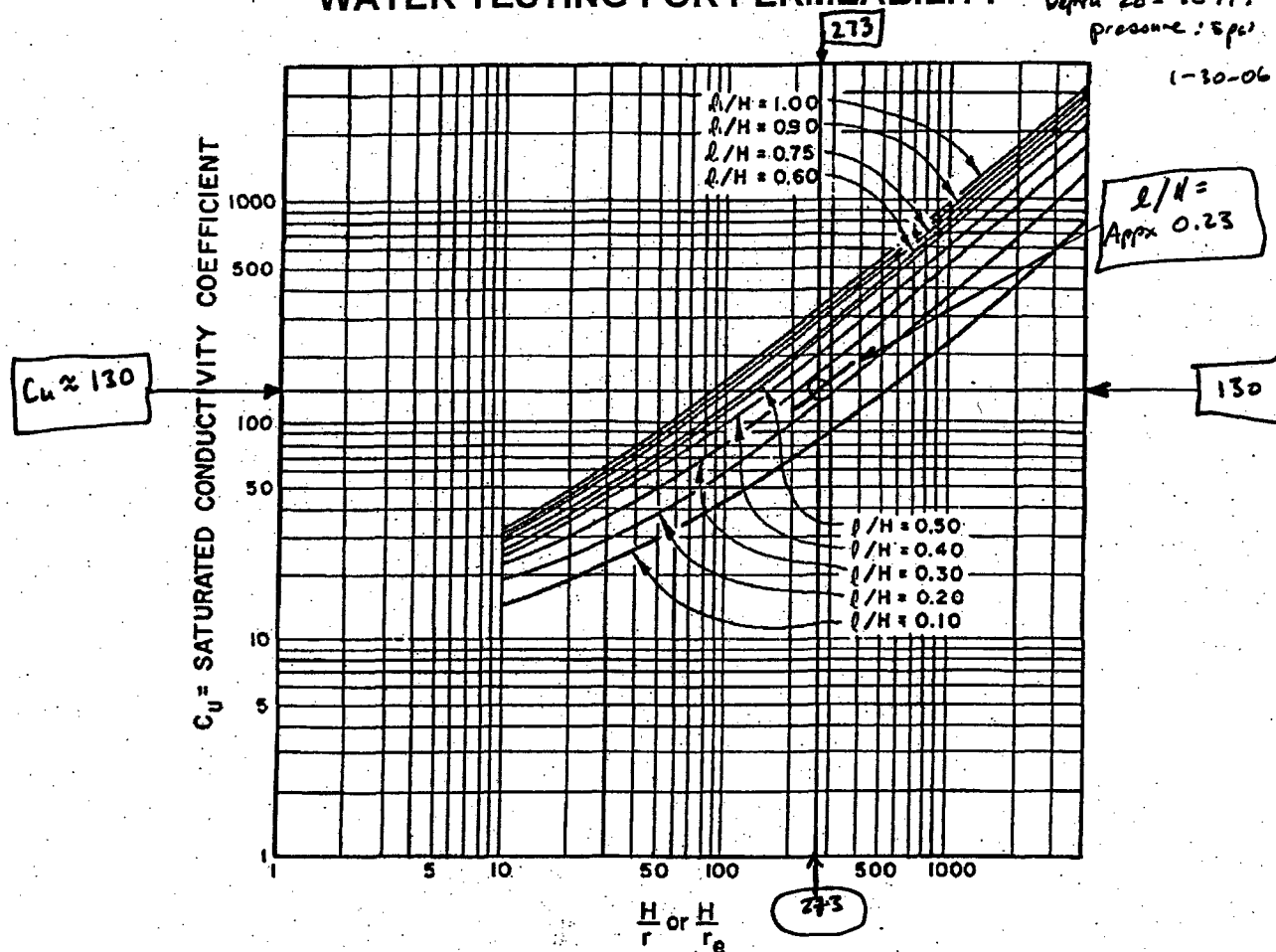


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

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PACKER TEST SET-UP SHEET

JOB NO.:

DATE: 1-30-06

JOB NAME: Crescent Junction Site

PREPARED: Mark Kautsky

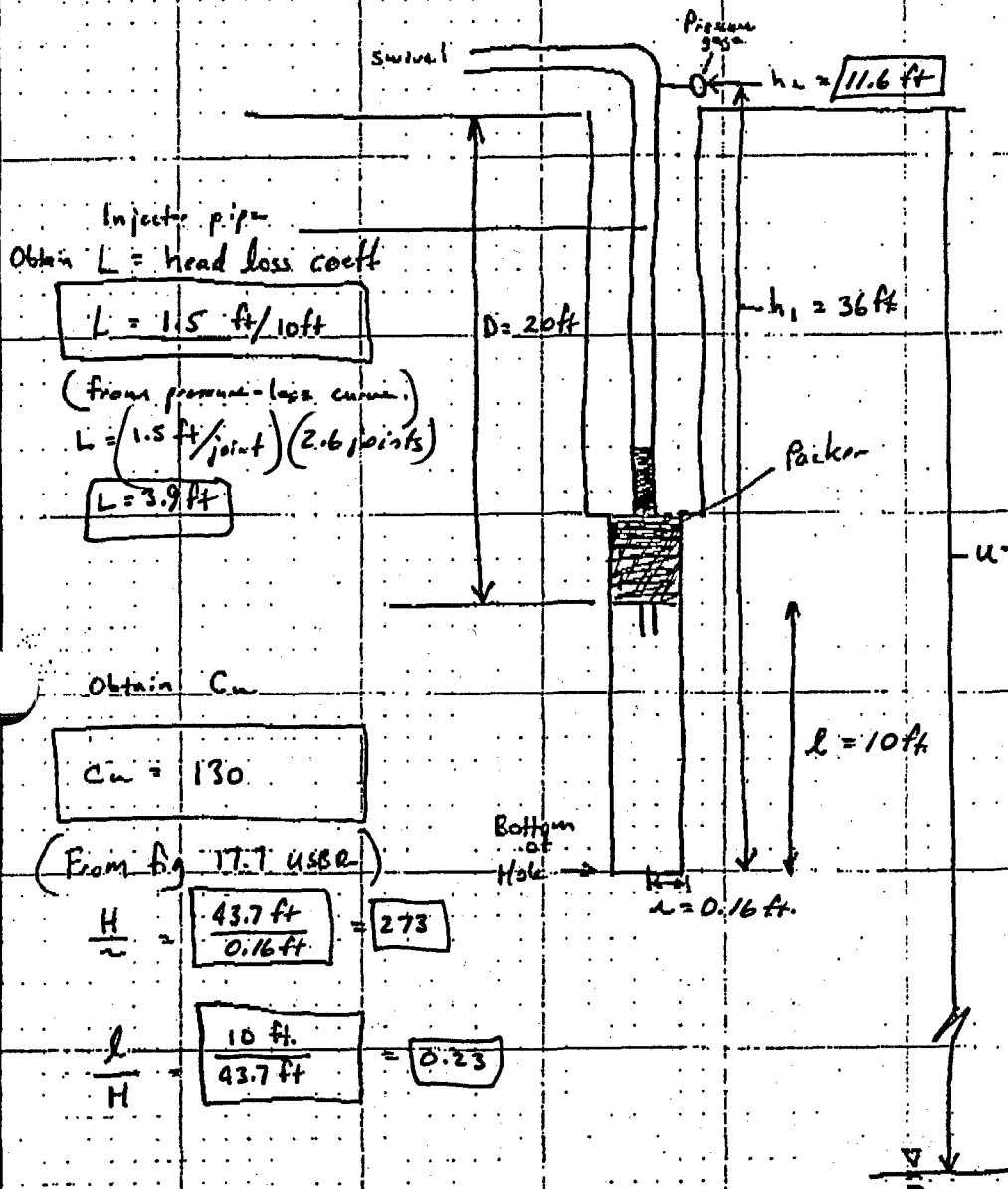
REVIEWED:

SHEET NO.: 1 OF

Borehole 213

Depth: 20 - 30 ft

Pressure: 11.6 ft. (SP)



Injecter pipe
Obtain L = head loss coeff

$$L = 1.5 \text{ ft/10ft}$$

(from pressure-loss curve)
 $L = (1.5 \text{ ft/joint}) (2.6 \text{ joints})$

$$L = 3.9 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$= 36 \text{ ft} + 11.6 \text{ ft} - 3.9 \text{ ft}$$

$$H = 43.7 \text{ ft}$$

Obtain C_u

$$C_u = 130$$

(From Fig. 17.7 USBR)

$$\frac{H}{l} = \frac{43.7 \text{ ft}}{0.16 \text{ ft}} = 273$$

$$\frac{l}{H} = \frac{10 \text{ ft}}{43.7 \text{ ft}} = 0.23$$

Calculate K :

Method 1,
Zone 1,
USBR

$$K = \frac{Q}{C_u \cdot l \cdot H} = \frac{(32 \text{ gal/min}) \left(\frac{1440 \text{ min}}{\text{day}} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(130) (0.16 \text{ ft}) (43.7 \text{ ft})}$$

$$K = 6.8 \text{ ft}^2/\text{d}$$

$$K = 2.4 \times 10^{-3} \text{ cm/s}$$

Stoller

DATE 1-23-06

JOB NAME Crescent Junction

PREPARED: H. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

BOREHOLE: 213

Depth: 20-30 ft.

Pressure (hr): 10 psi (23.1 ft)

Unsaturated Zone Calculation:

Definitions: L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4$ gpm

$$X = \frac{H}{T_u} (100) ; \text{percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10 \text{ ft}$$

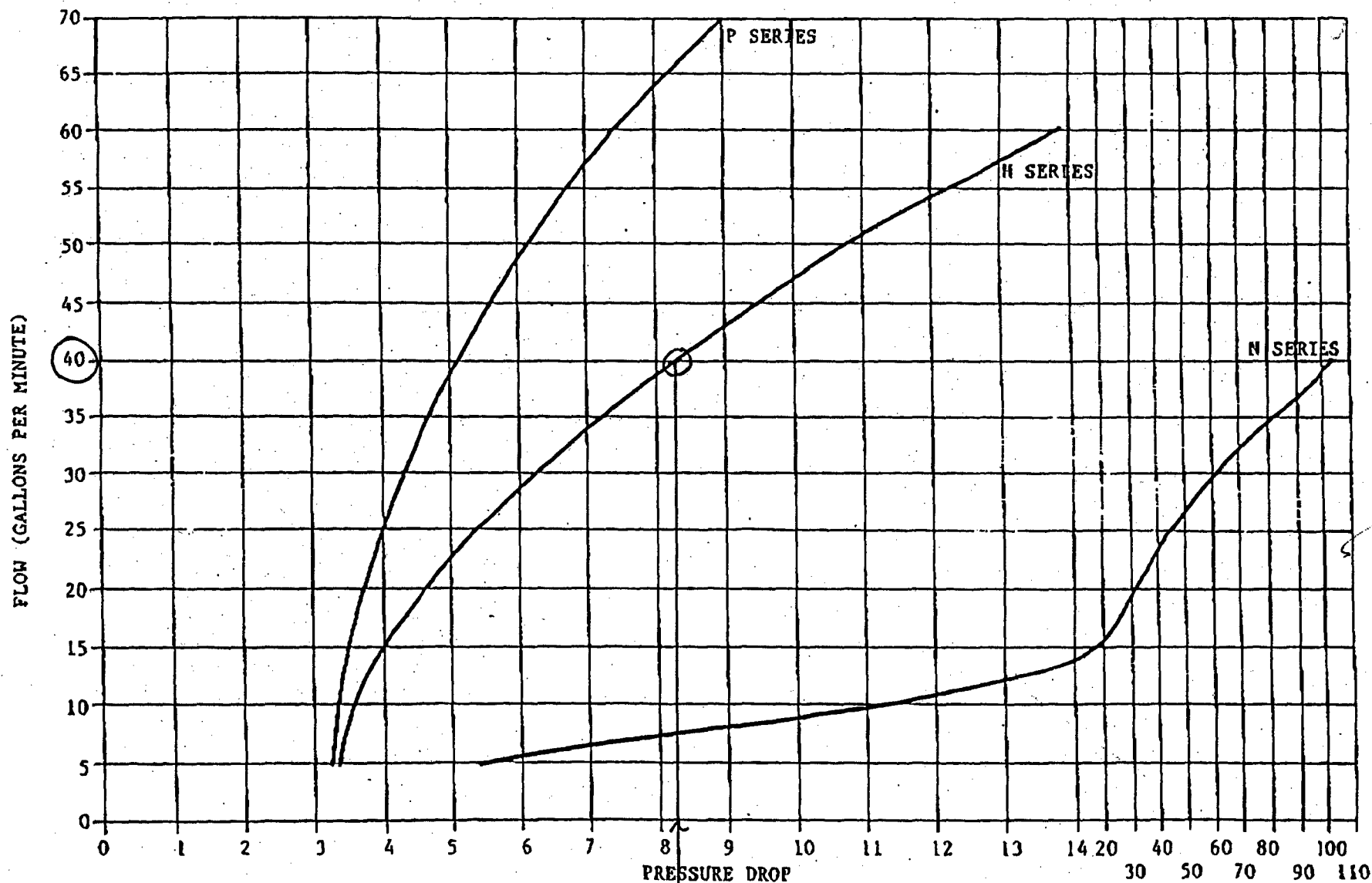
$$T_u = U - D + H = 120 \text{ ft} - 20 \text{ ft} + 54.2 \text{ ft} = \boxed{154.2 \text{ ft}}$$

$$\frac{T_u}{L} = \frac{154.2 \text{ ft}}{10 \text{ ft}} = \boxed{15.4}$$

$$H = h_1 + h_2 - L = 54.2 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{54.2 \text{ ft}}{154.2 \text{ ft}} \times (100) = \boxed{35}$$

PRESSURE LOSS CURVE



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From: WIRELINE TYPE II service manual, Bock Longyear.

$$8.2 \text{ psi/100ft} = 1.9 \text{ ft/joint}$$

Booth 213
 11/1/20-20 ft
 Pressure: 10 psi
 1-30-06

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

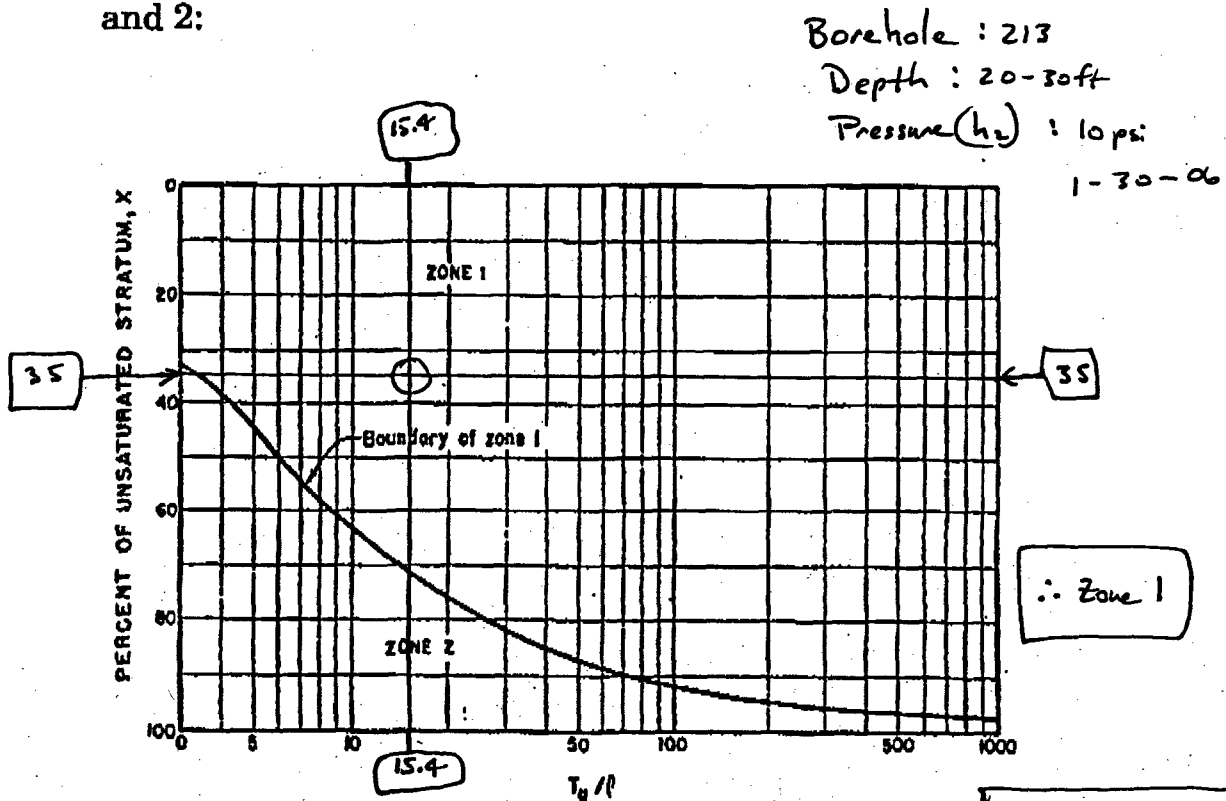


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 15.4$$

$$X = 35$$

WATER TESTING FOR PERMEABILITY

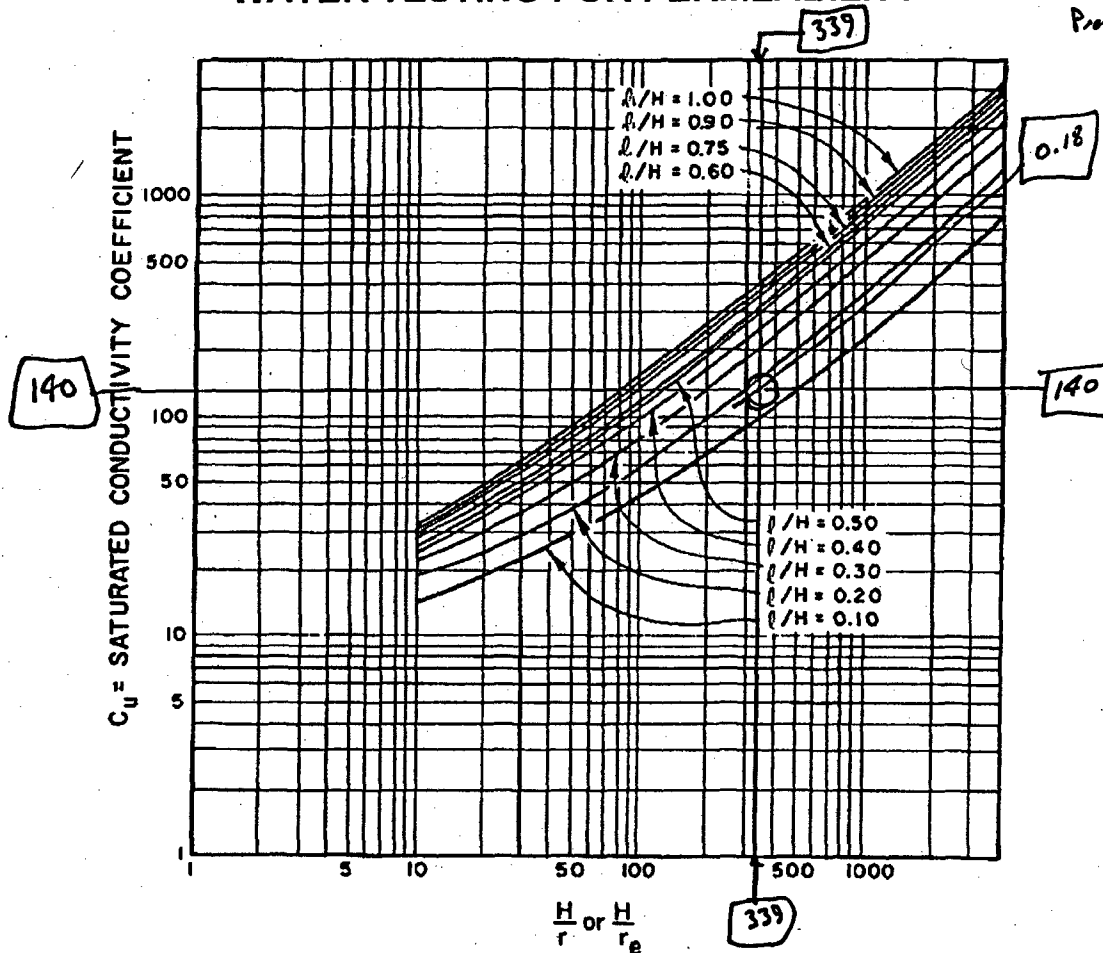


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

Stoller

PACKER TEST SET-UP SHEET

JOB NO: _____

DATE: 1-30-06

JOB NAME: Crescent Junction Site

PREPARED: Mark Kautsky

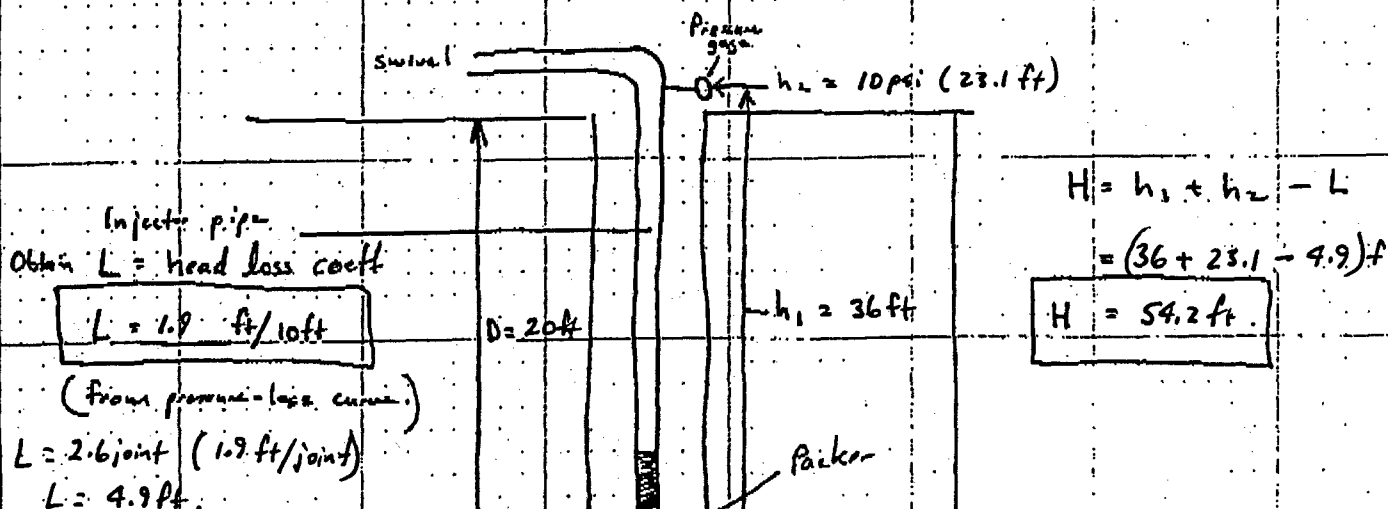
REVIEWED: _____

SHEET NO: 1 OF _____

Borehole 213

20-30 ft.

pressure: 10 psi



Obtain C_u

$C_u \approx 140$

(From Fig. IT.7 USBR)

$$\frac{H}{l} = \frac{54.2 \text{ ft}}{0.16 \text{ ft}} = 339$$

$$\frac{l}{H} = \frac{10 \text{ ft}}{54.2 \text{ ft}} = 0.18$$

Calculate K :

Method 1,
Zone 1,
USBR

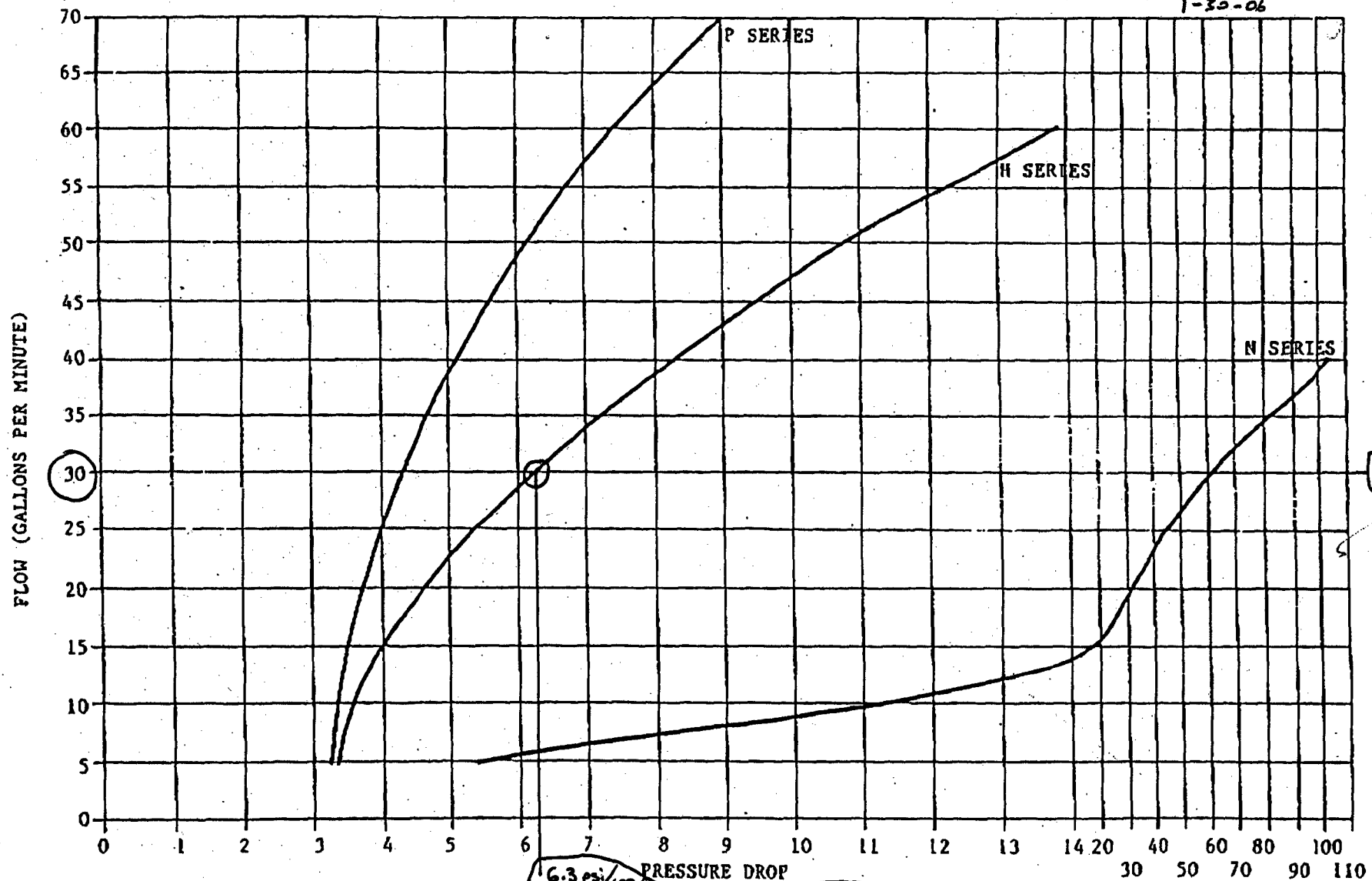
$$K = \frac{Q}{C_u \cdot l \cdot H} = \frac{\left(\frac{40 \text{ gal}}{\text{min}}\right) \left(\frac{1440 \text{ min}}{\text{day}}\right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}}\right)}{(140) (0.16 \text{ ft}) (54.2 \text{ ft})}$$

$$K = 6.3 \text{ ft/d}$$

$$K = 2.2 \times 10^{-3} \text{ cm/s}$$

PRESSURE LOSS CURVE

Borehole 213
Depth: 20-30 ft
Pressure 5 psi (retest)
1-30-06



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From: WIRELINE TYPE II service manual, Bont Lanyear.

Borehole 213
Depth: 20-30
Pressure: 5 psi
1-30-06

T-115 P.29/32 F-001

8018741018

From-LAYNE CHRISTENSEN

Jul-25-05 04:21pm

49-V

Stoller

PACKER TEST SET-UP SHEET

JOB NO.:

DATE: 1-30-06

JOB NAME: Crescent Junction Site

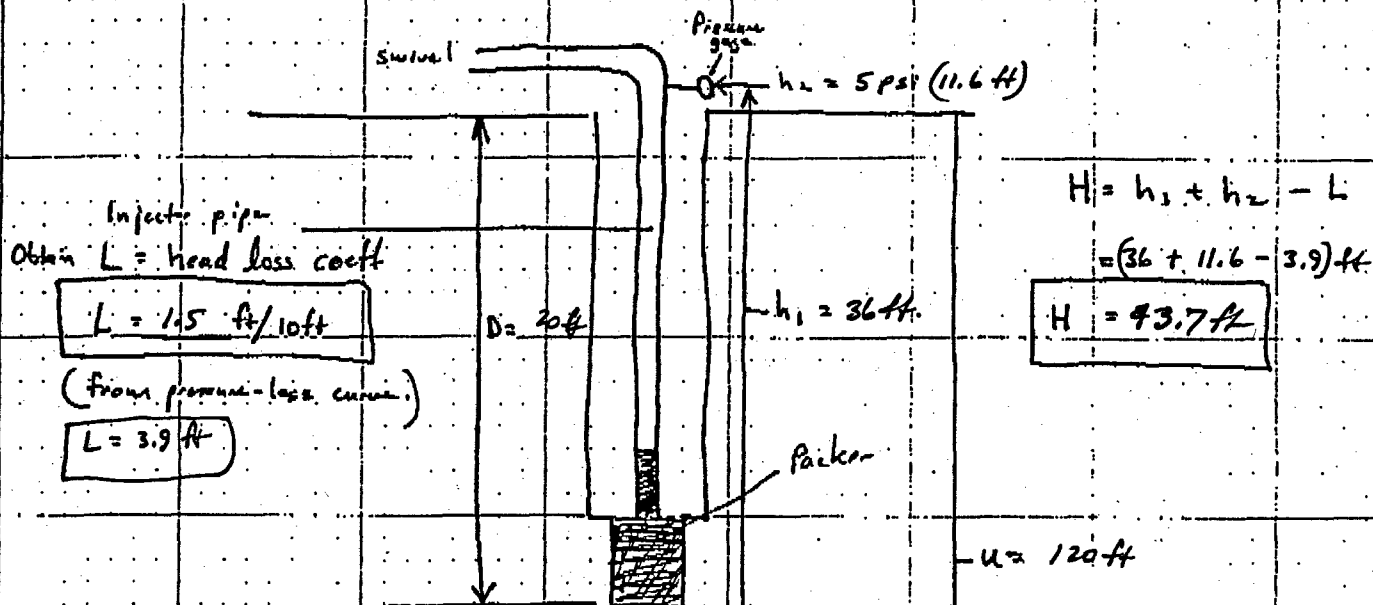
PREPARED: Mark Kantsky

REVIEWED: Borehole 213

SHEET NO.: 1 OF

Depth: 20-30 ft.

Pressure 5 psi (retest)



Obtain C_u

$C_u = 130$

(From Fig. 17.1 USBR)

$$\frac{H}{l} = \frac{43.7 \text{ ft}}{10 \text{ ft}} = 2.73$$

$$\frac{l}{H} = \frac{10 \text{ ft}}{43.7 \text{ ft}} = 0.23$$

Calculate K :

Method 1,
Zone 1,
USBR

$$K = \frac{Q}{C_u \cdot l \cdot H} = \frac{\left(\frac{30 \text{ gal}}{\text{min}}\right) \left(\frac{1440 \text{ min}}{\text{d}}\right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}}\right)}{(130) (0.16 \text{ ft}) (43.7 \text{ ft})}$$

$$K = 6.4 \text{ ft/d}$$

$$K = 2.2 \times 10^{-3} \text{ cm/s}$$

Packer-Test Record

Page 1 of 1

Project Name: Crescent Junction Characterization Date: 12-02-05

Field Representative: Mark Kautsky Borehole No.: 213 Total Depth: 40

Depth to Water (TOC): 120 ± Borehole Cleaned? Yes X No Date: 12-02-05

Test Interval (BGL): from 30 to 40 ft. Swivel/Elbow Height (AGL) 6 ft

Conductor Pipe, Type, and Size: HQ/HX

Time	Gauge Pressure (psi)	Flow Meter Reading
09:30	5	38660
09:31	5	38697 37 gpm
09:32	5	38736 39 gpm
09:33	5	38775 39 gpm
09:44 0934	5	38815 40 gpm
09:45 0935	5	38854 39 gpm
0936	5	38893 39 gpm
0937	10	38934
0938	10	38979 45 gpm
0939	10	39023 44 gpm
0940	10	39068 45 gpm
09:41	10	390 39113 45 gpm
09:42	10	39158 45 gpm
0943	5	39198
0944	5	39236 38 gpm
0945	5	39275 39 gpm
0946	5	39314 39 gpm
0947	5	end test: out of water

Stoller

FORM

DATE 1-23-06

JOB NAME: Crescent Junction

PREPARED: M. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

Borehole: 213

Depth: 30-40 ft

Pressure (h_w): 5 psi (11.6 ft)

Unsaturated Zone Calculation:

Definitions: L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) ; \text{percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10 \text{ ft}$$

$$T_u = U - D + H = 120 \text{ ft} - 30 \text{ ft} + 50.8 \text{ ft} = \boxed{141 \text{ ft}}$$

$$\frac{T_u}{L} = \frac{141}{10} = \boxed{14.1}$$

$$H = h_1 + h_2 - L = (46 + 11.6 - 6.8) \text{ ft} = 50.8 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{50.8 \text{ ft}}{141} (100) = \boxed{36}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 213

Depth : 30-40 ft.

Pressure (h_2) : 5 psi (11.6 ft)

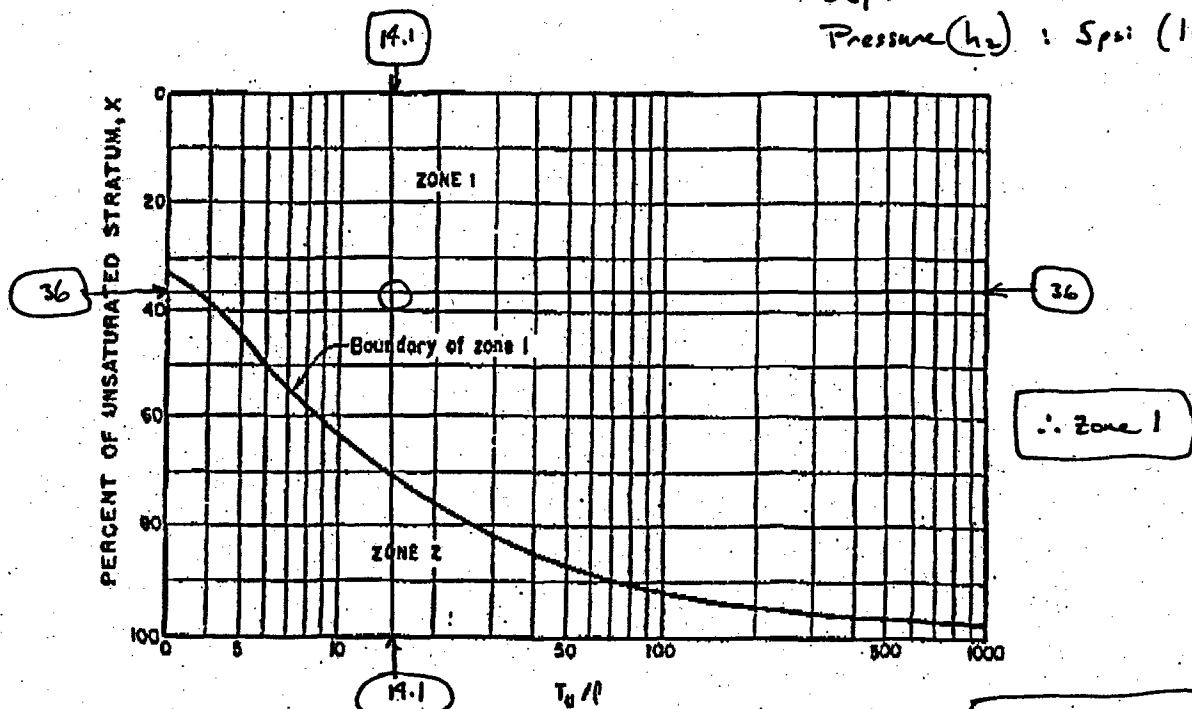
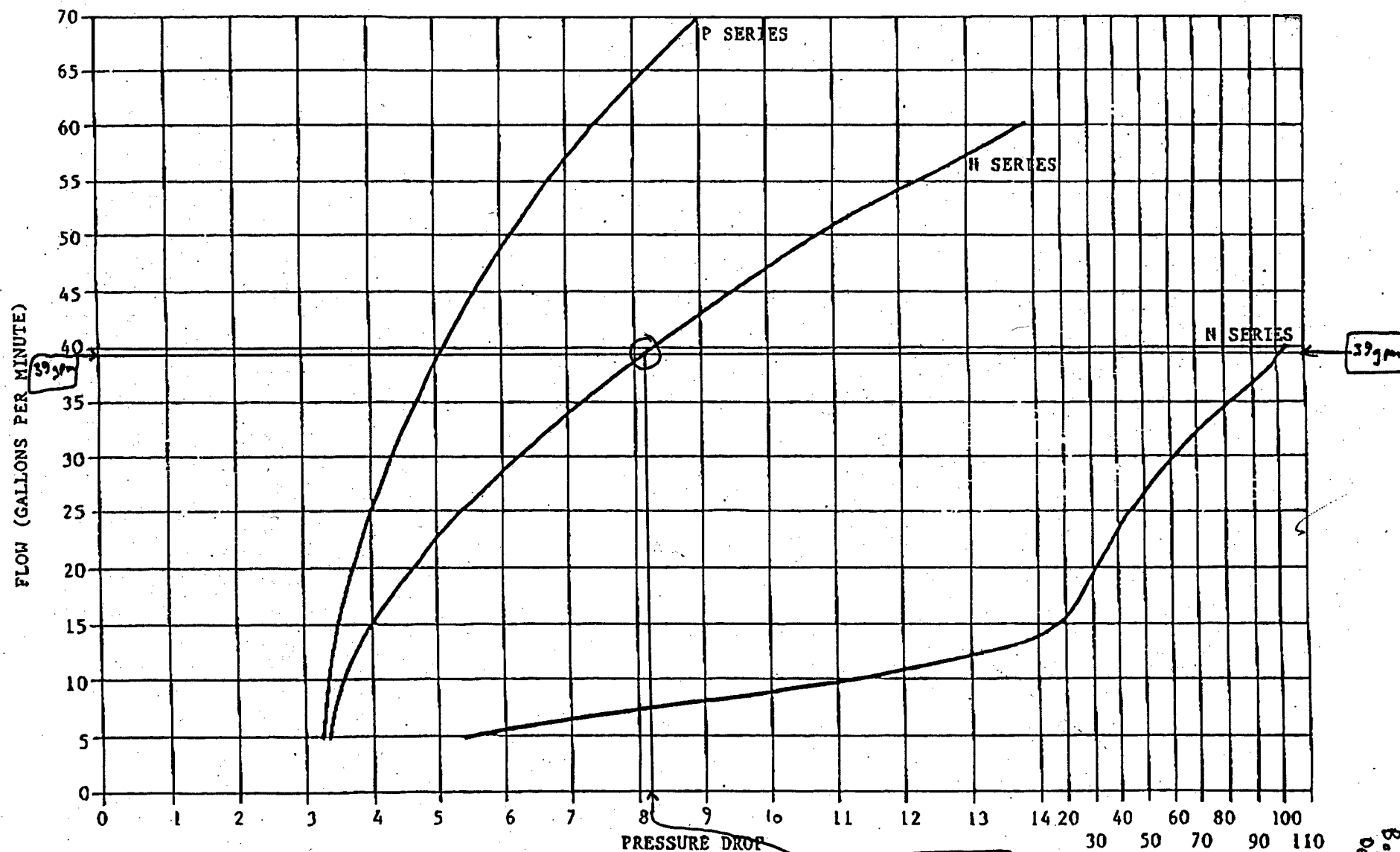


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{\rho} = 14.1$$

$$X = 36$$

PRESSURE LOSS CURVE



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From: WIRELINE TYPE II service manual, Borek Longyear.

Borehole 213
Depth: 30-40 ft
Pressure: 5 psi
1-30-06

WATER TESTING FOR PERMEABILITY

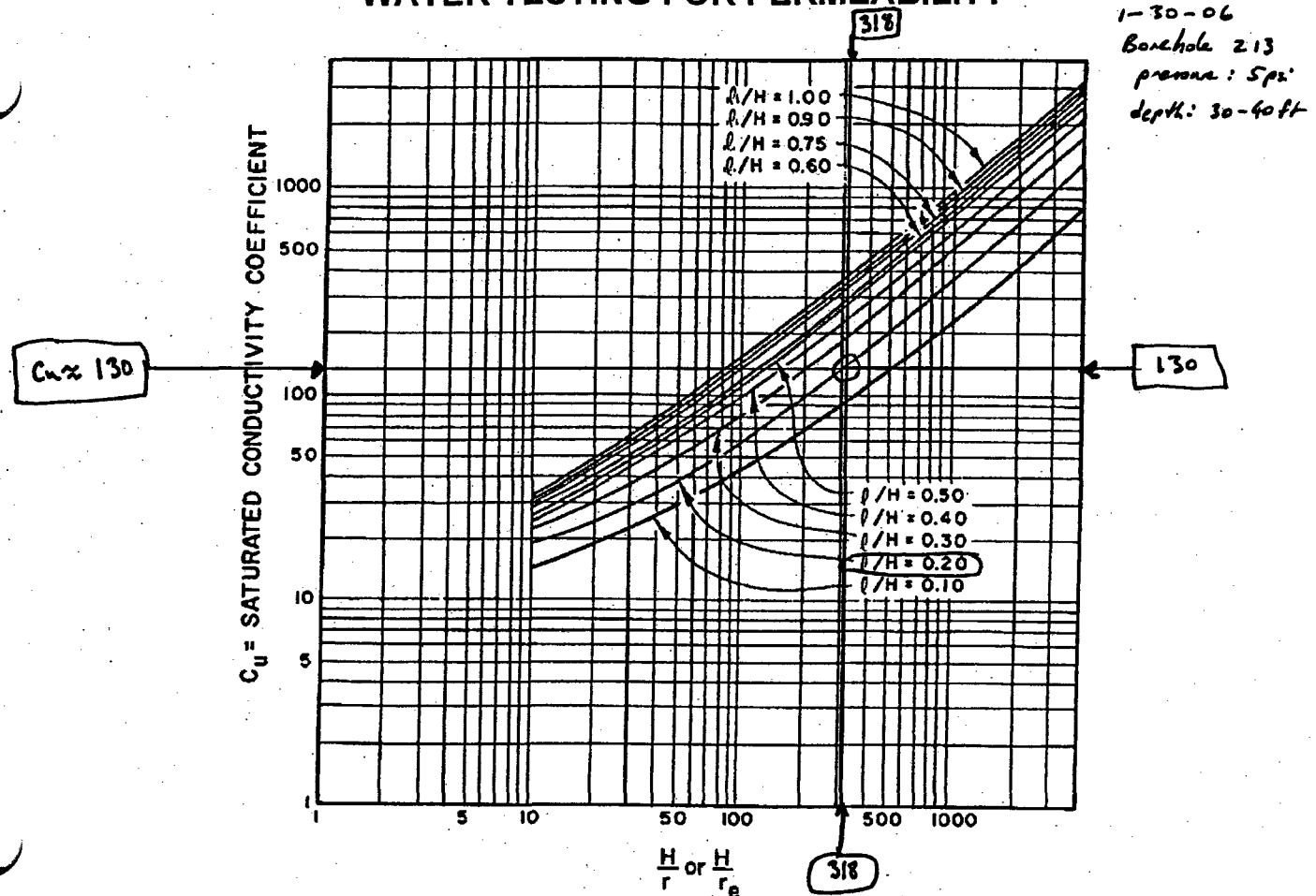


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

Stoller

PACKER TEST SET-UP SHEET

JOB NO: _____

DATE: 1-30-06

JOB NAME: Crescent Junction Site

PREPARED: Mark Kautsky

REVIEWED: _____

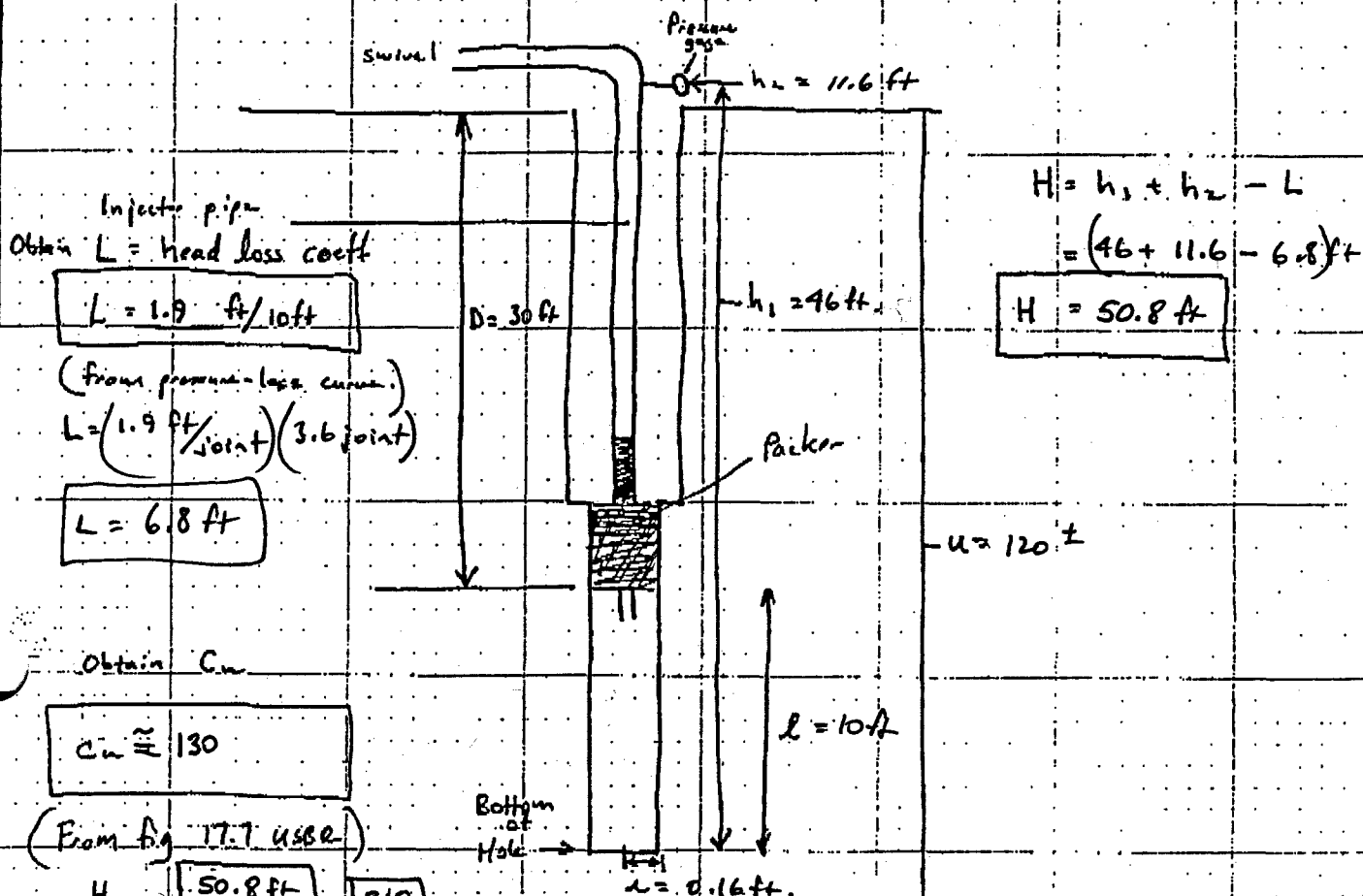
SHEET NO: 1

OF

Borehole 212

Depth: 30-40 ft

Pressure: 11.6 ft (5 psi)



Stoller

DATE 1-23-06

JOB NAME: Crescent Junction

PREPARED: M. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSIS

BOREHOLE: 213

Depth: 30 - 40 ft

Unsaturated Zone Calculation:

Pressure (h_2): 10 psi (23.1 ft)Definitions: L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) ; \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 10$$

$$T_u = U - D + H = (120 - 30 + 61.3) \text{ ft} = 151$$

$$\frac{T_u}{L} = \left(\frac{151 \text{ ft}}{10 \text{ ft}} \right) = \boxed{15.1}$$

$$H = h_1 + h_2 - L = \boxed{61.3 \text{ ft}}$$

$$X = \frac{H}{T_u} (100) = \frac{61.3 \text{ ft}}{151 \text{ ft}} \times 100\% \approx \boxed{41}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 213
Depth : 30-40 ft.
Pressure (h_2) : 10 psi (23.1 ft)

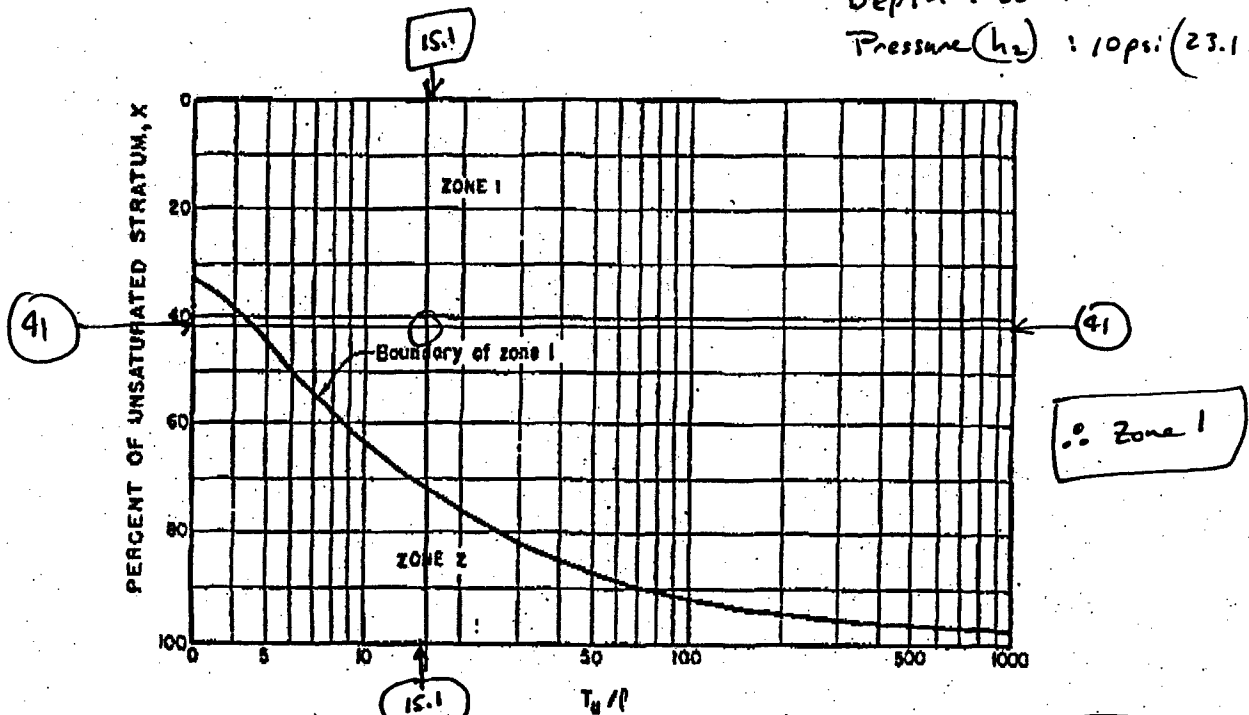
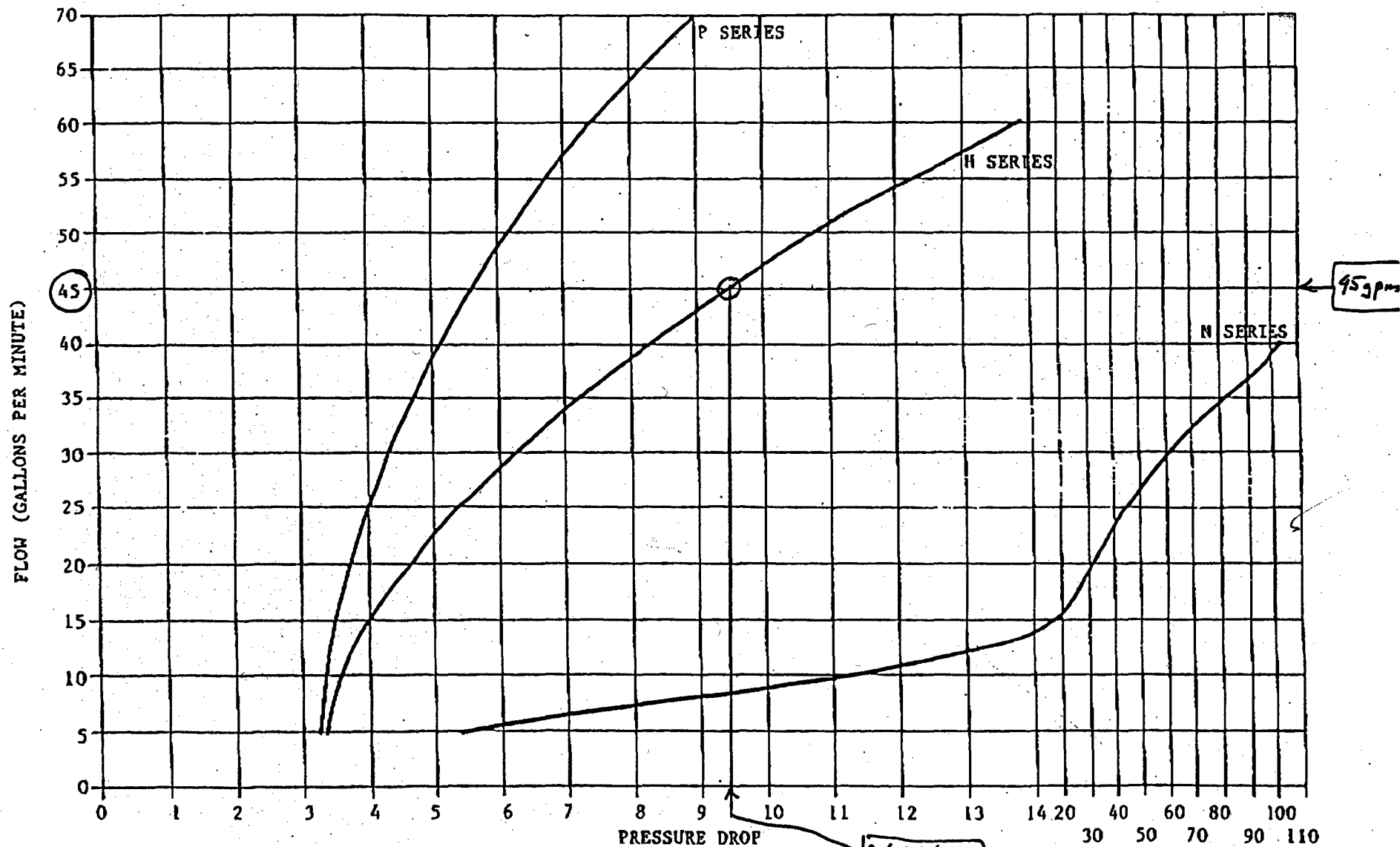


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{e} = 15.1$$

$$X = 41$$

PRESSURE LOSS CURVE



* TEST PERFORMED IN WATER TEMPERATURE OF 60°F (15.5°C)

* THIS CHART IS MEANT TO BE USED HAS A GUIDE ONLY. THE MEASUREMENTS WERE OBTAINED UNDER CONTROLLED LAB CONDITIONS AND ACTUAL FIELD CONDITIONS MAY VARY.

From: WIRELINE TYPE II service manual, Boart Longyear.

Booth 213
Depth 30-40 ft
Pressure 10 psi
1-30-06

WATER TESTING FOR PERMEABILITY

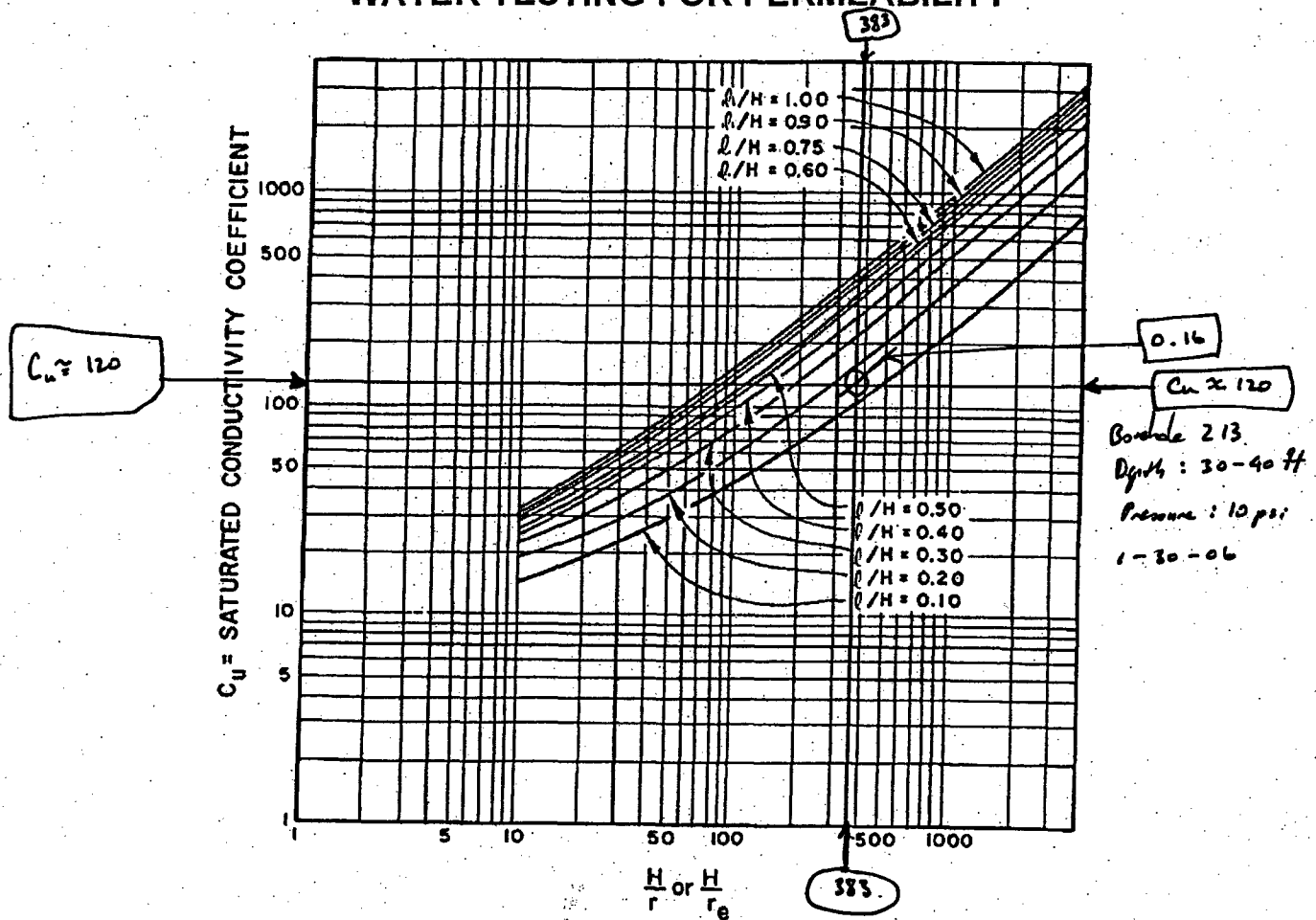


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

PACKER TEST SET-UP SHEET

Zone 1

JOB No: _____

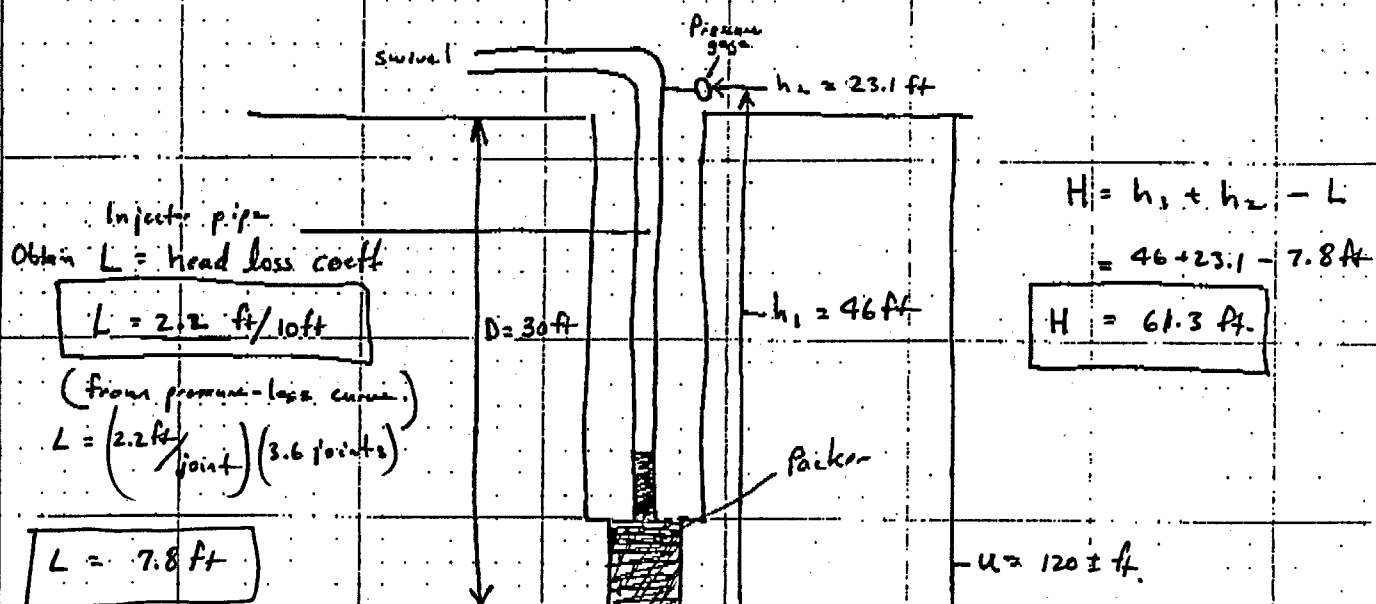
DATE: 1-30-06

JOB NAME: Crescent Junction Site

PREPARED: Mark Kautsky REVIEWED

SHEET NO.: 1 OF 1

OF Depth 30-40 ft.
pressure: 10 psi



Obtain Cw

Ch. 120

(From fig 17.7 USBR)

$$\frac{H}{z} = \frac{61.3 \text{ ft}}{0.16 \text{ ft}} = 383$$

$$\frac{L}{H} = \frac{10 \text{ ft}}{61.3 \text{ ft}} = 0.161$$

Calculate K :

Method 1,
Zone 1,
USBR

$$K = \frac{Q}{C_u \cdot H} = \frac{\left(\frac{45 \text{ gal}}{\text{min}}\right) \left(\frac{1490 \text{ min}}{1}\right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}}\right)}{(120)(0.16 \text{ ft})(61.3 \text{ ft})}$$

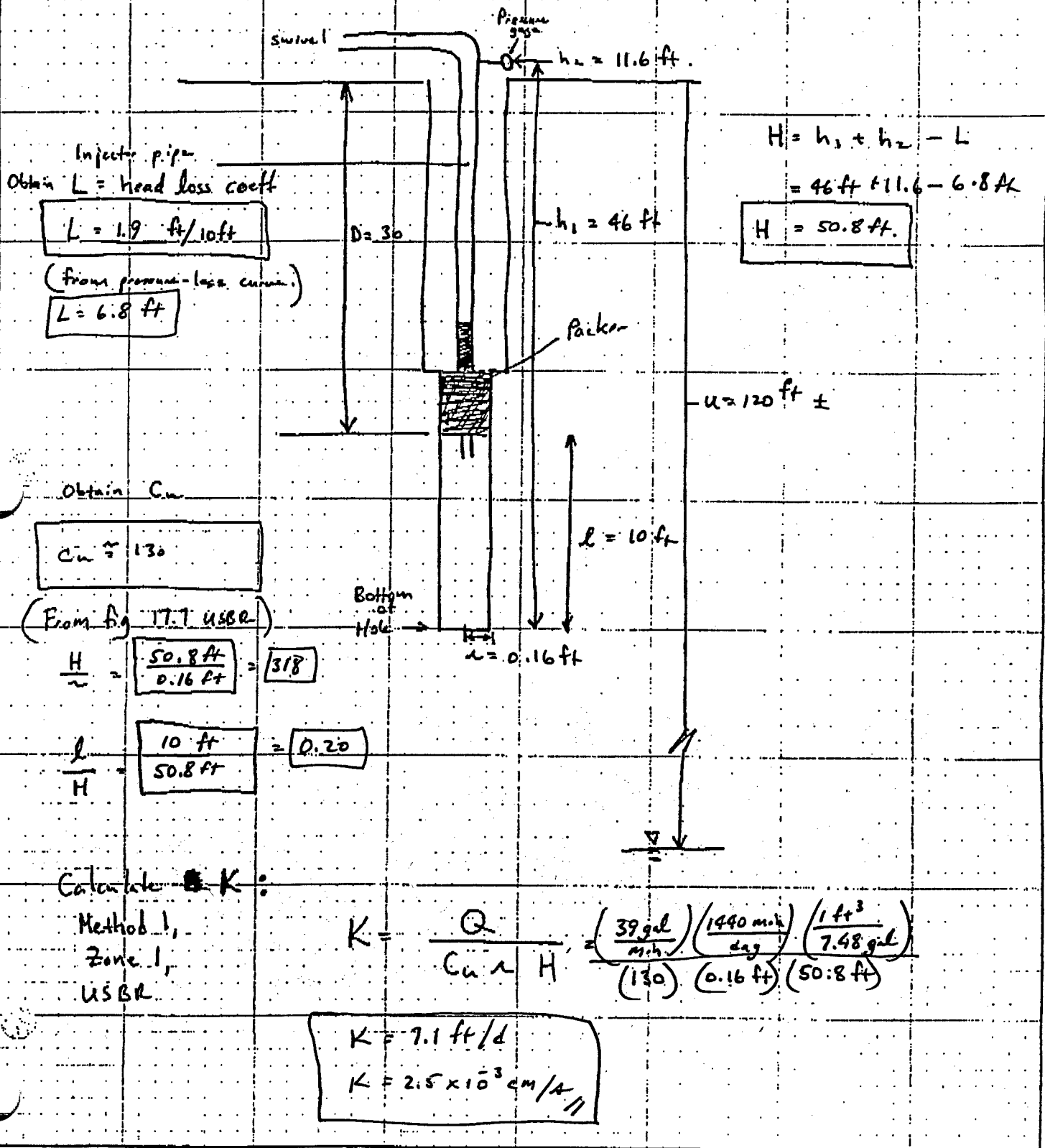
$$K = 7.4 \text{ ft/d}$$

$$K = 2.6 \times 10^{-3} \text{ cm/sec}$$

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PACKER TEST SET-UP SHEET

JOB NO: _____ DATE: 1-30-06
 JOB NAME: Crescent Junction Site
 PREPARED: Mark Kautsky REVIEWED: _____
 SHEET NO.: 1 OF 1
 Borehole 213
 Depth: 30-40 ft
 Pressure: 5 psi (retest)



Packer-Test Record

Page 1 of 2Project Name: Mock-Circum Jet Characterization Date: 01/14/06Field Representative: R. Rupp Borehole No. 0204 Total Depth: 300'Depth to Water (TOC): 225 ft. Borehole Cleaned? Yes ☒ No ☐ Date: 01/12/06Test Interval (BGL): from 80 to 92 ft. Swivel/Elbow Height (AGL) 4.0 ft.Conductor Pipe, Type and Size: 1-inch ID Thin Wall STEEL TUBING

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>1035</u>	<u>10 psi</u>	<u>39387.75</u>	
<u>1040</u>	<u>10</u>	<u>39387.8</u>	<u>0.01 gpm</u>
<u>1045</u>	<u>10</u>	<u>39387.8</u>	<u>0</u>
<u>1050</u>	<u>10</u>	<u>39387.8</u>	<u>0</u>
<u>1055</u>	<u>10</u>	<u>39387.8</u>	<u>0</u>
<u>1100</u>	<u>20 psi</u>	<u>39388.0</u>	<u>0.04 gpm</u>
<u>1105</u>	<u>20</u>	<u>39388.15</u>	<u>0.03</u>
<u>1110</u>	<u>20</u>	<u>39388.25</u>	<u>0.02</u>
<u>1115</u>	<u>20</u>	<u>39388.4</u>	<u>0.03</u>
<u>1120</u>	<u>20</u>	<u>39388.55</u>	<u>0.03</u>
<u>1125</u>	<u>20</u>	<u>39388.7</u>	<u>0.03</u>
<u>1130</u>	<u>30 psi</u>	<u>39389.0</u>	<u>0.06</u>
<u>1135</u>	<u>30</u>	<u>39389.25</u>	<u>0.05</u>
<u>1140</u>	<u>30</u>	<u>39389.35</u>	<u>0.02</u>
<u>1145</u>	<u>30</u>	<u>39389.35</u>	<u>0</u>
<u>1150</u>	<u>30</u>	<u>39389.35</u>	<u>0</u>
<u>1155</u>	<u>30</u>	<u>39389.35</u>	<u>0</u>

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Packer-Test Record

Page 2 of 2

Project Name: Maula-Crescent Is. Characterization Date: 01/14/06

Field Representative: R. Rupp Borehole No. 0204 Total Depth: 300'

Depth to Water (TOC): 225' Borehole Cleaned? Yes ☒ No ☐ Date: 01/12/06

Test Interval (BGL): from 80 to 92 ft. Swivel/Elbow Height (AGL) 4.0 ft.

Conductor Pipe, Type and Size: 1-inch ID Thin Wall steel tubing

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>1200</u>	<u>20 psi</u>	<u>39389.45</u>	<u>0.02 gpm</u>
<u>1205</u>	<u>20</u>	<u>39389.7</u>	<u>0.05</u>
<u>1210</u>	<u>20</u>	<u>39389.95</u>	<u>0.05</u>
<u>1215</u>	<u>20</u>	<u>39390.15</u>	<u>0.04</u>
<u>1220</u>	<u>20</u>	<u>39390.35</u>	<u>0.04</u>
<u>1225</u>	<u>20</u>	<u>39390.55</u>	<u>0.04</u>
<u>1230</u>	<u>10 psi</u>	<u>39390.55</u>	<u>0</u>
<u>1235</u>	<u>10</u>	<u>39390.6</u>	<u>0.01</u>
<u>1240</u>	<u>10</u>	<u>39390.65</u>	<u>0.01</u>
<u>1245</u>	<u>10</u>	<u>39390.65</u>	<u>0</u>
<u>1250</u>	<u>10</u>	<u>39390.65</u>	<u>0</u>
<u>1255</u>	<u>10</u>	<u>39390.65</u>	<u>0</u>

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FORM

DATE 1-25-06

JOB NAME: Crescent Junction

PREPARED: H. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

BOREHOLE: 204

Depth: 80 - 92 ft

Pressure (h_2): 10 psi (23.1 ft)

Unsaturated Zone Calculation:

Definitions:

 L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100); \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = (225 \text{ ft}) - (92 \text{ ft}) + (119.1 \text{ ft}) = 252.1 \text{ ft}$$

$$\frac{T_u}{L} = \frac{252.1 \text{ ft}}{12 \text{ ft}} = \boxed{21}$$

$$H = h_1 + h_2 - L = (96 \text{ ft}) + (23.1 \text{ ft}) - \emptyset = 119.1 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{119.1 \text{ ft}}{252.1 \text{ ft}} (100) = \boxed{47}$$

$$h_1 = (D) + (\text{stick up height}) = (92 \text{ ft}) + (4 \text{ ft}) = 96 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

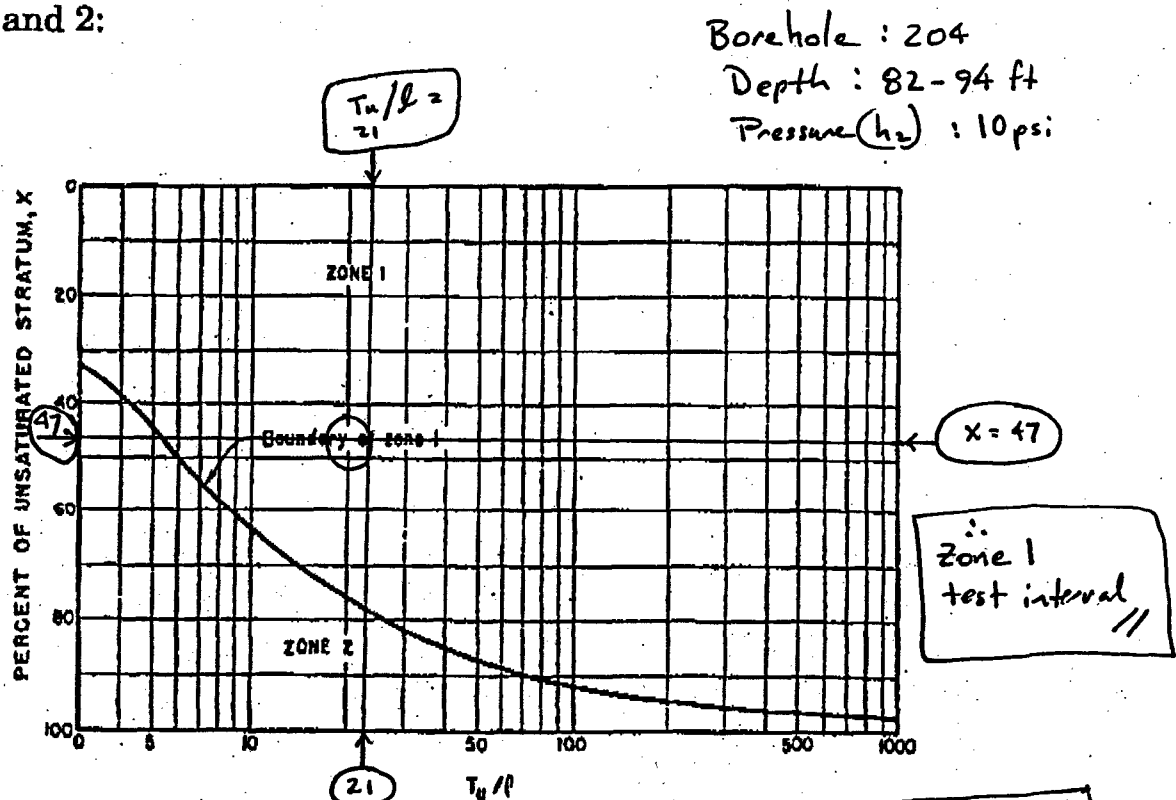


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

WATER TESTING FOR PERMEABILITY

1-25-06

Borehole : 204

Depth : 80-92 ft.

Pressure : 10 psi

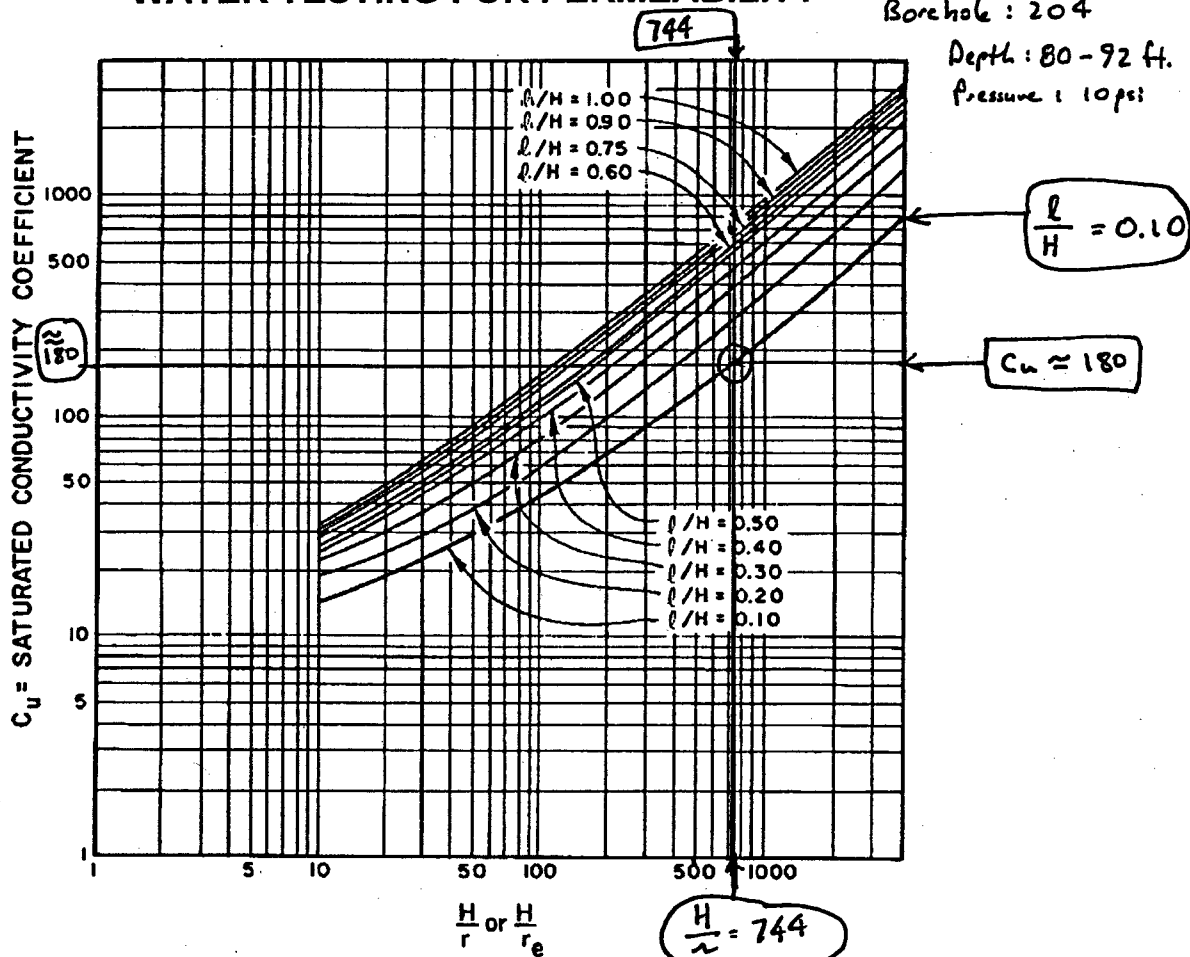


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

JOB NO. _____ DATE: 1-25-06

JOB NAME: Crescent Junction Site

PREPARED: _____

REVIEWED: _____

SHEET NO. _____

OF _____

Borehole 204

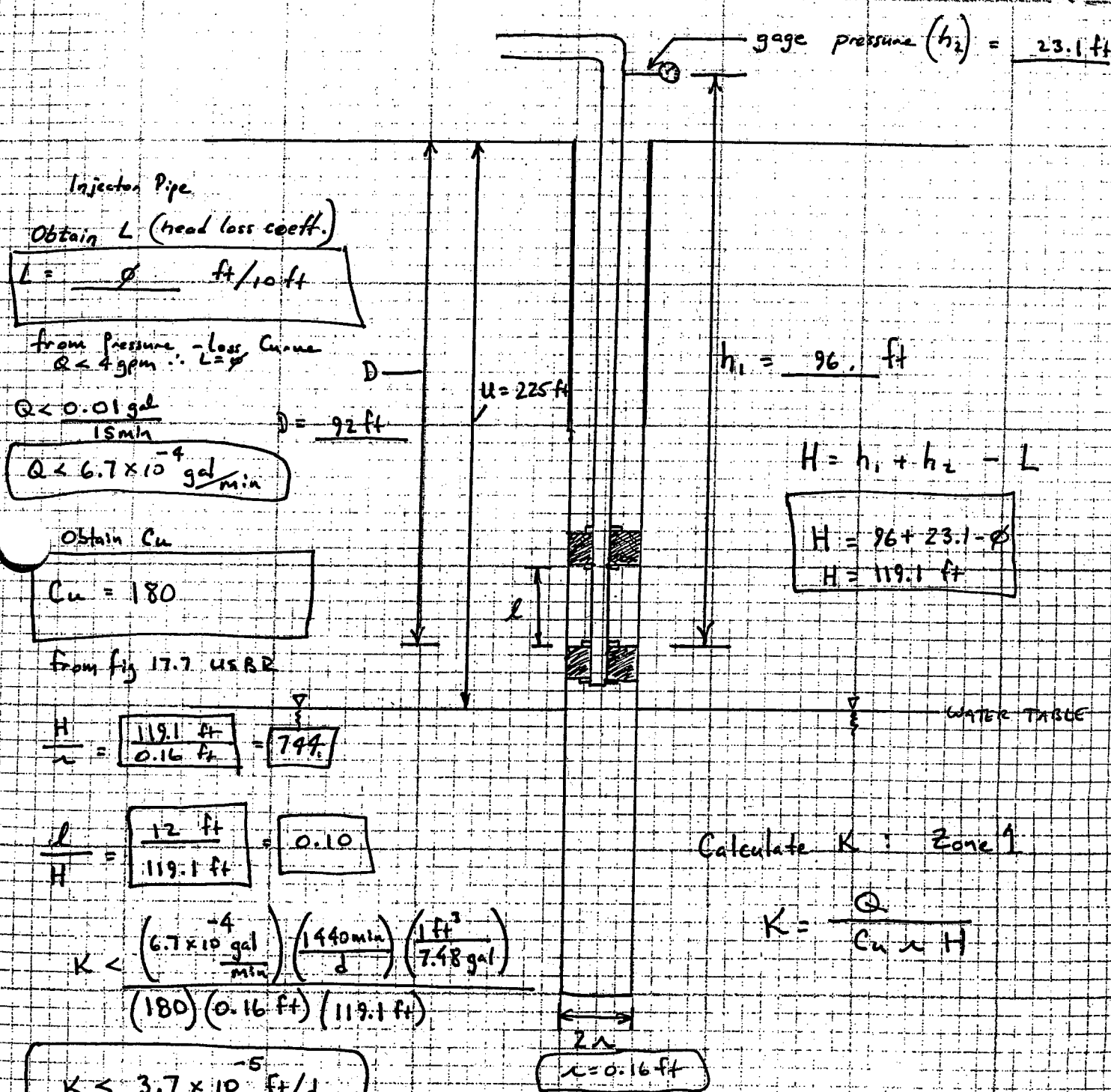
Depth: 80-92 ft

Pressure: 10 psi (23.1 ft)

Packer Test Set-up Sheet

For straddle packer tests in Zone I

- Above water Table -



Stoller

DATE 1-25-06

JOB NAME: Crescent Junction

PREPARED: H. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

BOREHOLE: 204

Depth: 80-92 ft.

Pressure (h_2): 20 psi (46.2 ft)

Unsaturated Zone Calculation:

Definitions: L = length of test section

$$T_u = U - D + H$$

U = Thickness of Unsaturated Material

D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

L = head loss; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100); \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = (225 \text{ ft}) - (92 \text{ ft}) + (142.2 \text{ ft}) = 275.2 \text{ ft}$$

$$\frac{T_u}{L} = \frac{275.2 \text{ ft}}{12 \text{ ft}} \approx 23$$

$$H = h_1 + h_2 - L = 96 \text{ ft} + 46.2 \text{ ft} - 0 = 142.2 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{142.2 \text{ ft}}{275.2 \text{ ft}} (100) \approx 52$$

$$h_1 = D + \text{stickup height} = 92 \text{ ft} + 4 \text{ ft} = 96 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

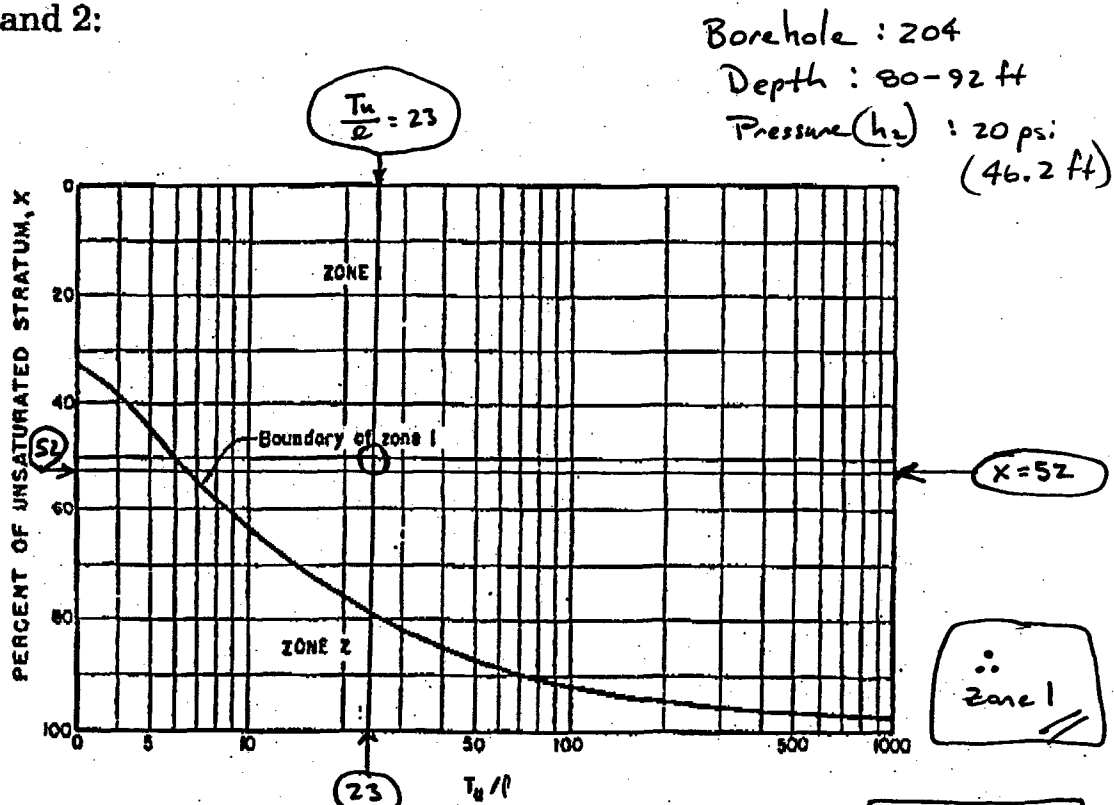


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{\rho} = 23$$

$$X = 52$$

Borehole 204
Depth: 80-92 ft
Pressure: 20 psi

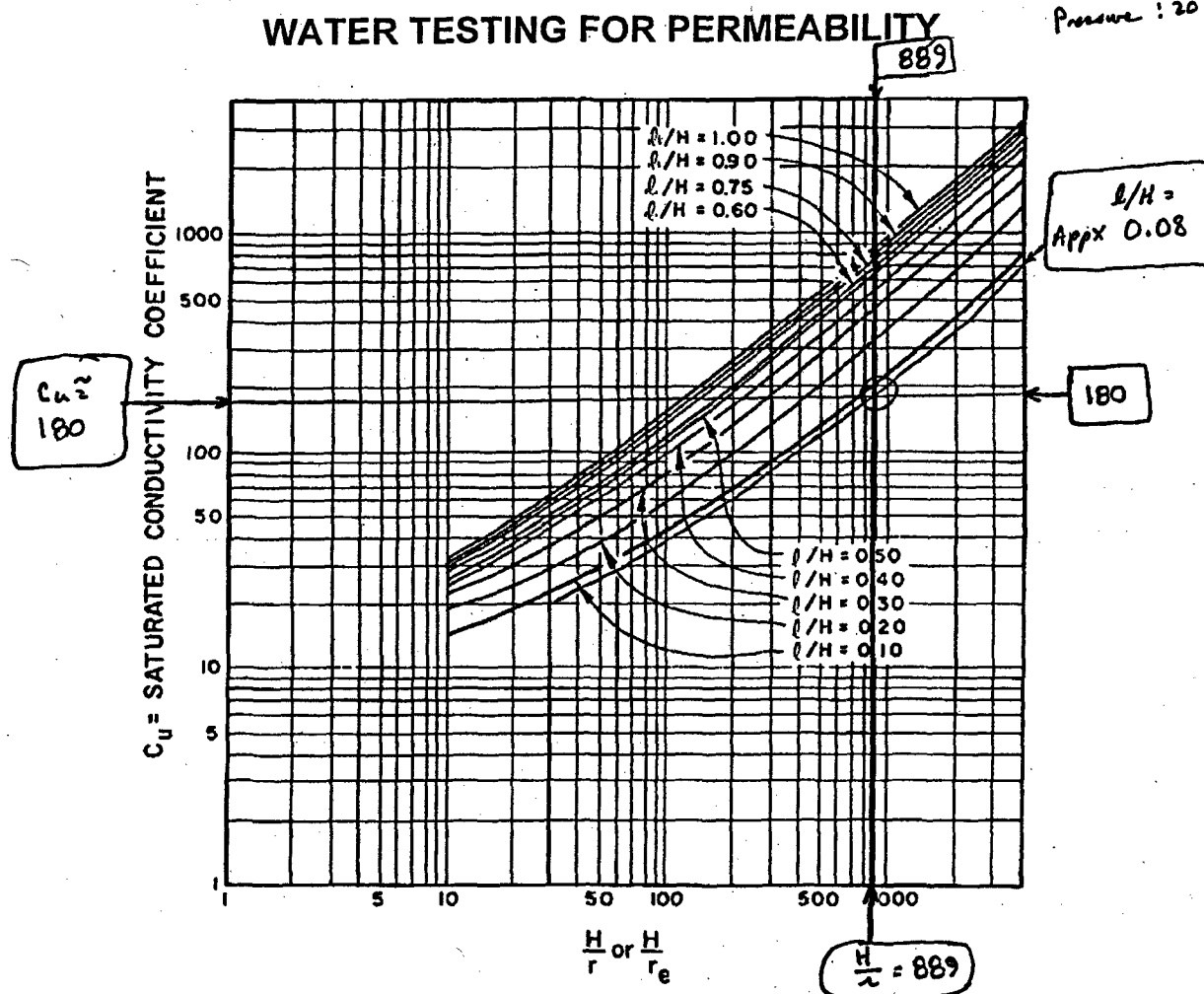


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet.

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

JOB NO. _____ DATE _____

JOB NAME: Crescent Junction site

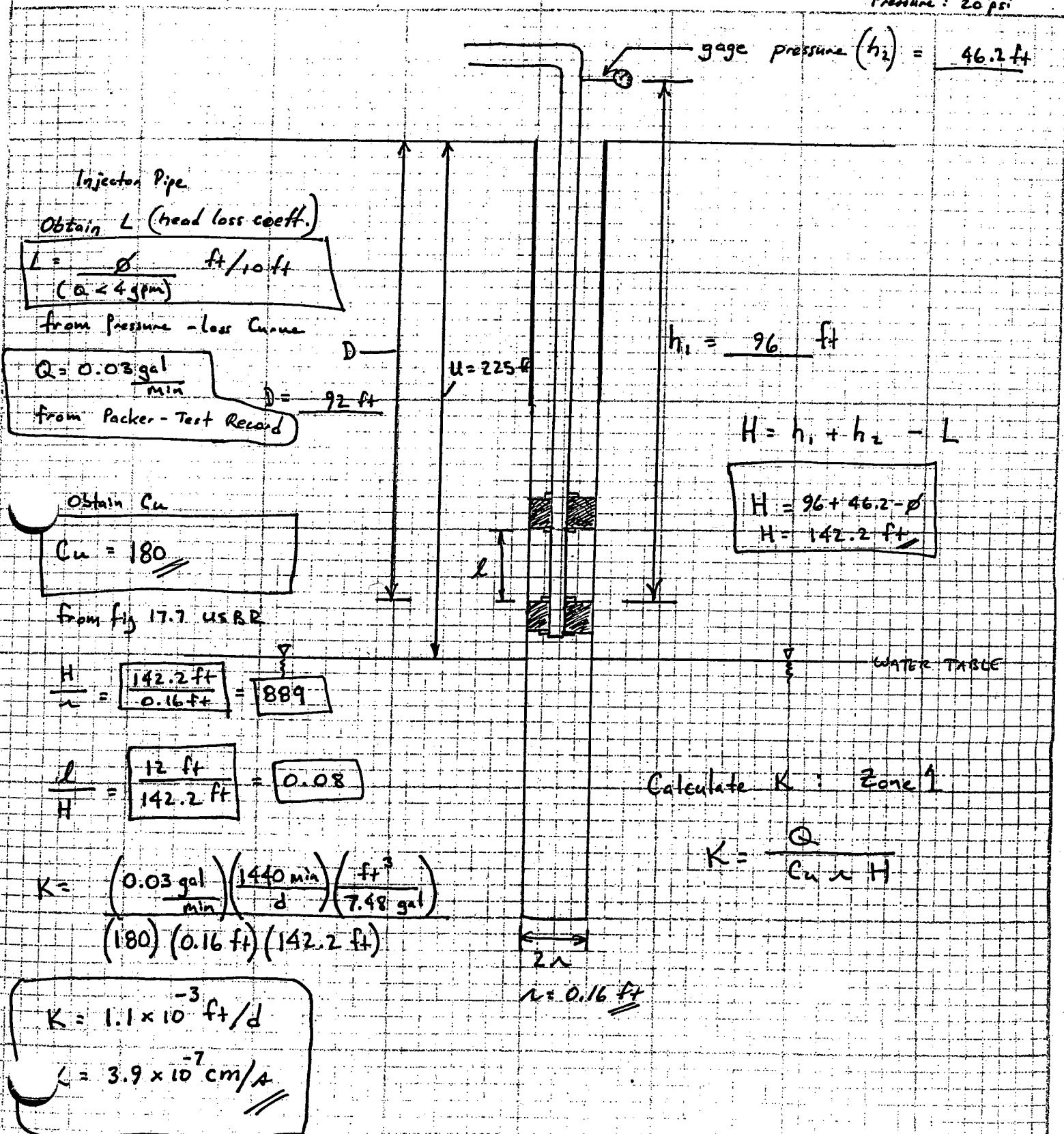
PREPARED: M. Kentsky REVIEWED: _____

SHEET NO. _____ OF _____

Borehole: 204
Depth: 80-92
Pressure: 20 psi

Packer Test Set-up Sheet

For straddle packer tests in Zone 1
- Above water Table -



Soller

DATE

1-23-06

JOB NAME Crescent Junction

PREPARED: M. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

BOREHOLE : 204

Depth : 80-92

Pressure (h_2) : 30psi (69.3 ft)

Unsaturated Zone Calculation:

Definitions: L = length of test section

$$T_u = U - D + H$$

U = Thickness of Unsaturated Material

D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

L = head loss ; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) ; \text{percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = 225 \text{ ft} - 92 \text{ ft} + 165.3 \text{ ft} = 298.3 \text{ ft}$$

$$\frac{T_u}{L} = \frac{298.3 \text{ ft}}{12 \text{ ft}} = \boxed{24.9}$$

$$H = h_1 + h_2 - L = 96 \text{ ft} + 69.3 \text{ ft} = 165.3 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{165.3 \text{ ft}}{298.3 \text{ ft}} (100) = \boxed{55}$$

$$h_1 = D + \text{stick-up height} = 92 \text{ ft} + 4 \text{ ft} = 96 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

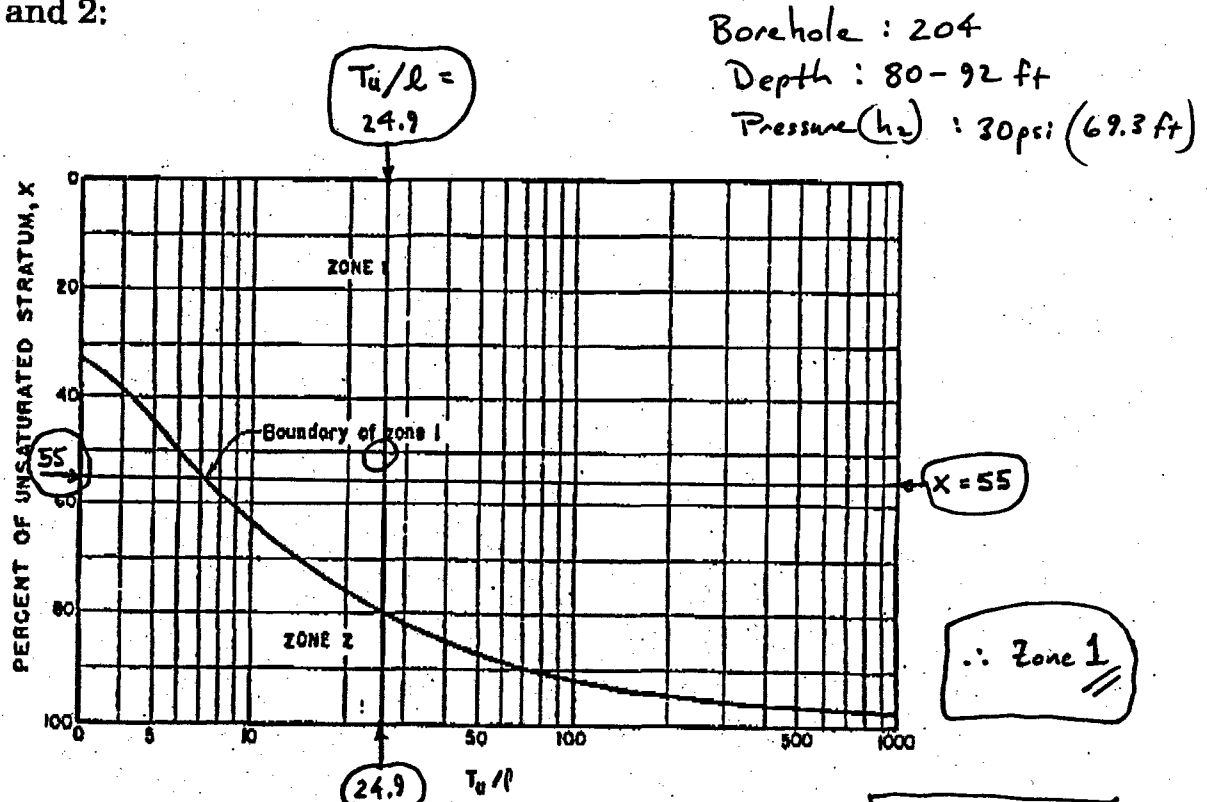


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 24.9$$

$$X = 55$$

Borehole : 204
 Depth : 80-92 ft
 Pressure : 30 psi
 1-23-06

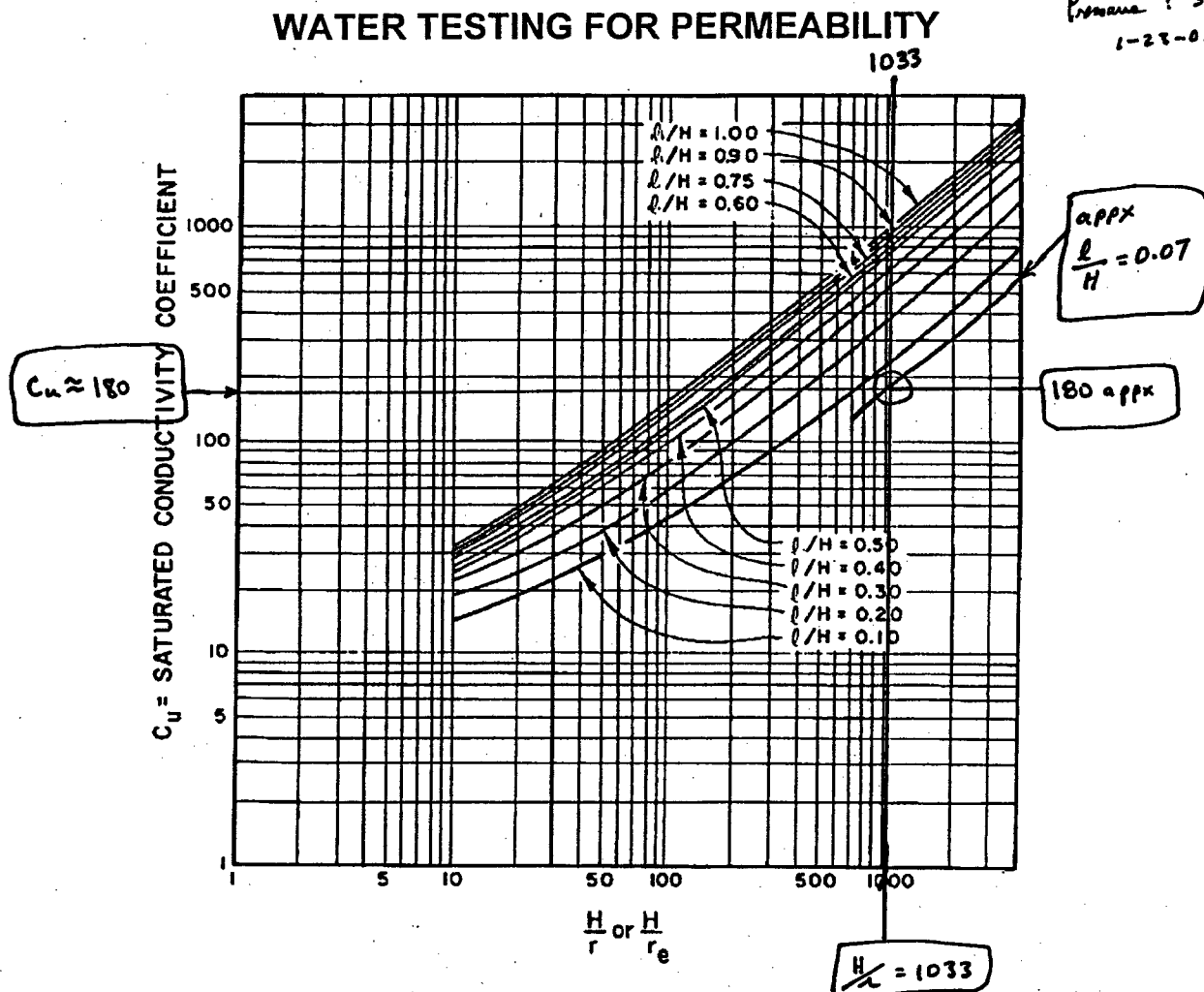


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , l , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

Packer Test Set-up Sheet

For straddle packer tests in Zone I

- Above water Table -

Injector Pipe

Obtain L (head loss coeff.)

$$L = \frac{\phi}{Q < 4 \text{ gpm}} \text{ ft/10 ft}$$

from Pressure - Loss Curve

$$Q < \frac{0.01 \text{ gal}}{15 \text{ min}}$$

$$Q < 6.7 \times 10^{-4} \text{ gal/min}$$

$$D = 92 \text{ ft}$$

$$u = 225 \text{ ft}$$

$$h_1 = 96 \text{ ft}$$

$$H = h_1 + h_2 - L = 96 + 69.3 - 0$$

$$H = 165.3 \text{ ft}$$

Obtain C_u

$$C_u = 180$$

from fig 17.7 USBR

$$\frac{H}{L} = \frac{165.3 \text{ ft}}{0.16 \text{ ft}} = 1033$$

$$\frac{l}{H} = \frac{12 \text{ ft}}{165.3 \text{ ft}} = 0.07$$

$$K < \frac{(6.7 \times 10^{-4} \text{ gal/min}) \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(180) (0.16 \text{ ft}) (165.3 \text{ ft})}$$

$$K < 2.7 \times 10^{-5} \text{ ft/d}$$

$$K < 9.6 \times 10^{-9} \text{ cm/s}$$

Calculate K : Zone 1

$$K = \frac{Q}{C_u L H}$$

$$r = 0.16 \text{ ft}$$

JOB NO.

DATE: 1-25-06

JOB NAME: Crescent Junction Site

PREPARED: Mark Kantak

REVIEWED:

Borehole 204

Depth: 80-92 ft

Pressure: 20 psi (retest)

SHEET NO.

OF

Packer Test Set-Up Sheet

For straddle packer tests in Zone 1
- Above water Table -

Injector Pipe

Obtain L (head loss coeff.)

$$L = \frac{\phi}{Q} \text{ ft/10 ft}$$

($Q < 4 \text{ gal/min}$)

from Pressure-Loss Curve

$$Q = 0.04 \frac{\text{gal}}{\text{min}}$$

per Packer Test Record

$$D = 92 \text{ ft}$$

Obtain C_u

$$C_u = 180$$

from fig 17.7 USBR

$$\frac{H}{L} = 889$$

$$\frac{d}{H} = 0.08$$

$$K = \frac{(0.04 \frac{\text{gal}}{\text{min}}) \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{\text{ft}^3}{7.48 \text{ gal}} \right)}{(180) (0.16 \text{ ft}) (142.2 \text{ ft})}$$

$$K = 1.9 \times 10^{-3} \text{ ft/d}$$

$$K = 6.6 \times 10^{-7} \text{ cm/s}$$

$$\text{gage pressure } (h_2) = 46.2 \text{ ft}$$

$$h_1 = 96 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$H = 142.2 \text{ ft}$$

$$U = 225 \text{ ft}$$

WATER TABLE

Calculate K : Zone 1

$$K = \frac{Q}{C_u \cdot L \cdot H}$$

$$2r$$

$$r = 0.16 \text{ ft}$$

JOB NO.:

DATE: 1-25-06

JOB NAME: Crescent Junction site

PREPARED: M. Kautsky

REVIEWED:

Borehole: 204

Depth: 80-92 ft

Pressure: 10 psi (retest)

SHEET NO.:

OF

Packer Test Set-up Sheet

For straddle packer tests in Zone 1

- Above water Table -

gage pressure (h_2) = 23.1 ft

Injector Pipe

Obtain L (head loss coeff.)

$$L = \frac{d}{Q} \text{ ft/10 ft}$$

($Q < 4 \text{ gal/min}$)

from Pressure - Loss Curve

$$Q < \frac{0.01 \text{ gal}}{15 \text{ min}}$$

$$Q < 6.7 \times 10^{-4} \text{ gal/min}$$

per Packer Test Record

Obtain C_u

$$C_u = 180$$

from fig 17.7 USBR

$$\frac{H}{h} = \frac{119.1 \text{ ft}}{0.16 \text{ ft}} = 744$$

$$\frac{d}{H} = 0.10$$

$$K < \frac{(6.7 \times 10^{-4} \text{ gal/min}) \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(180) (0.16 \text{ ft}) (119.1 \text{ ft})}$$

$$K < 3.7 \times 10^{-5} \text{ ft/d}$$

$$K < 1.3 \times 10^{-8} \text{ cm/s}$$

D

U = 225 ft

$$h_1 = 96 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$H = 119.1 \text{ ft}$$

WATER TABLE

Calculate K : Zone 1

$$K = \frac{Q}{C_u \cdot h \cdot H}$$

2h

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Packer-Test Record

Page 1 of 2

Project Name: Moab-Crescent Jet Characterization Date: 01/13/06 - 01/14/06

Field Representative: R. Rupp Borehole No. 0204 Total Depth: 300 ft.

Depth to Water (TOC): 225 ft Borehole Cleaned? Yes ☒ No ☐ Date: 01/12/06

Test Interval (BGL): from 110 to 122 ft. Swivel/Elbow Height (AGL) 4.0 ft.

Conductor Pipe, Type and Size: 1-inch ID thin wall steel tubing

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>1610</u>	<u>10 psi</u>	<u>39377.1</u>	
<u>1615</u>	<u>10</u>	<u>39377.2</u>	<u>0.02 gpm</u>
<u>1620</u>	<u>10</u>	<u>39377.35</u>	<u>0.03</u>
<u>1625</u>	<u>10</u>	<u>39377.35</u>	<u>0</u>
<u>1630</u>	<u>10</u>	<u>39377.35</u>	<u>0</u>
<u>1635</u>	<u>10</u>	<u>39377.35</u>	<u>0</u>
<u>1640</u>	<u>10</u>	<u>39377.35</u>	<u>0</u>
<u>1641</u>	<u>20 psi</u>	<u>39378.05</u>	
<u>1645</u>	<u>20</u>	<u>39378.4</u>	<u>0.09 gpm</u>
<u>1650</u>	<u>20</u>	<u>39378.55</u>	<u>0.03</u>
<u>1655</u>	<u>20</u>	<u>39378.85</u>	<u>0.06</u>
<u>1700</u>	<u>20</u>	<u>39378.05 Rev</u>	<u>0.04</u>
<u>1705</u>	<u>20</u>	<u>39379.25</u>	<u>0.04</u>
<u>1710</u>	<u>20</u>	<u>39379.3</u>	<u>0.01</u>
<u>1715</u>	<u>20</u>	<u>39379.35</u>	<u>0.01</u>
<u>1720</u>	<u>20</u>	<u>39379.4</u>	<u>0.01</u>
<u>0800</u>	<u>30 psi</u>	<u>39379.05</u>	
<u>0805</u>	<u>30</u>	<u>39379.15</u>	<u>0.02 gpm</u>

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RECORD COPY

established 1959

Packer-Test Record

Page 2 of 2

Project Name: Morb - Crescent Jct Characterization Date: 01/14/06

Field Representative: R. Rupp Borehole No. 0204 Total Depth: 300 ft

Depth to Water (TOC): 225 ft Borehole Cleaned? Yes ☒ No ☐ Date: 01/12/06

Test Interval (BGL): from 110 to 122 ft. Swivel/Elbow Height (AGL) 7.0 ft

Conductor Pipe, Type and Size: 1-inch ID thin wall tubing

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>0810</u>	<u>30 psi</u>	<u>39379.5</u>	<u>0.07 gpm</u>
<u>0815</u>	<u>30</u>	<u>39379.8</u>	<u>0.06</u>
<u>0820</u>	<u>30</u>	<u>39380.1</u>	<u>0.06</u>
<u>0825</u>	<u>30</u>	<u>39380.3</u>	<u>0.04</u>
<u>0830</u>	<u>30</u>	<u>39380.5</u>	<u>0.04</u>
<u>0835</u>	<u>30</u>	<u>39380.7</u>	<u>0.04</u>
<u>0840</u>	<u>20 psi</u>	<u>39380.4</u>	<u>-0.06</u>
<u>0845</u>	<u>20</u>	<u>39380.3</u>	<u>-0.02</u>
<u>0850</u>	<u>20</u>	<u>39380.3</u>	<u>0</u>
<u>0855</u>	<u>20</u>	<u>39380.3</u>	<u>0</u>
<u>0900</u>	<u>10 psi</u>	<u>39379.75</u>	<u>-0.11</u>
<u>0905</u>	<u>10</u>	<u>39378.75</u>	<u>-0.20</u>
<u>0910</u>	<u>10</u>	<u>39378.85</u>	<u>0.02</u>
<u>0915</u>	<u>10</u>	<u>39378.5</u>	<u>-0.07</u>
<u>0920</u>	<u>10</u>	<u>39378.4</u>	<u>-0.02</u>
<u>0925</u>	<u>10</u>	<u>39378.15</u>	<u>-0.05</u>
<u>0930</u>	<u>10</u>	<u>39378.0</u>	<u>-0.03</u>
<u>0935</u>	<u>10</u>	<u>39377.95</u>	<u>-0.01</u>
<u>0940</u>	<u>10</u>	<u>39377.85</u>	<u>-0.02</u>
<u>0945</u>	<u>10</u>	<u>39377.85</u>	<u>0</u>
<u>0950</u>	<u>10</u>	<u>39377.85</u>	<u>0</u>
<u>0955</u>	<u>10</u>	<u>39377.85</u>	<u>0</u>

Stoller

DATE: 1-26-06

JOB NAME: Crescent Junction

PREPARED: M. Kautsky

REVIEWED:

SHEET NO: OF

PACKER TEST ANALYSES

BOREHOLE: 204

Depth: 110-122 ft

Pressure (h_2): 10 psi (23.1 ft)

Unsaturated Zone Calculation:

Definitions:

L = length of test section

$T_u = U - D + H$

U = Thickness of Unsaturated Material

D = distance from ground surface to bottom of test section

$H = h_1 + h_2 - L$

L = head loss; ignore if $Q < 4$ gpm

$X = \frac{H}{T_u} (100)$; percent unsaturated material

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = (225 \text{ ft}) - (122 \text{ ft}) + (149.1 \text{ ft}) = 252.1 \text{ ft}$$

$$\frac{T_u}{L} = \frac{252.1 \text{ ft}}{12 \text{ ft}} = \boxed{21}$$

$$H = h_1 + h_2 - L = 126 \text{ ft} + 23.1 \text{ ft} - 0 = 149.1 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{149.1 \text{ ft}}{252.1 \text{ ft}} (100) = \boxed{59}$$

$$h_1 = 122 \text{ ft} + 4 \text{ ft} = 126 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

1-26-06

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

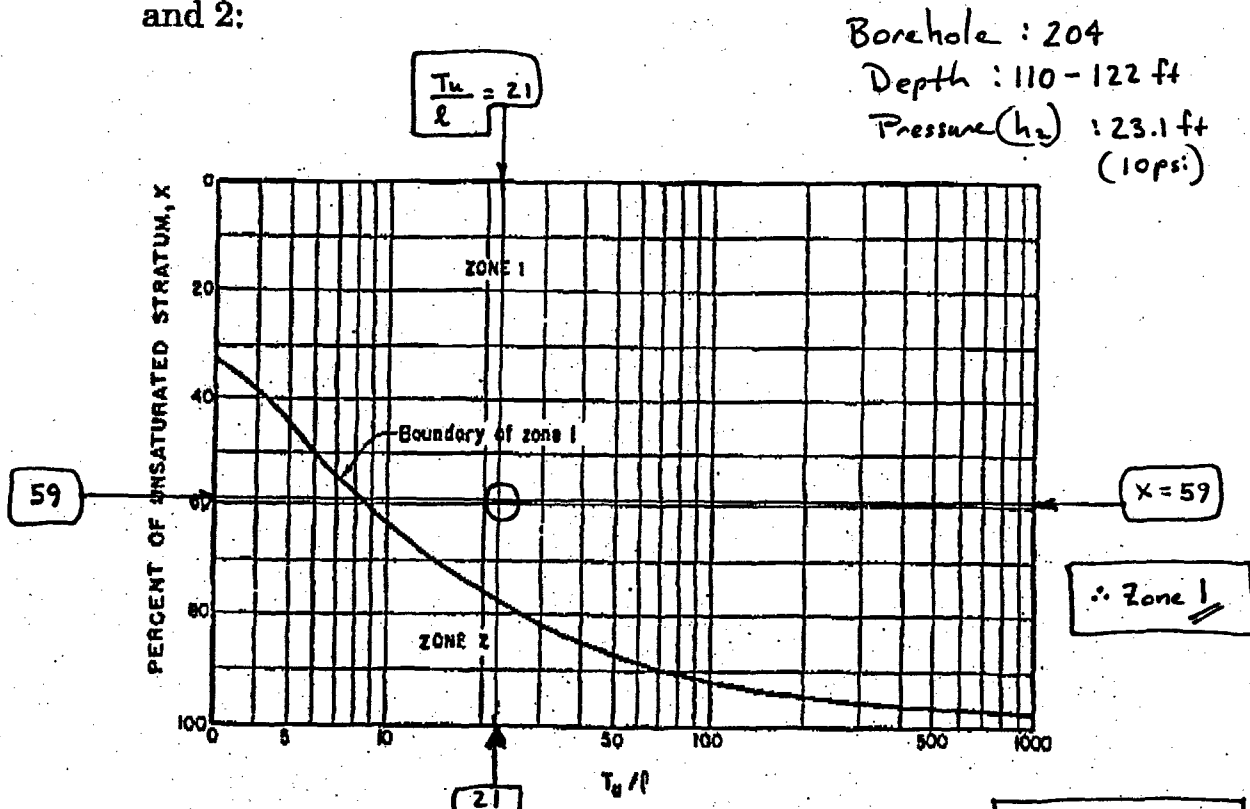


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{\ell} = 21$$

$$X = 59$$

WATER TESTING FOR PERMEABILITY

$$app \approx \frac{H}{L} = 932$$

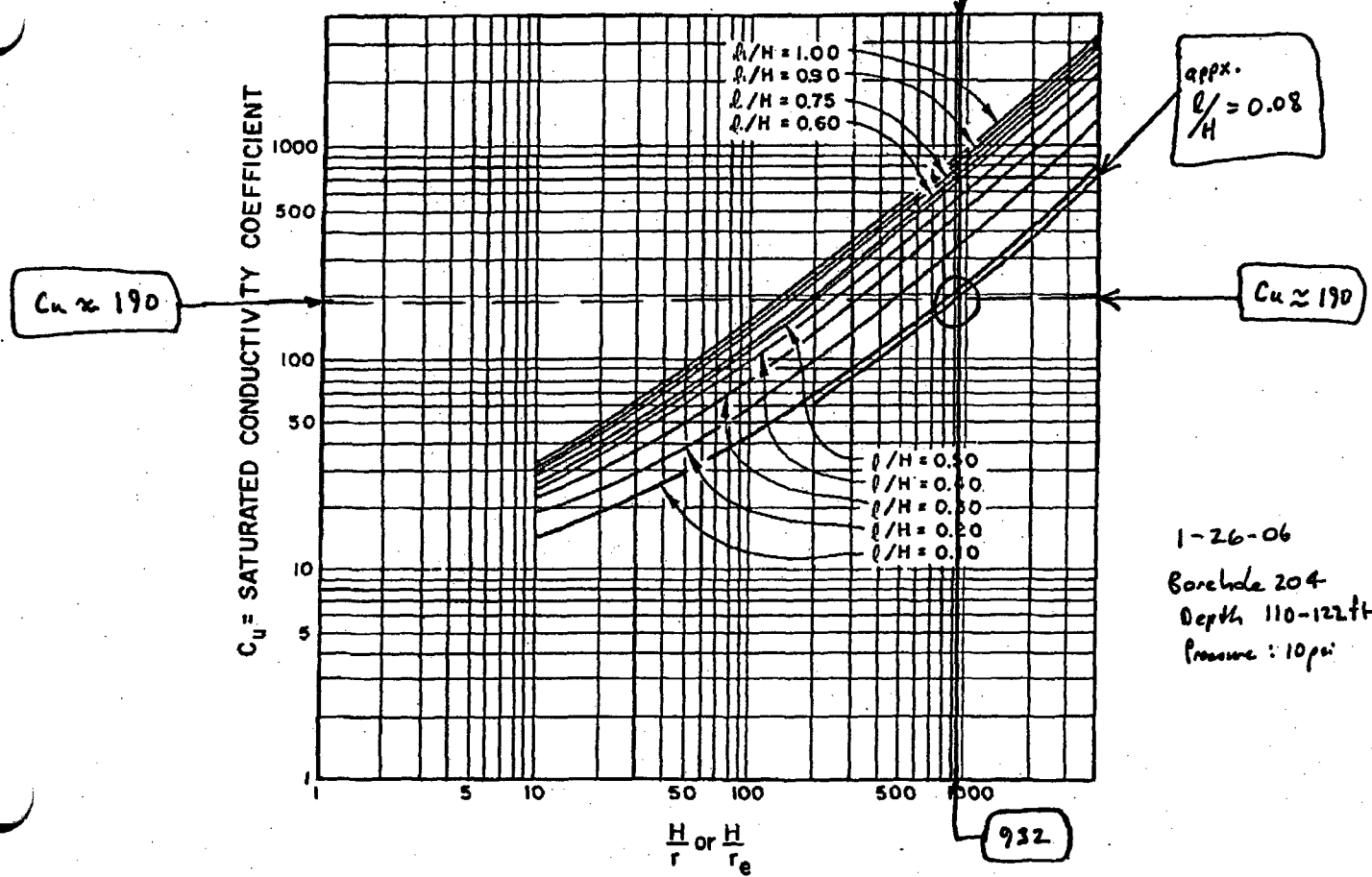


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , l , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

JOB NO.:

DATE: 1-26-06

JOB NAME: Crescent Junction site

PREPARED: M. Kautsky

REVIEWED:

Borehole 204

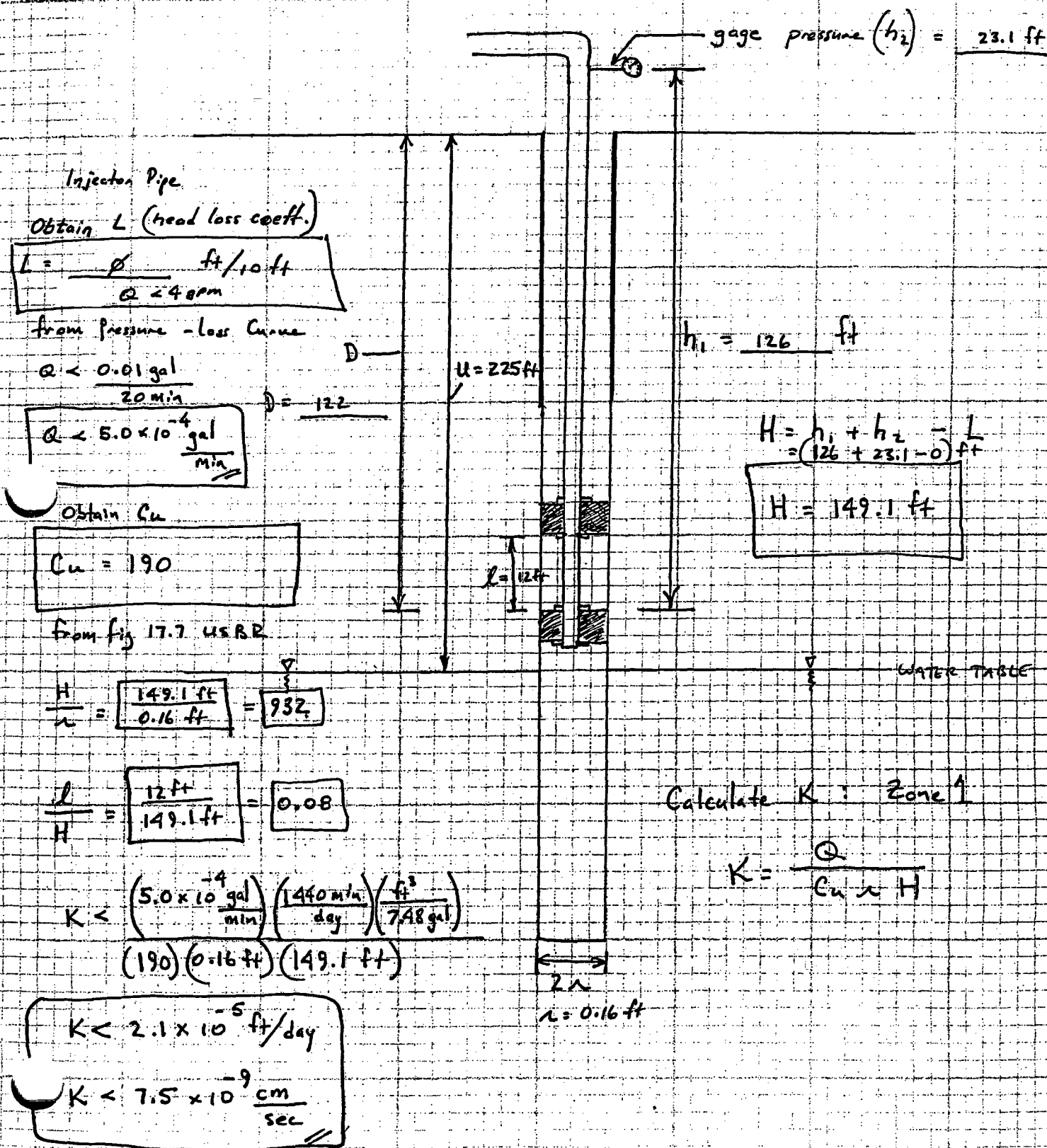
Depth: 110-122 ft.

SHEET NO.:

OF

Pressure: 10 psi

Packer Test Set-up Sheet For straddle packer tests in Zone 1 - Above water Table -



JOB NAME Crescent Junction

PREPARED: H. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSIS

BOREHOLE: 204

Depth: 110 - 122 ft

Pressure (h_2): 20 psi (46.2 ft)

Unsaturated Zone Calculation:

Definitions:

 L = length of test section $T_u = u - D + H$ u = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section $H = h_1 + h_2 - L$ L = head loss; ignore if $Q < 4$ gpm $X = \frac{H}{T_u} (100)$; percent unsaturated material

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = u - D + H = (225 \text{ ft}) - (122 \text{ ft}) + (172.2 \text{ ft}) = 275.2 \text{ ft}$$

$$\frac{T_u}{L} = \frac{275.2 \text{ ft}}{12 \text{ ft}} = \boxed{23}$$

$$H = h_1 + h_2 - L = (126 \text{ ft}) + (46.2 \text{ ft}) - 0 = 172.2 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{172.2 \text{ ft}}{275.2 \text{ ft}} (100) = \boxed{63}$$

$$h_1 = 122 \text{ ft} + 4 \text{ ft} = 126 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2: 1-26-06

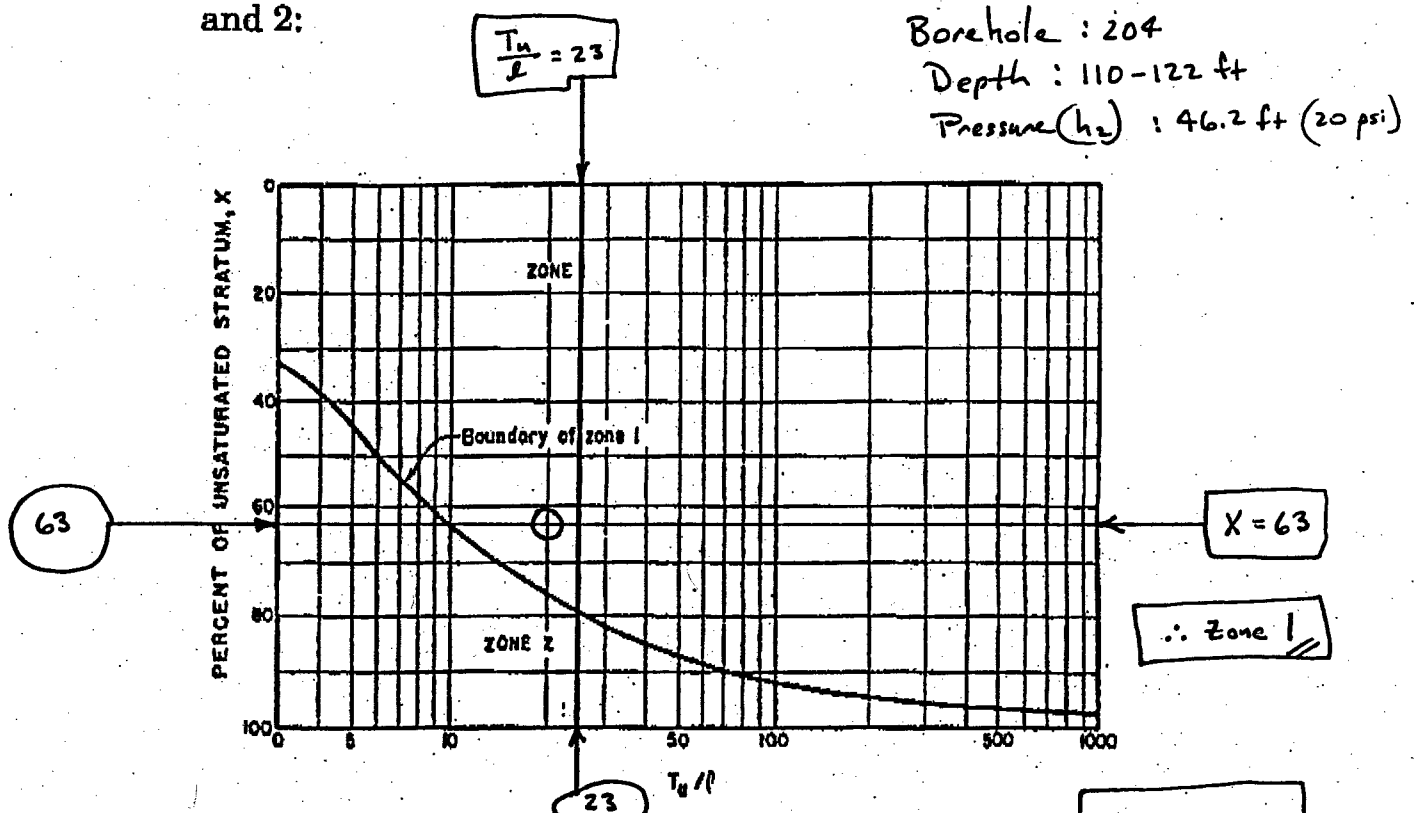


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 23$$

$$X = 63$$

1-26-06
 Batch 204
 Depth 110-122
 pressure 20 psi

WATER TESTING FOR PERMEABILITY

$$\frac{H}{L} = 1076$$

$$\text{Appx } \frac{\ell}{H} = 0.07$$

$$C_u \approx 270$$

$$C_u \approx 270$$

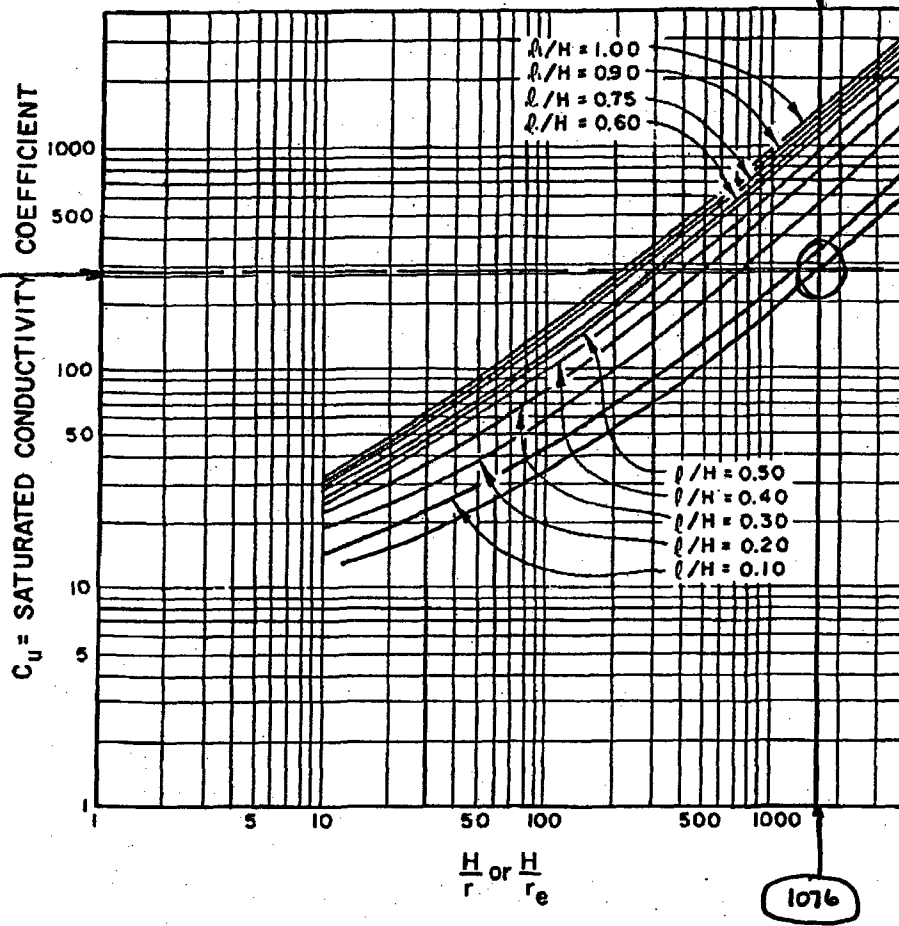


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , ℓ , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

JOB NO. _____ DATE: 1-26-06

JOB NAME: Crescent Junction site

PREPARED: M. Kautsky

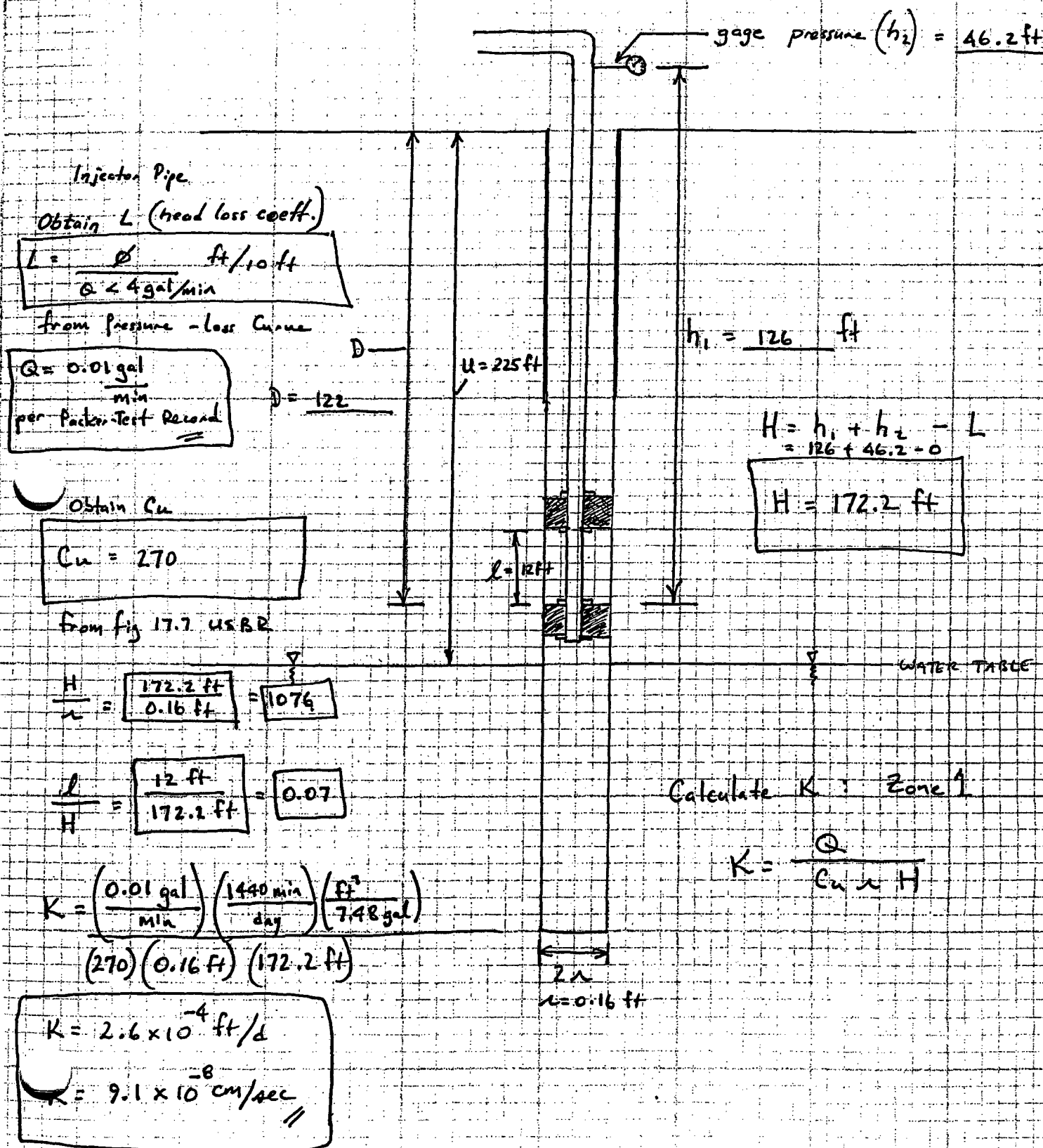
REVIEWED: _____

Borehole: 204

SHEET NO. _____ OF _____

Depth: 110-122 ft
pressure: 20 psi

Packer Test Set-up Sheet For straddle packer tests in Zone I - Above water Table -



Stoller

FORM NO. DATE 1-26-06

JOB NAME: Crescent Junction

PREPARED: M. Kautsky REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

BOREHOLE: 204

Depth: 110-122 ft

Pressure (h_2): 30 psi 69.3 ftUnsaturated Zone Calculation:Definitions: L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100); \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = 225 \text{ ft} - 122 \text{ ft} + 195.3 \text{ ft} = 298 \text{ ft}$$

$$\frac{T_u}{L} = \frac{298 \text{ ft}}{12 \text{ ft}} = \boxed{25}$$

$$H = h_1 + h_2 - L = 126 \text{ ft} + 69.3 \text{ ft} - 0 = 195.3 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{195.3 \text{ ft}}{298 \text{ ft}} (100) = \boxed{65}$$

$$h_1 = 122 \text{ ft} + 4 \text{ ft} = 126 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 204
Depth : 110-122
Pressure (h_2) : 30 psi (69.3 ft)

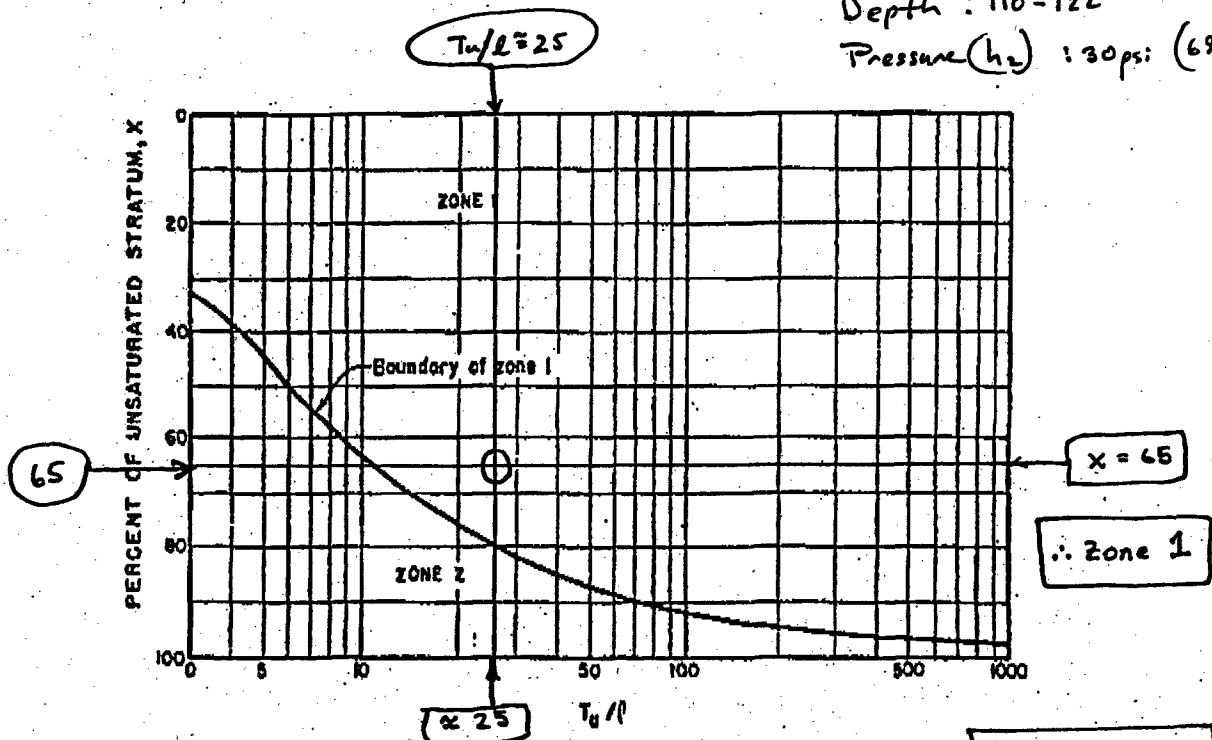


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 25$$

$$X = 65$$

WATER TESTING FOR PERMEABILITY

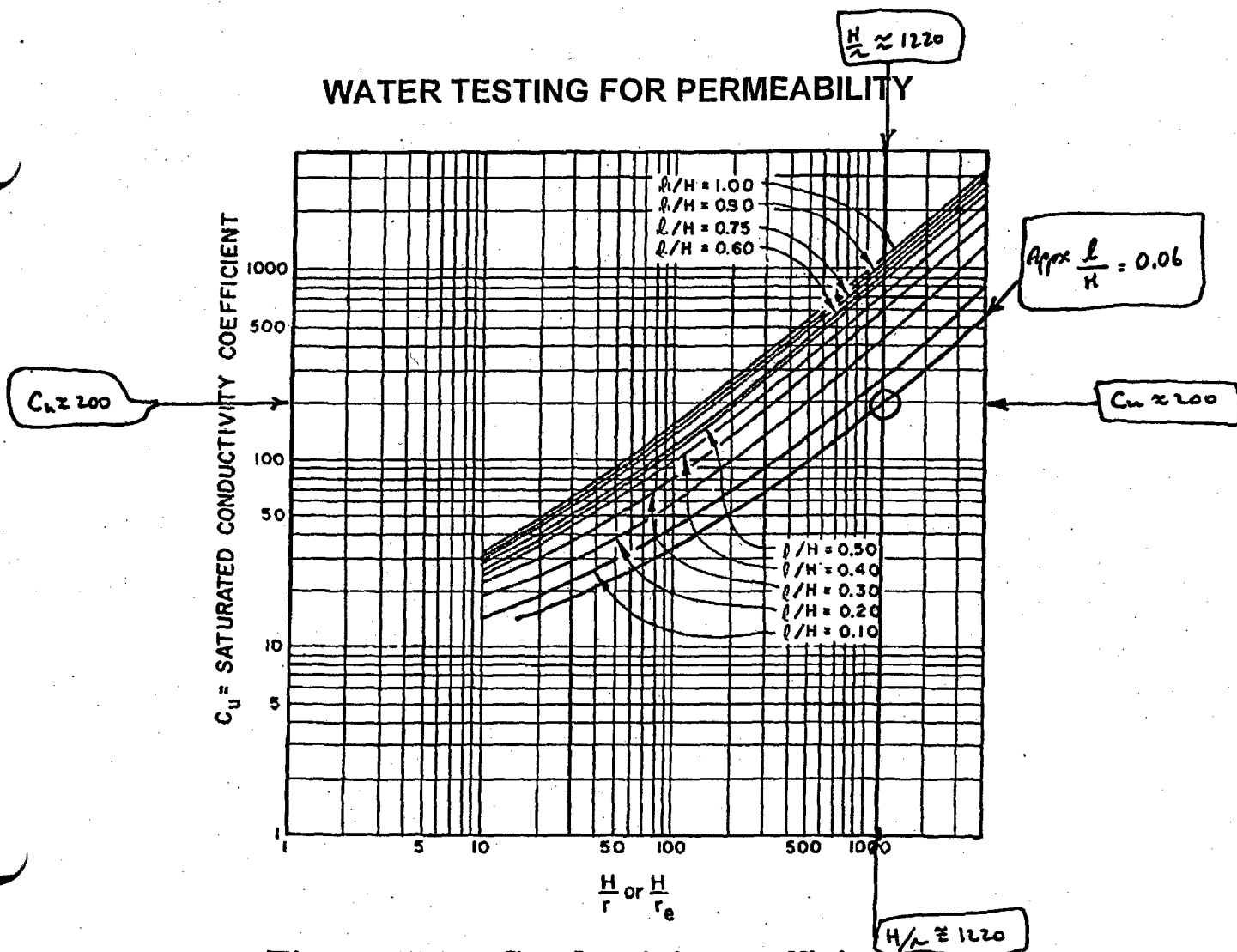


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , l , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

JOB NO. _____ DATE: 1-26-06

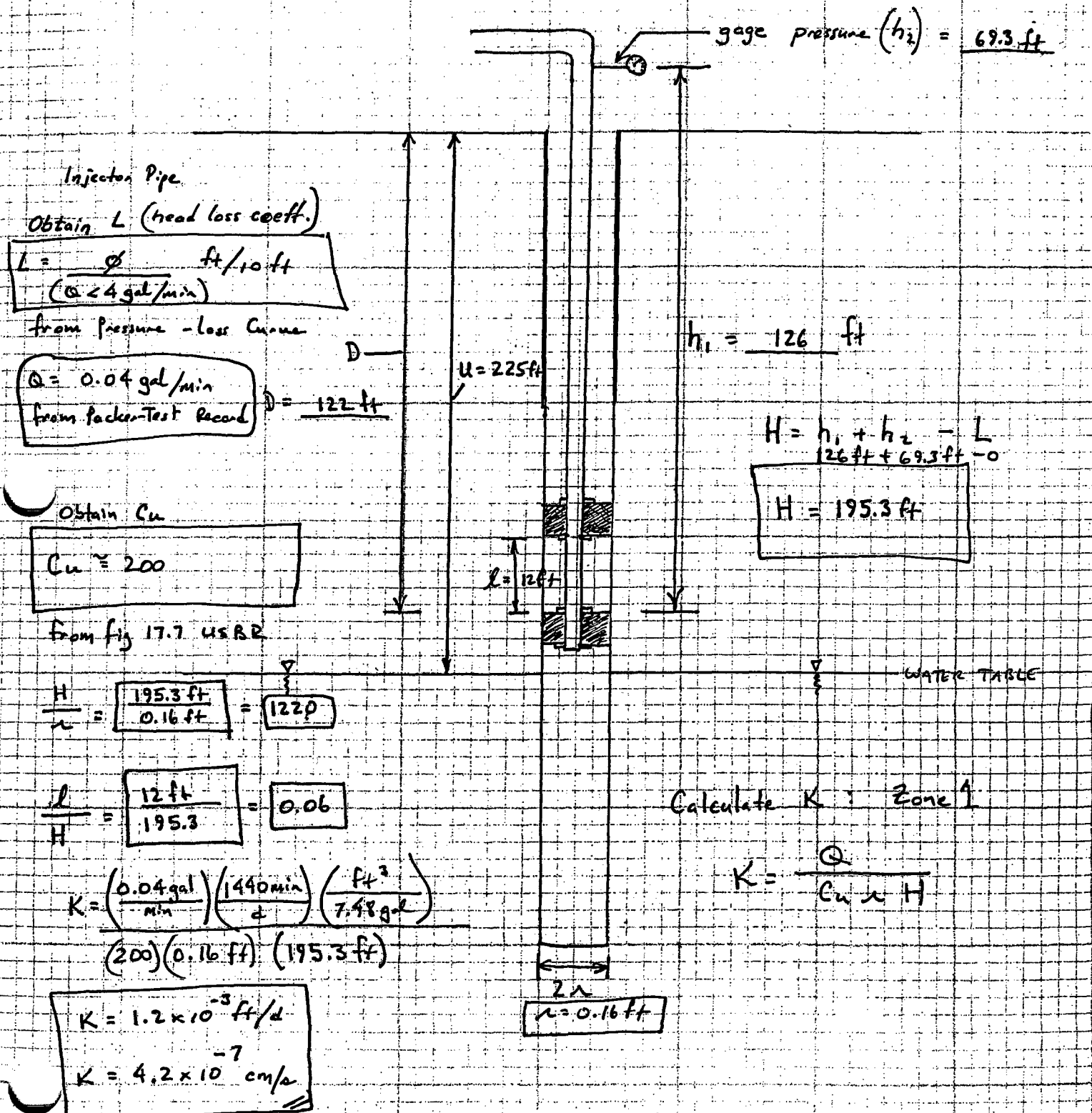
JOB NAME: Crescent Junction Site

PREPARED: M. Kautsky

Boreshole 204
Depth: 110-122 ft
Pressure: 30 psi

SHEET NO. _____ OF _____

Packer Test Set-up Sheet For straddle packer tests in Zone I - Above water Table -



JOB NO.

DATE: 1-26-06

JOB NAME: Crescent Junction site

PREPARED: M. Kautsky

REVIEWED:

Borehole: 204

SHEET NO.

OF

Depth: 110-122

pressure: 20 psi (ref test)

Packer Test Set-up Sheet

For straddle packer tests in Zone I
- Above water Table -gage pressure (h_2) = 46.2 ft.

Injector Pipe

Obtain L (head loss coeff.)

$$L = \frac{\phi}{Q} \text{ ft/10 ft}$$

$Q < 4 \text{ gpm}$

from Pressure - Loss Curve

$$Q < 0.1 \text{ gal/10 min}$$

per packer test Record

$$Q < 0.1 \text{ gal/min}$$

$$D = 122$$

$$U = 225 \text{ ft}$$

$$h_1 = 126 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$= 126 \text{ ft} + 46.2 \text{ ft} - 0$$

$$H = 172.2 \text{ ft.}$$

Obtain C_u

$$C_u = 270$$

from fig 17.7 USBR

$$\frac{H}{r} = \frac{172.2 \text{ ft}}{0.16 \text{ ft}} = 1076$$

$$\frac{d}{H} = \frac{12 \text{ ft}}{172.2 \text{ ft}} = 0.07$$

$$K < \left(\frac{0.01 \text{ gal}}{\text{min}} \right) \left(\frac{1440 \text{ min}}{\text{day}} \right) \left(\frac{\text{ft}^3}{7.48 \text{ gal}} \right)$$

$$270 (0.16 \text{ ft}) (172.2 \text{ ft})$$

$$K < 2.6 \times 10^{-4} \text{ ft/d}$$

$$K < 9.1 \times 10^{-8} \text{ cm/s}$$

Calculate K : Zone 1

$$K = \frac{Q}{C_u r H}$$

$$2r \approx 0.16 \text{ ft}$$

JOB NO.

DATE: 1-26-06

JOB NAME: Crescent Junction site

PREPARED: M. Kantsky

REVIEWED:

Borehole 204

Depth: 110-122 ft.

Pressure: 10 psi (retest)

SHEET NO.

OF

Stoller

Packer Test Set-Up Sheet

For straddle packer tests in Zone I

- Above water Table -

gage pressure (h_2) = 23.1 ft

Injector Pipe

Obtain L (head loss coeff.)

$$L = \frac{\phi}{Q} \text{ ft/10 ft}$$

$Q \leq 4 \text{ gpm}$

from Pressure - loss Curve

$$Q < 0.01 \frac{\text{gal}}{20 \text{ min}}$$

$$Q < 5.0 \times 10^{-4} \frac{\text{gal}}{\text{min}}$$

Obtain C_u

$$C_u = 190$$

From fig 17.7 USBR

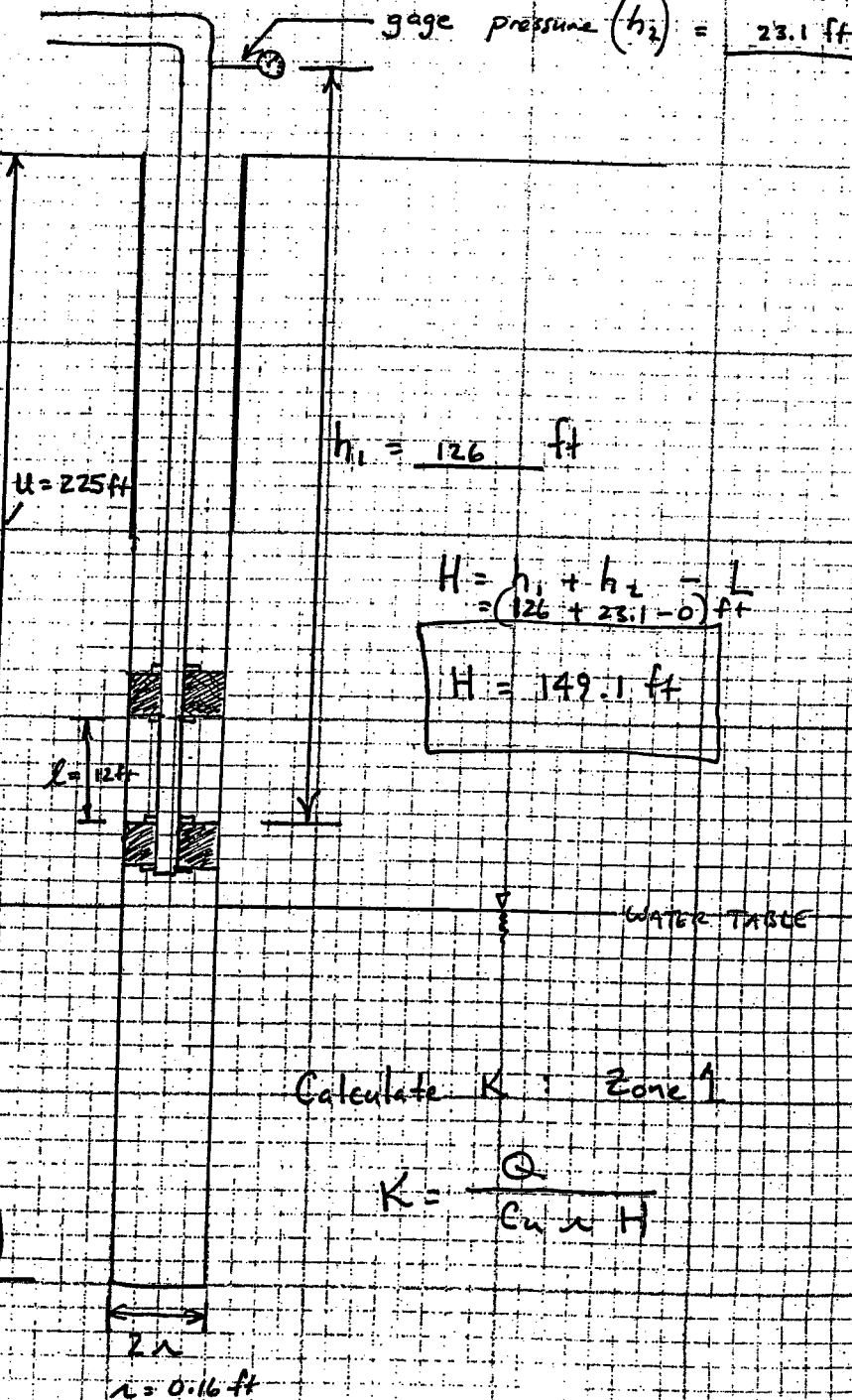
$$\frac{H}{r} = \frac{149.1 \text{ ft}}{0.16 \text{ ft}} = 932$$

$$\frac{l}{H} = \frac{12 \text{ ft}}{149.1 \text{ ft}} = 0.08$$

$$K < \frac{(5.0 \times 10^{-4} \frac{\text{gal}}{\text{min}}) (1440 \frac{\text{min}}{\text{day}}) (\frac{\text{ft}^3}{7.48 \text{ gal}})}{(190) (0.16 \text{ ft}) (149.1 \text{ ft})}$$

$$K < 2.1 \times 10^{-5} \text{ ft/day}$$

$$K < 7.5 \times 10^{-9} \frac{\text{cm}}{\text{sec}}$$

Calculate K : Zone 1

$$K = \frac{Q}{C_u r H}$$

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Packer-Test Record

Page 1 of 3

Project Name: Moab-Crescent Jet characterization Date: 01/13/06

Field Representative: R. Rupp Borehole No. 0204 Total Depth: 300 ft

Depth to Water (TOC): 225 ft Borehole Cleaned? Yes ☒ No ☐ Date: 01/12/06

Test Interval (BGL): from 283 to 295 ft. Swivel/Elbow Height (AGL) 2.0 ft.

Conductor Pipe, Type and Size: 1 inch ID thin wall steel tubing

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>0953</u>	<u>5 psi</u>	<u>39344.4</u>	
<u>0958</u>	<u>5</u>	<u>39344.4</u>	<u>0</u>
<u>1003</u>	<u>5</u>	<u>39344.4</u>	<u>0</u>
<u>1008</u>	<u>5</u>	<u>39344.4</u>	<u>0</u>
<u>1013</u>	<u>5</u>	<u>39344.4</u>	<u>0</u>
<u>1015</u>	<u>10 psi</u>	<u>39345.2</u>	
<u>1020</u>	<u>10</u>	<u>39345.2</u>	<u>0</u>
<u>1025</u>	<u>10</u>	<u>39345.25</u>	<u>0.01 gpm</u>
<u>1030</u>	<u>10</u>	<u>39345.45</u>	<u>0.04</u>
<u>1035</u>	<u>10</u>	<u>39345.7</u>	<u>0.05</u>
<u>1040</u>	<u>10</u>	<u>39346.05</u>	<u>0.07</u>
<u>1045</u>	<u>10</u>	<u>39346.30</u>	<u>0.05</u>
<u>1050</u>	<u>10</u>	<u>39346.6</u>	<u>0.06</u>
<u>1055</u>	<u>10</u>	<u>39346.85</u>	<u>0.05</u>
<u>1100</u>	<u>10</u>	<u>39347.2</u>	<u>0.07</u>
<u>1105</u>	<u>10</u>	<u>39347.4</u>	<u>0.04</u>
<u>1110</u>	<u>10</u>	<u>39347.7</u>	<u>0.06</u>
<u>1115</u>	<u>10</u>	<u>39348.05</u>	<u>0.07</u>
<u>1120</u>	<u>10</u>	<u>39348.45</u>	<u>0.08</u>
<u>1125</u>	<u>10</u>	<u>39348.8</u>	<u>0.07</u>
<u>1130</u>	<u>10</u>	<u>39349.1</u>	<u>0.06</u>
<u>1135</u>	<u>10</u>	<u>39349.45</u>	<u>0.07</u>

(4-110)

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Packer-Test Record

Page 2 of 3

Project Name: MOCK - CONCRETE SET CHANGING Date: 01/13/06

Field Representative: R. RUPP Borehole No. 0204 Total Depth: 300'

Depth to Water (TOC): 225' Borehole Cleaned? Yes ☒ No ☐ Date: 01/12/06

Test Interval (BGL): from 283 to 295 ft. Swivel/Elbow Height (AGL) 2.0 ft.

Conductor Pipe, Type and Size: 1-inch ID Thin WALL STEEL TUBING

	Time	Gauge Pressure	Flow Meter Reading	Flow Rate
	<u>1140</u>	<u>20 psi</u>	<u>39349.85</u>	<u>0.08 gpm</u>
	<u>1145</u>	<u>20</u>	<u>39349.85</u>	<u>0</u>
	<u>1150</u>	<u>20</u>	<u>39349.85</u>	<u>0</u>
	<u>1155</u>	<u>20</u>	<u>39349.85</u>	<u>0</u>
<u>Adjust Valves</u>	<u>1200</u>	<u>20</u>	<u>39350.04</u>	
<u>adjust valves</u>	<u>1205</u>	<u>20</u>	<u>39351.2</u>	
	<u>1210</u>	<u>20</u>	<u>39351.75</u>	<u>0.11 gpm</u>
	<u>1215</u>	<u>20</u>	<u>39352.35</u>	<u>0.12</u>
	<u>1220</u>	<u>20</u>	<u>39353.0</u>	<u>0.13</u>
<u>10 min →</u>	<u>1230</u>	<u>20</u>	<u>39354.4</u>	<u>0.14</u>
	<u>1235</u>	<u>20</u>	<u>39355.1</u>	<u>0.14</u>
	<u>1240</u>	<u>20</u>	<u>39355.95</u>	<u>0.17</u>
	<u>1245</u>	<u>20</u>	<u>39356.70</u>	<u>0.15</u>
	<u>1250</u>	<u>20</u>	<u>39357.60</u>	<u>0.18</u>
	<u>1255</u>	<u>20</u>	<u>39358.40</u>	<u>0.16</u>
	<u>1300</u>	<u>20</u>	<u>39359.1</u>	<u>0.14</u>
	<u>1305</u>	<u>20</u>	<u>39360.0</u>	<u>0.18</u>
	<u>1310</u>	<u>20</u>	<u>39360.8</u>	<u>0.16</u>
	<u>1315</u>	<u>20</u>	<u>39361.55</u>	<u>0.15</u>
	<u>1320</u>	<u>20</u>	<u>39362.4</u>	<u>0.17</u>
	<u>1325</u>	<u>20</u>	<u>39363.25</u>	<u>0.17</u>
	<u>1330</u>	<u>20</u>	<u>39364.1</u>	<u>0.17</u>

(A-111)

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Packer-Test Record

Page 3 of 3

Project Name: Mock-Cement Jet Driveterm. in Date: 01/13/86

Field Representative: R. Rupp Borehole No. 0204 Total Depth: 300'

Depth to Water (TOC): 225' Borehole Cleaned? Yes ☒ No ☐ Date: 01/12/86

Test Interval (BGL): from 283 to 295 ft. Swivel/Elbow Height (AGL) 2.0'

Conductor Pipe, Type and Size: 1" ID Thin Wall Steel Tubing

	Time	Gauge Pressure	Flow Meter Reading	Flow Rate
Adjust Valves	<u>1335</u>	<u>10 psi</u>	<u>39364.0</u>	<u> </u>
	<u>1340</u>	<u>10</u>	<u>39364.0</u>	<u>-0</u>
Adjust Valves	<u>1345</u>	<u>10</u>	<u>39364.1</u>	<u>0.02 gpm</u>
	<u>1350</u>	<u>10</u>	<u>39364.1</u>	<u>-0</u>
	<u>1355</u>	<u>10</u>	<u>39364.1</u>	<u>-0</u>
	<u>1400</u>	<u>10</u>	<u>39364.1</u>	<u>-0</u>
	<u>1405</u>	<u>5</u>	<u>39364.0</u>	<u>-0</u>
	<u>1410</u>	<u>5</u>	<u>39364.0</u>	<u>-0</u>
	<u>1415</u>	<u>5</u>	<u>39364.0</u>	<u>-0</u>
	<u>1420</u>	<u>5</u>	<u>39364.0</u>	<u>-0</u>
	<u> </u>	<u> </u>	<u> </u>	<u> </u>
	<u> </u>	<u> </u>	<u> </u>	<u> </u>
	<u> </u>	<u> </u>	<u> </u>	<u> </u>
	<u> </u>	<u> </u>	<u> </u>	<u> </u>
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FIELD MANUAL

1-27-06
Crescent Junction Site.
Borehole 204
Depth 283-295
All pressures

$$T_u = 75 - 65 + 125.1 = 135.1 \text{ feet}$$

$$X = \frac{125.1}{135.1} (100) = 92.6\% \text{ also } \frac{T_u}{l} = \frac{135.1}{10} = 13.5$$

The test section is located in zone 2 (figure 17-6). To determine the saturated conductivity coefficient, C_s , from figure 17-8:

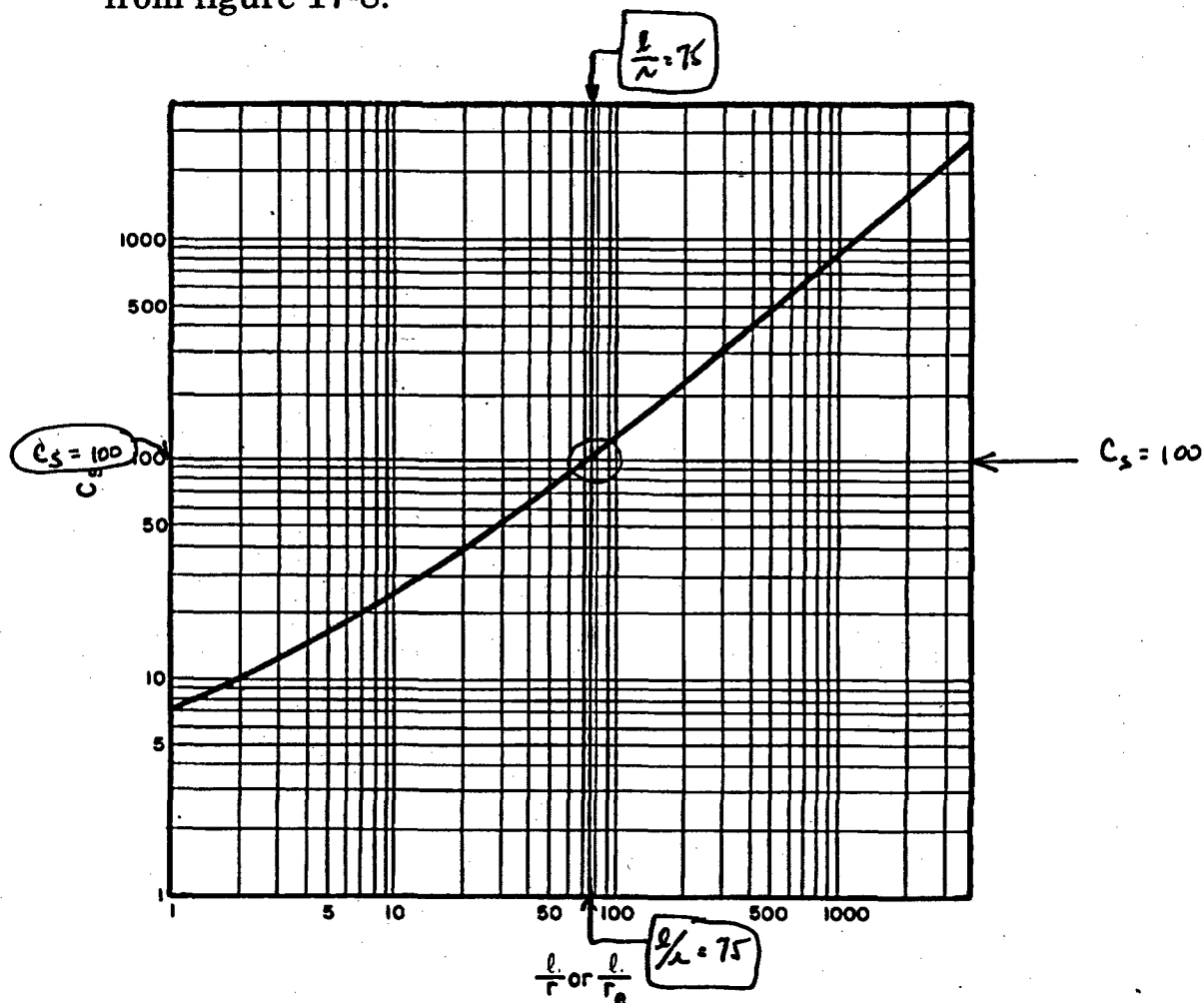


Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.

Stoller

For Straddle Packer Tests below water table
zone 3; Method 2 USBR

JOB NO.: _____ DATE: 1-27-06

JOB NAME: Crescent Junction Site

PREPARED: M. Kautsky

REVIEWED: _____

SHEET NO.: _____ OF _____

Borehole 204
Depth 283-295
Pressure: 5 psi

Obtain L from
pressure-loss curve
if $Q > 4 \text{ gpm}$

$$L = \boxed{\emptyset}$$

$Q < 4 \text{ gpm}$

$$Q < \frac{0.01 \text{ gal}}{20 \text{ min}}$$

$$Q < 5 \times 10^{-4} \text{ gal/min}$$

$$D = \boxed{295 \text{ ft}}$$

$$H = h_1 + h_2 - L$$

$$H = 227 + 11.6 - \emptyset$$

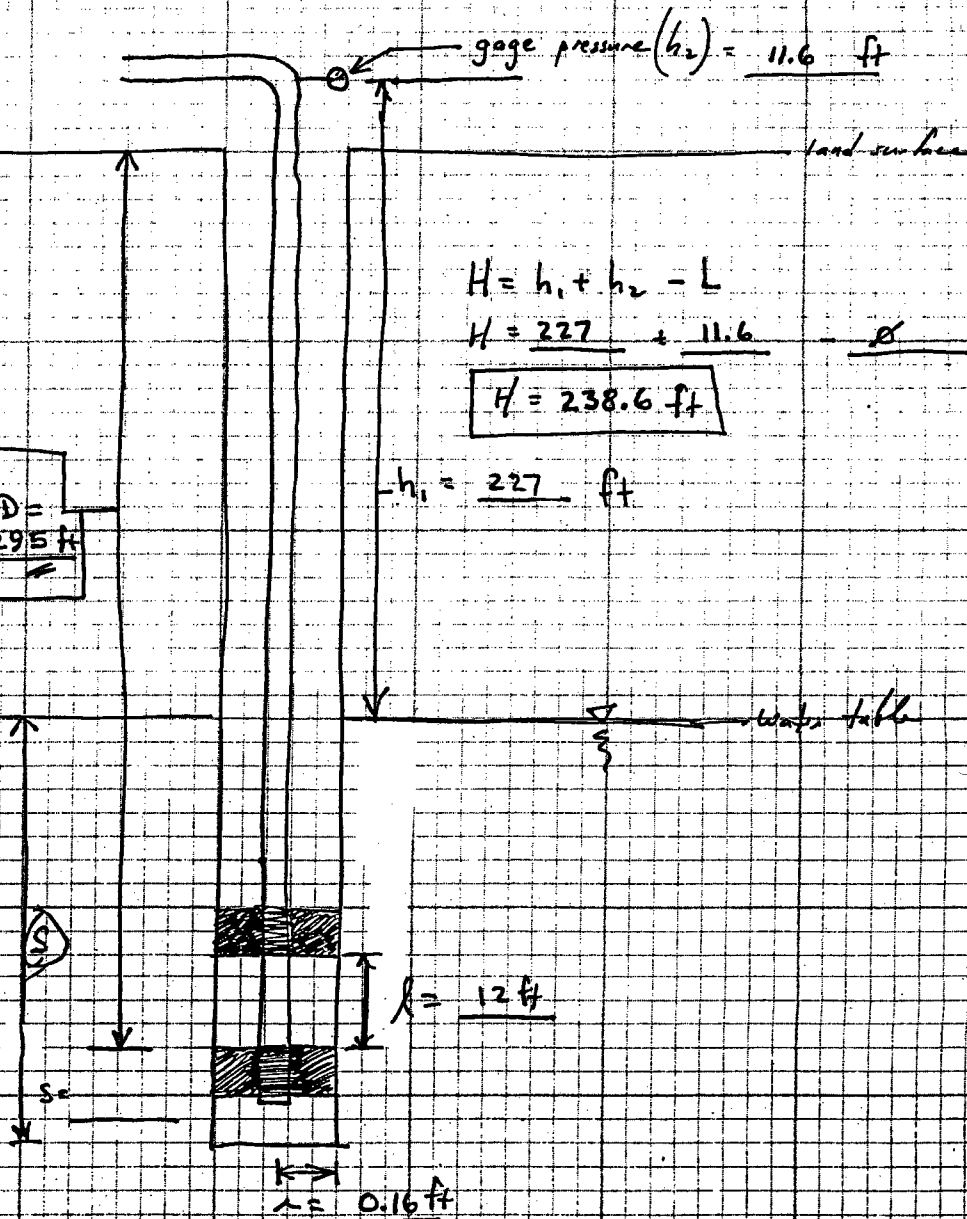
$$H = \boxed{238.6 \text{ ft}}$$

$$h_1 = \boxed{227 \text{ ft}}$$

C_s from Figure 17-8

$$\frac{h}{r} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = \boxed{100}$$



$$K < \frac{Q}{C_s \cdot h \cdot H}$$

$$K < \frac{(5 \times 10^{-4} \text{ gal/min}) (1440 \text{ min/d}) (1 \text{ ft}^3/7.48 \text{ gal})}{(100) (0.16 \text{ ft}) (238.6 \text{ ft})}$$

$$K < 2.5 \times 10^{-5} \text{ ft/d}$$

$$K < 8.9 \times 10^{-9} \text{ cm/s}$$

Stoller

For Straddle Lecker Tests below water table
Zone 3; Method 2 USBR

JOB NO.: _____ DATE: 1-27-06

JOB NAME: Crescent Junction Site

PREPARED: M. Kautsky

REVIEWED:

Borehole 204

SHEET NO.: _____

OF _____

Depth: 283-295
Pressure: 10 psi

Obtain L from
pressure loss curve
if $Q > 4 \text{ gpm}$

$$L = \begin{cases} \phi & (Q < 4 \text{ gpm}) \end{cases}$$

$$Q = 0.07 \text{ gal/min}$$

$$D = 295$$

$$H = h_1 + h_2 - L$$

$$H = 227 \text{ ft} + 23.1$$

$$H = 250.1 \text{ ft}$$

$$h_1 = 227 \text{ ft}$$

$$\text{gage pressure } (h_2) = 23.1 \text{ ft}$$

land surface

water table

C_s from Figure 17-8

$$\frac{h}{L} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = 100$$

$$h = 12 \text{ ft}$$

$$L = 0.16 \text{ ft}$$

$$K = \frac{Q}{C_s \cdot L \cdot H}$$

$$K = \frac{(0.07 \frac{\text{gal}}{\text{min}}) (\frac{1440 \text{ min}}{d}) (\frac{1 \text{ ft}^3}{7.48 \text{ gal}})}{(100) (0.16 \text{ ft}) (250.1 \text{ ft})} = 3.4 \times 10^{-3} \text{ ft/d}$$

$$K = 3.4 \times 10^{-3} \text{ ft/d} ; K = 1.2 \times 10^{-6} \text{ cm/s}$$

Stoller

For Straddle Packer Tests below water table
zone 3; Method 2 USBR

JOB NO.: _____ DATE: 1-27-06

JOB NAME: Crescent Junction site

PREPARED: M. Kautsky REVIEWED: _____

SHEET NO.: _____ OF _____ Borehole 204
Depth: 283-295 ft
pressure: 20 psi

Obtain L from
pressure-loss curve
if $Q > 4 \text{ gpm}$

$$L = \begin{cases} \phi & (Q < 4 \text{ gal/min}) \end{cases}$$

$$Q = 0.17 \text{ gal/min}$$

$$D = 295 \text{ ft}$$

$$\text{gage pressure } (h_2) = 46.2 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$H = 227 + 46.2$$

$$H = 273.2 \text{ ft}$$

$$h_1 = 227 \text{ ft}$$

C_s from Figure 17-8

$$\frac{h}{r} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = 100$$

$$h = 12 \text{ ft}$$

$$r = 0.16 \text{ ft}$$

$$K = \frac{Q}{C_s \cdot H}$$

$$K = \frac{(0.17 \text{ gal/min}) \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(100) (0.16 \text{ ft}) (273.2 \text{ ft})}$$

$$K = 7.5 \times 10^{-3} \text{ ft/d}$$

$$K = 2.6 \times 10^{-6} \text{ cm/s}$$

Stoller

For Straddle Packer Tests below water table
Zone 3; Method 2 USBR

JOB NO.: _____ DATE: 1-27-06

JOB NAME: Crescent Junction Site

PREPARED: Mark Kautsky REVIEWED: _____

SHEET NO.: _____ OF _____
Borehole: 204
Depth: 283-295 ft.
pressure: 10 psi (retest)

Obtain L from
pressure loss curve
if $Q > 4 \text{ gpm}$

$$L = \begin{cases} \phi & (Q < 4 \text{ gpm}) \end{cases}$$

$$Q < \frac{0.01 \text{ gal}}{15 \text{ min}}$$

$$Q < 6.7 \times 10^{-4} \text{ gpm}$$

$$D = 295 \text{ ft}$$

$$H = h_1 + h_2 = L$$

$$H = 227 + 23.1$$

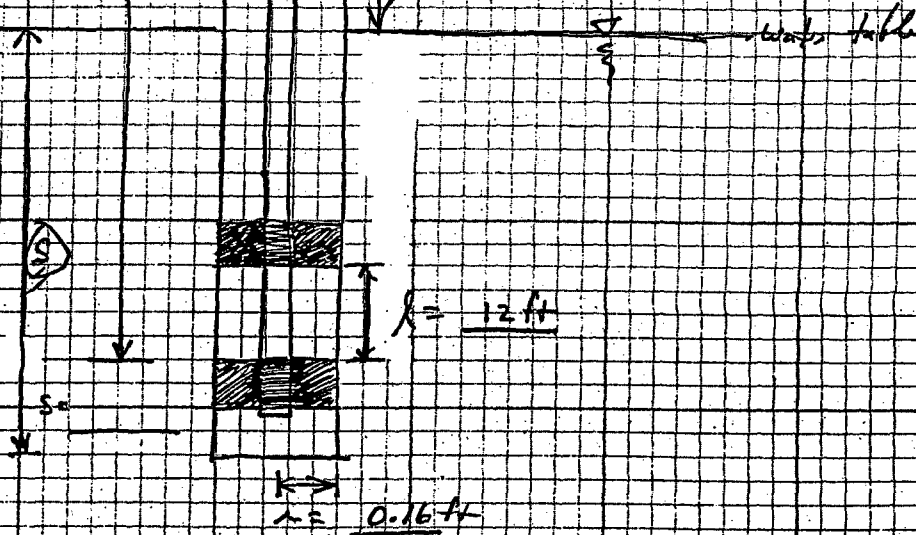
$$H = 250.1 \text{ ft}$$

$$h_1 = 227 \text{ ft}$$

C_s from Figure 17-8

$$\frac{h}{x} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = 100$$



$$K = \frac{Q}{C_s \cdot L \cdot H}$$

$$K < \frac{(6.7 \times 10^{-4} \frac{\text{gal}}{\text{min}}) (\frac{1440 \text{ min}}{1}) (\frac{\text{ft}^3}{7.48 \text{ gal}})}{(100) (0.16 \text{ ft}) (250.1 \text{ ft})}$$

$$K < 3.2 \times 10^{-5} \text{ ft/c}$$

$$K < 1.1 \times 10^{-8} \text{ cm/s}$$

Stoller

For Straddle Pecker Tests below water table
Zone 3; Method 2 USBR

JOB NO.: _____ DATE: 1-27-06

JOB NAME: Crescent Junction site

PREPARED: Mark Rautsky REVIEWED: _____

SHEET NO.: _____ OF _____
Borehole 204
Depth: 283-295 ft
pressure: 5 psi (retest)

Obtain L from
pressure-loss curve
if $Q > 4 \text{ gpm}$

$$L = \boxed{\emptyset}$$

($Q < 4 \text{ gal/min}$)

$$Q < \frac{0.01 \text{ gal}}{15 \text{ min}}$$

$$Q < 6.7 \times 10^{-4} \frac{\text{gal}}{\text{min}}$$

$$D = \boxed{295}$$

$$H = h_1 + h_2 - L$$

$$H = 227 + 11.6$$

$$H = \boxed{238.6 \text{ ft}}$$

$$h_1 = 227 \text{ ft}$$

$$\text{gage pressure } (h_2) = 11.6 \text{ ft}$$

land surface

water table

C_s from Figure 17-8

$$\frac{L}{r} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = \boxed{100}$$



$s =$

$r =$

$$r = 0.16 \text{ ft}$$

$$K = \frac{Q}{C_s \cdot L \cdot H}$$

$$K < \frac{(6.7 \times 10^{-4} \frac{\text{gal}}{\text{min}}) (1440 \text{ min}) (1 \text{ ft}^3)}{(100) (0.16 \text{ ft}) (238.6 \text{ ft})}$$

$$K < 3.4 \times 10^{-5} \text{ ft/d}$$

$$K < 1.2 \times 10^{-8} \text{ cm/s}$$

Stoller

RECORD COPY

established 1959

Packer-Test Record

Page 1 of 2

Project Name: Moul - Crescent Jet Characterization Date: 01/16/06

Field Representative: R. Rupp Borehole No. 0208 Total Depth: 300 ft

Depth to Water (TOC): 187.5 ft Borehole Cleaned? Yes ☒ No ☐ Date: 01/15/06

Test Interval (BGL): from 90 to 102 ft. Swivel/Elbow Height (AGL) 4.5 ft.

Conductor Pipe, Type and Size: 1-inch ID thin wall steel tubing

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>0800</u>	<u>10 psi</u>	<u>39421.70</u>	
<u>0805</u>	<u>10</u>	<u>39421.70</u>	<u>0</u>
<u>0810</u>	<u>10</u>	<u>39421.70</u>	<u>0</u>
<u>0815</u>	<u>10</u>	<u>39421.70</u>	<u>0</u>
<u>0820</u>	<u>10</u>	<u>39421.70</u>	<u>0</u>
<u>0825</u>	<u>10</u>	<u>39421.70</u>	<u>0</u>
<u>0830</u>	<u>10</u>	<u>39421.70</u>	<u>0 gpm</u>
<u>0835</u>	<u>20 psi</u>	<u>39422.40</u>	<u>0.14</u>
<u>0840</u>	<u>20</u>	<u>39422.40</u>	<u>0</u>
<u>0845</u>	<u>20</u>	<u>39422.35</u>	<u>-0.01</u>
<u>0850</u>	<u>20</u>	<u>39422.35</u>	<u>0</u>
<u>0855</u>	<u>20</u>	<u>39422.35</u>	<u>0</u>
<u>0900</u>	<u>20</u>	<u>39422.35</u>	<u>0</u>
<u>0905</u>	<u>20</u>	<u>39422.35</u>	<u>0 gpm</u>
<u>0910</u>	<u>30 psi</u>	<u>39422.75</u>	<u>0.08</u>
<u>0915</u>	<u>30</u>	<u>39422.75</u>	<u>0</u>
<u>0920</u>	<u>30</u>	<u>39422.75</u>	<u>0</u>
<u>0925</u>	<u>30</u>	<u>39422.75</u>	<u>0</u>

Stoller

RECORD COPY

established 1959

Packer-Test Record

Page 2 of 2

Project Name: Moab - Crescent Jet Chromatography Date: 01/16/06

Field Representative: R. Rupp Borehole No. 0208 Total Depth: 300 ft.

Depth to Water (TOC): 187.5 ft. Borehole Cleaned? Yes ☒ No ☐ Date: 01/15/06

Test Interval (BGL): from 90 to 102 ft. Swivel/Elbow Height (AGL) 4.5 ft.

Conductor Pipe, Type and Size: 1-inch ID Thin Wall Steel Tubing

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>0930</u>	<u>30 psi</u>	<u>39422.75</u>	<u>0</u>
<u>0935</u>	<u>30</u>	<u>39422.75</u>	<u>0</u>
<u>0940</u>	<u>30</u>	<u>39422.75</u>	<u>0 gpm</u>
<u>0945</u>	<u>20 psi</u>	<u>39422.70</u>	<u>-0.01</u>
<u>0950</u>	<u>20</u>	<u>39422.70</u>	<u>0</u>
<u>0955</u>	<u>20</u>	<u>39422.70</u>	<u>0</u>
<u>1000</u>	<u>20</u>	<u>39422.70</u>	<u>0</u>
<u>1005</u>	<u>20</u>	<u>39422.70</u>	<u>0</u>
<u>1010</u>	<u>20</u>	<u>39422.70</u>	<u>0</u>
<u>1015</u>	<u>20</u>	<u>39422.70</u>	<u>0</u>
<u>1020</u>	<u>10 psi</u>	<u>39422.70</u>	<u>0</u>
<u>1025</u>	<u>10</u>	<u>39422.70</u>	<u>0</u>
<u>1030</u>	<u>10</u>	<u>39422.70</u>	<u>0</u>
<u>1035</u>	<u>10</u>	<u>39422.70</u>	<u>0</u>
<u>1040</u>	<u>10</u>	<u>39422.70</u>	<u>0</u>
<u>1045</u>	<u>10</u>	<u>39422.70</u>	<u>0</u>
<u>1050</u>	<u>10</u>	<u>39422.70</u>	<u>0</u>

Stoller

DATE: 1-23-06

JOB NAME: Crescent Junction

PREPARED: M. Kautsky

REVIEWED:

SHEET NO: OF

PACKER TEST ANALYSES

BOREHOLE: 208

Depth: 90-102 ft

Unsaturated Zone Calculation:

Pressure (h_2): 10 psi ($h_2 = 23.1$ ft)

Definitions: L = length of test section

$$T_u = U - D + H$$

U = Thickness of Unsaturated Material

D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

L = head loss; ignore if $Q < 4$ gpm

$$X = \frac{H}{T_u} (100); \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = 187.5 \text{ ft} - 102 \text{ ft} + 129.6 \text{ ft} = 215.1 \text{ ft}$$

$$\frac{T_u}{L} = \frac{215.1 \text{ ft}}{12 \text{ ft}} = \boxed{17.9}$$

$$H = h_1 + h_2 - \underset{\substack{\uparrow \\ Q < 4 \text{ gpm}}}{L} = 106.5 \text{ ft} + 23.1 \text{ ft} - 0 = 129.6 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{129.6 \text{ ft}}{215.1 \text{ ft}} (100) = \boxed{60.2}$$

$$h_1 = (102 + 4.5) \text{ ft} = 106.5 \text{ ft}$$

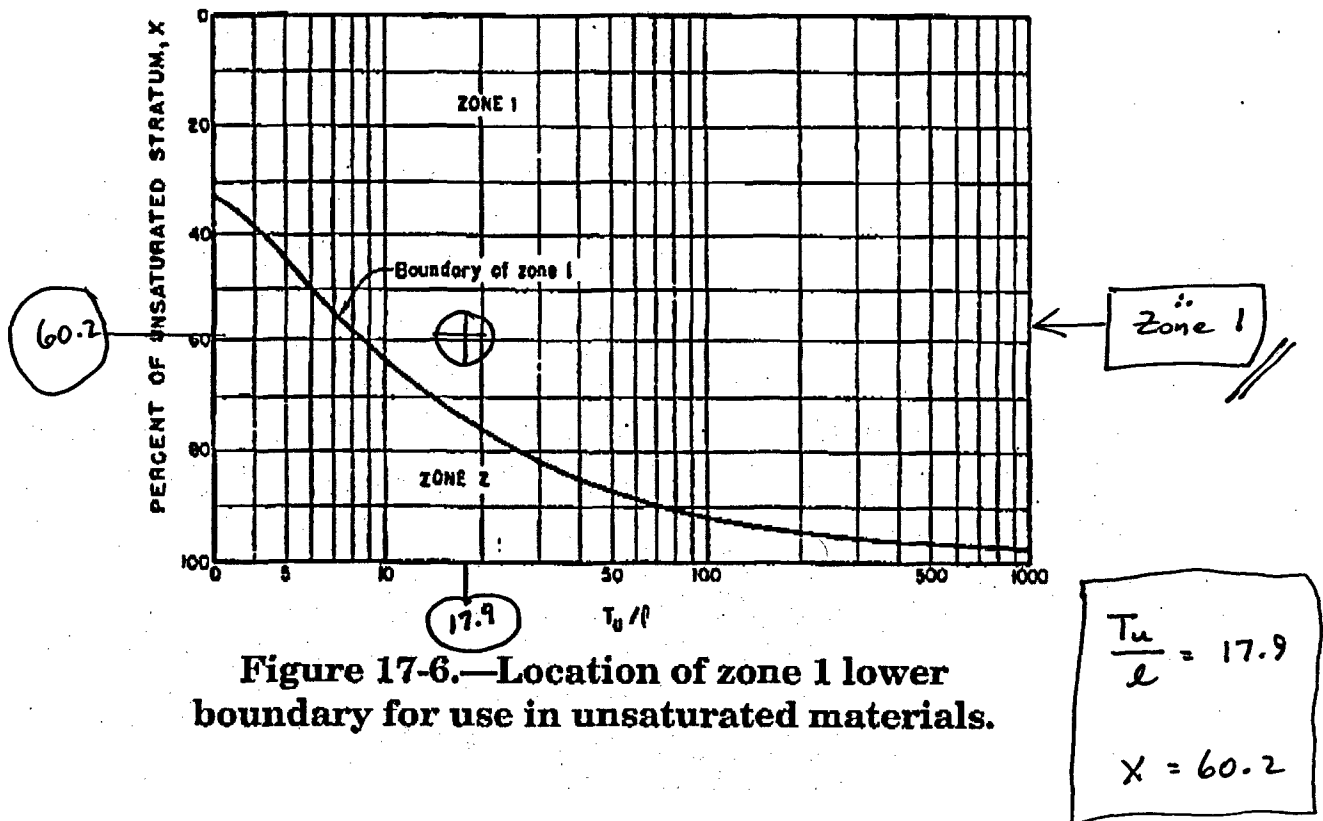
WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

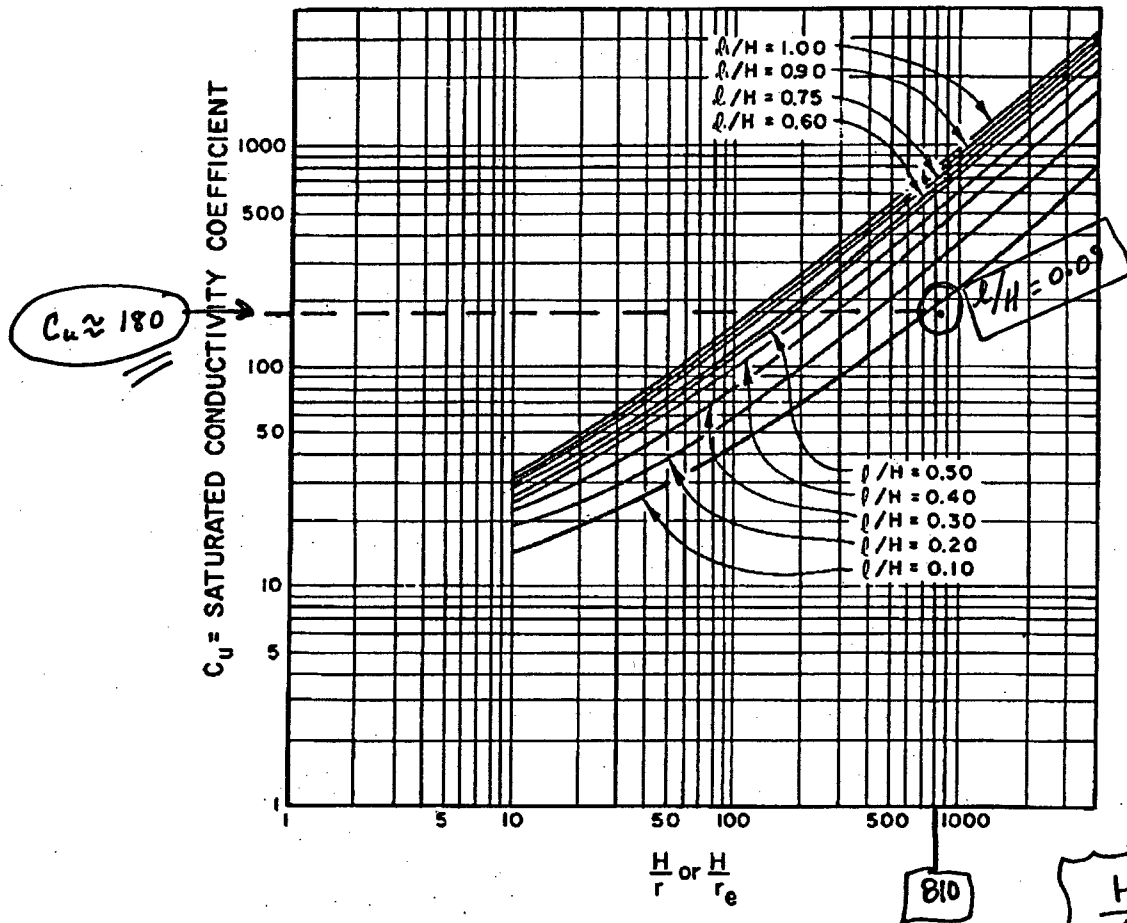
The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole: 208
Depth: 90-102 ft
Pressure: 10 psi



WATER TESTING FOR PERMEABILITY



Borehole : 208
 Depth : 90-102 ft
 Pressure (h_L) : 23.1 ft
 (10 psi)

Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

$$\frac{H}{r} = 810$$

$$\frac{l}{H} = 0.09$$

Zone 2

Given: U , l , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

JOB NO. Borehole: 208

DATE:

JOB NAME: Depth: 90-102 ft

PREPARED: Pressure (h_2): 23.1 ft

REVIEWED:

SHEET NO. Crescent Junction Side

Packer Test Set-up Sheet

For straddle packer tests in Zone I

- Above water Table -

Injector Pipe

Obtain L (head loss coeff.)

$$L = 0.0 \text{ ft}/10 \text{ ft}$$

from Pressure - Loss Curve
 $Q < 4 \text{ gpm}; L \approx 0$

$$D = 102 \text{ ft}$$

$$u = 187.5$$

$$\text{gage pressure } (h_2) = \frac{(10 \text{ psi})}{2.31} = 23.1 \text{ ft}$$

$$h_1 = 106.5 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$H = 106.5 + 23.1 - 0$$

$$H = 129.6 \text{ ft}$$

Obtain C_u

$$C_u = 180$$

from fig 17.7 USBR
(Attached)

$$\frac{H}{r} = \frac{129.6 \text{ ft}}{0.16 \text{ ft}} = 810$$

$$\frac{l}{H} = \frac{12 \text{ ft}}{129.6 \text{ ft}} = 0.09$$

$$Q < \frac{0.01 \text{ gal}}{30 \text{ min}}$$

$$Q < 3.33 \times 10^{-4} \text{ gpm}$$

$$K < \frac{3.33 \times 10^{-4} \text{ gal/min} \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(180)(0.16 \text{ ft})(129.6 \text{ ft})}$$

$$K < 1.7 \times 10^{-5} \text{ ft/d}$$

$$K < 6 \times 10^{-9} \text{ cm/s}$$

A-104

WATER TABLE

Calculate K : Zone I

$$K = \frac{Q}{C_u r H}$$

$$2r = 3.785 \text{ in } (0.32 \text{ ft})$$

$$r = 0.16 \text{ ft}$$

$$K < \frac{3.33 \times 10^{-4} \text{ gal/min} \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(180)(0.16 \text{ ft})(129.6 \text{ ft})}$$

Stoller

DATE 1-23-06

JOINTLINE Crescent Junction

PREPARED: M. Kautsky

REVIEWED:

SHEET NO: OF

PACKER TEST ANALYSES

BOREHOLE : 208

Depth : 90-102

Pressure (h_2) : 20psi ($h_2 = 46.2$ ft)

Unsaturated Zone Calculation:

Definitions:

L = length of test section

$T_u = U - D + H$

U = Thickness of Unsaturated Material

D = distance from ground surface to bottom of test section

$H = h_1 + h_2 - L$

L = head loss ; ignore if $Q < 4$ gpm

$X = \frac{H}{T_u} (100)$; percent unsaturated material

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = 187.5 \text{ ft} - 102 \text{ ft} + 152.7 \text{ ft} = 238.2 \text{ ft}$$

$$\frac{T_u}{L} = \frac{238.2 \text{ ft}}{12 \text{ ft}} = \boxed{19.8}$$

$$H = h_1 + h_2 - \underbrace{L}_{(Q < 4 \text{ gpm})} = 106.5 + 46.2 = 152.7 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{152.7 \text{ ft}}{238.2 \text{ ft}} = 0.64 (100) = \boxed{64}$$

$$h_1 = (102 + 4.5) \text{ ft} = 106.5 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 208
Depth : 90-102
Pressure (h_w) : 20 psi

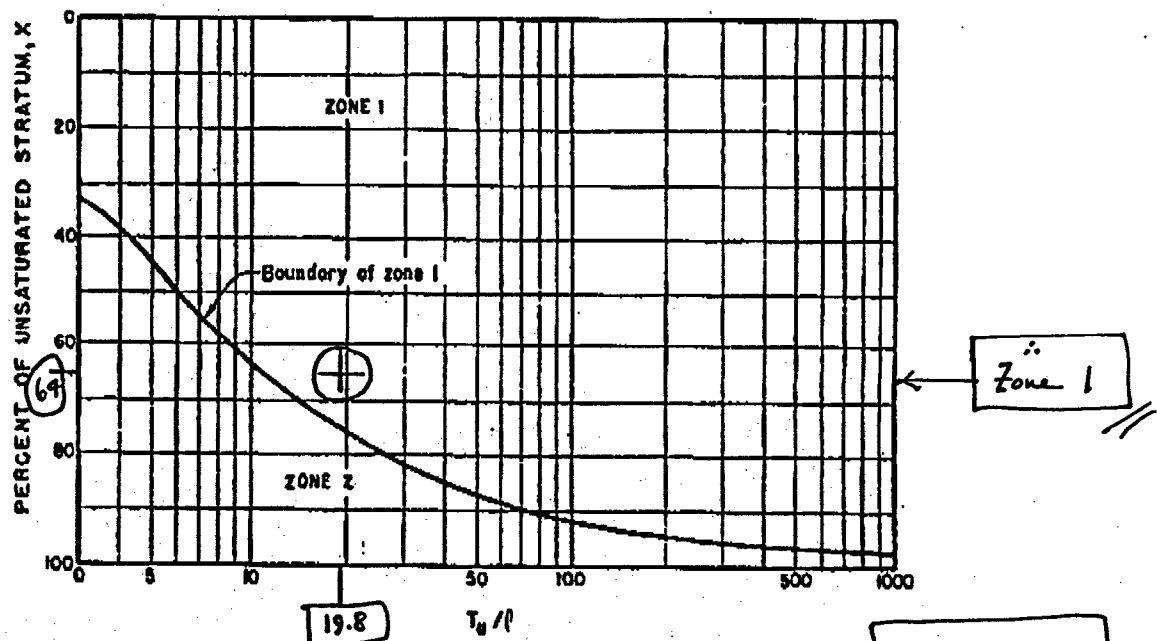


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 19.8$$

$$X = 64$$

WATER TESTING FOR PERMEABILITY

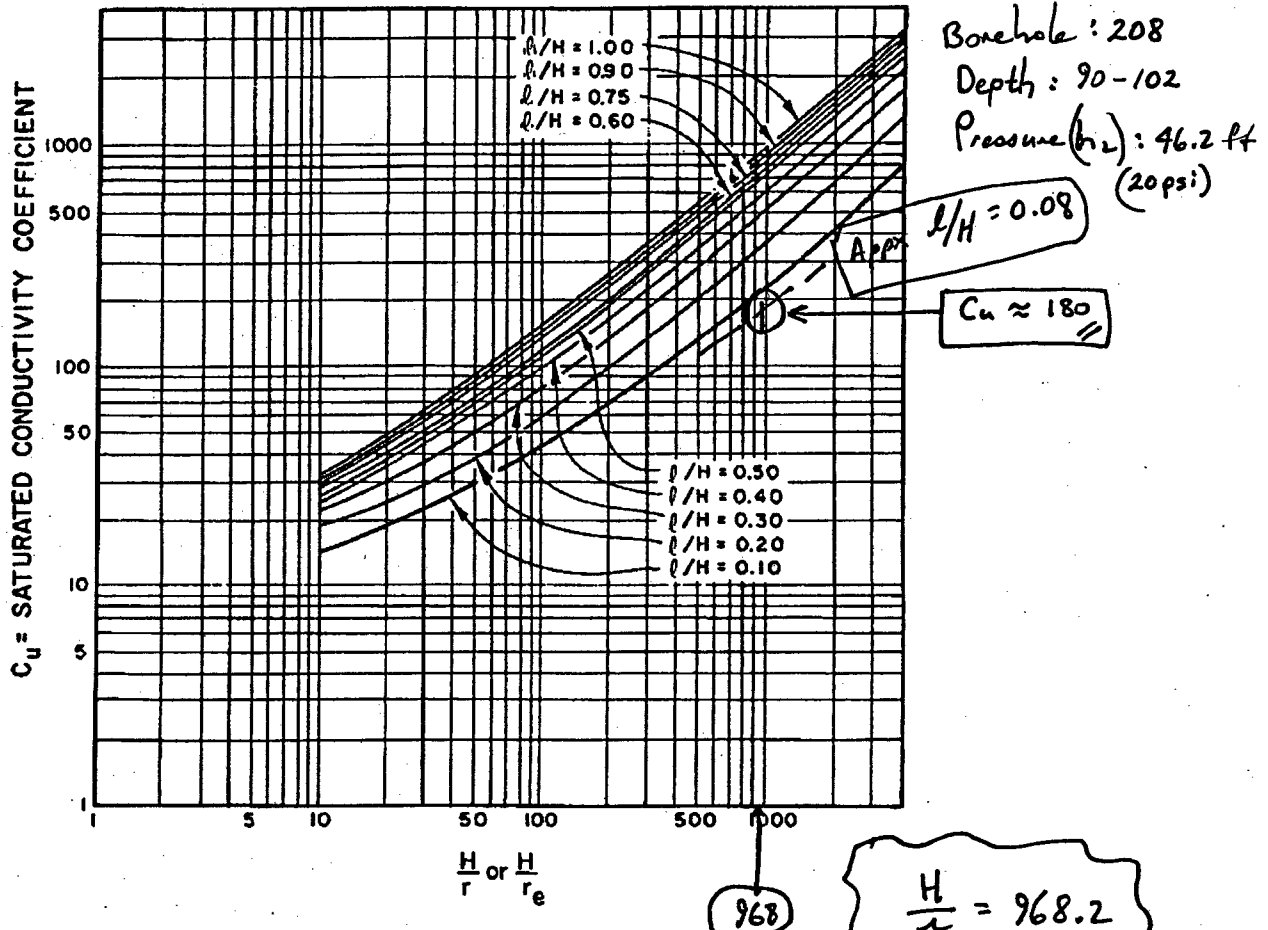


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

$$\frac{H}{r} = 968.2$$

$$\frac{l}{H} = 0.08$$

Zone 2

Given: U , l , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

JOB NO: Borchok 208

DATE:

JOB NAME: Depth 90-102 ft.

PREPARED: Pressure (h_2) = 46.2 ft (20 psi) REVIEWED:

SHEET NO. OF

Packer Test Set-up Sheet For straddle packer tests in Zone I - Above water Table -

Injector Pipe

Obtain L (head loss coeff.)

$$L = \frac{\phi}{Q} \text{ ft/10 ft}$$

($Q < 4.9 \text{ gpm}$)

from Pressure - loss Curve

$D \rightarrow$

$$D = 102 \text{ ft}$$

$$u = 1875 \text{ ft}$$

$$\text{gage pressure } (h_2) = 46.2 \text{ ft}$$

$$h_1 = 106.5 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$106.5 + 46.2 - 0$$

$$H = 152.7 \text{ ft}$$

Obtain C_u

$$C_u \approx 180$$

from fig 17.7 USBR (Attached)

$$\frac{H}{u} = \frac{152.7 \text{ ft}}{1875 \text{ ft}} = 968.2$$

$$\frac{l}{H} = \frac{12 \text{ ft}}{152.7 \text{ ft}} = 0.08$$

$$Q < 0.01 \text{ gal/20 min}$$

$$Q < 5.0 \times 10^{-4} \text{ gal/min}$$

$$K < \frac{(5.0 \times 10^{-4} \text{ gal/min}) \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(180)(0.16 \text{ ft})(152.7 \text{ ft})}$$

WATER TABLE

Calculate K : Zone I

$$K = \frac{Q}{C_u u H}$$

$$2u = 3.785''$$

$$u = 0.16 \text{ ft.}$$

$$K < 2.2 \times 10^{-5} \text{ ft/d}$$

$$K < 7.7 \times 10^{-9} \text{ cm/s}$$

Packer Test Analyses

BOREHOLE : 208

Depth : 90-102 ft

 Pressure (h_2) : 30psi $h_2 = 69.3 \text{ ft}$

Unsaturated Zone Calculation:

 Definitions : L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material

 D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss ; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) ; \text{ percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = 187.5 \text{ ft} - 102 \text{ ft} + 175.8 \text{ ft} = 261.3 \text{ ft}$$

$$\frac{T_u}{L} = \frac{261.3 \text{ ft}}{12 \text{ ft}} = \boxed{21.8}$$

$$H = h_1 + h_2 \left[\begin{array}{c} Q < 4 \text{ gpm} \\ \swarrow \\ 0 \end{array} \right] = h_1 + h_2 = 106.5 \text{ ft} + 69.3 \text{ ft} = 175.8 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{175.8 \text{ ft}}{261.3 \text{ ft}} (100) = \boxed{67.3}$$

$$h_1 = (102 + 4.5) \text{ ft} = 106.5 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 208
 Depth : 90-102 ft
 Pressure (h_2) : 30 psi (69.3 ft)
 (= h_2)

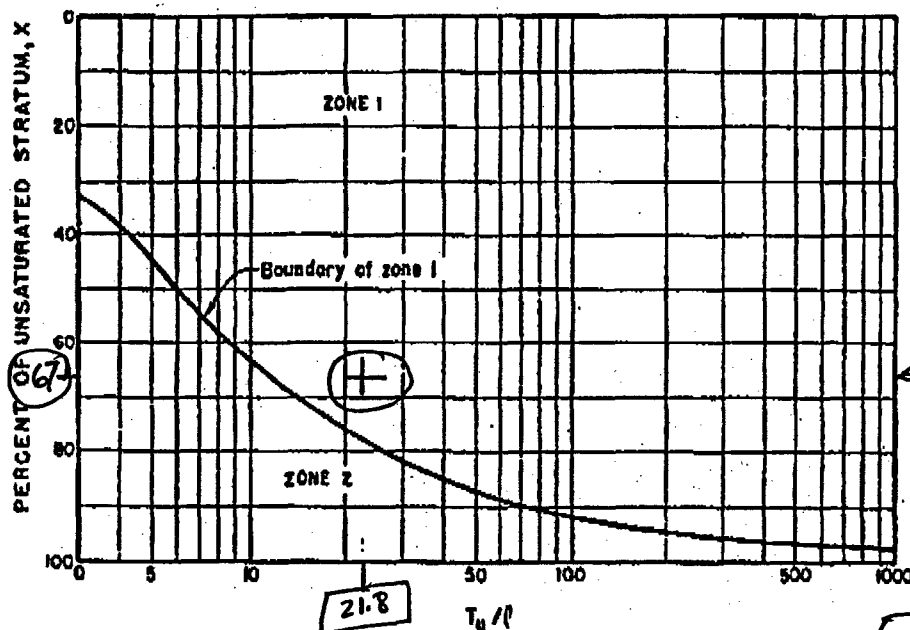


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 21.8$$

$$X = 67.3$$

WATER TESTING FOR PERMEABILITY

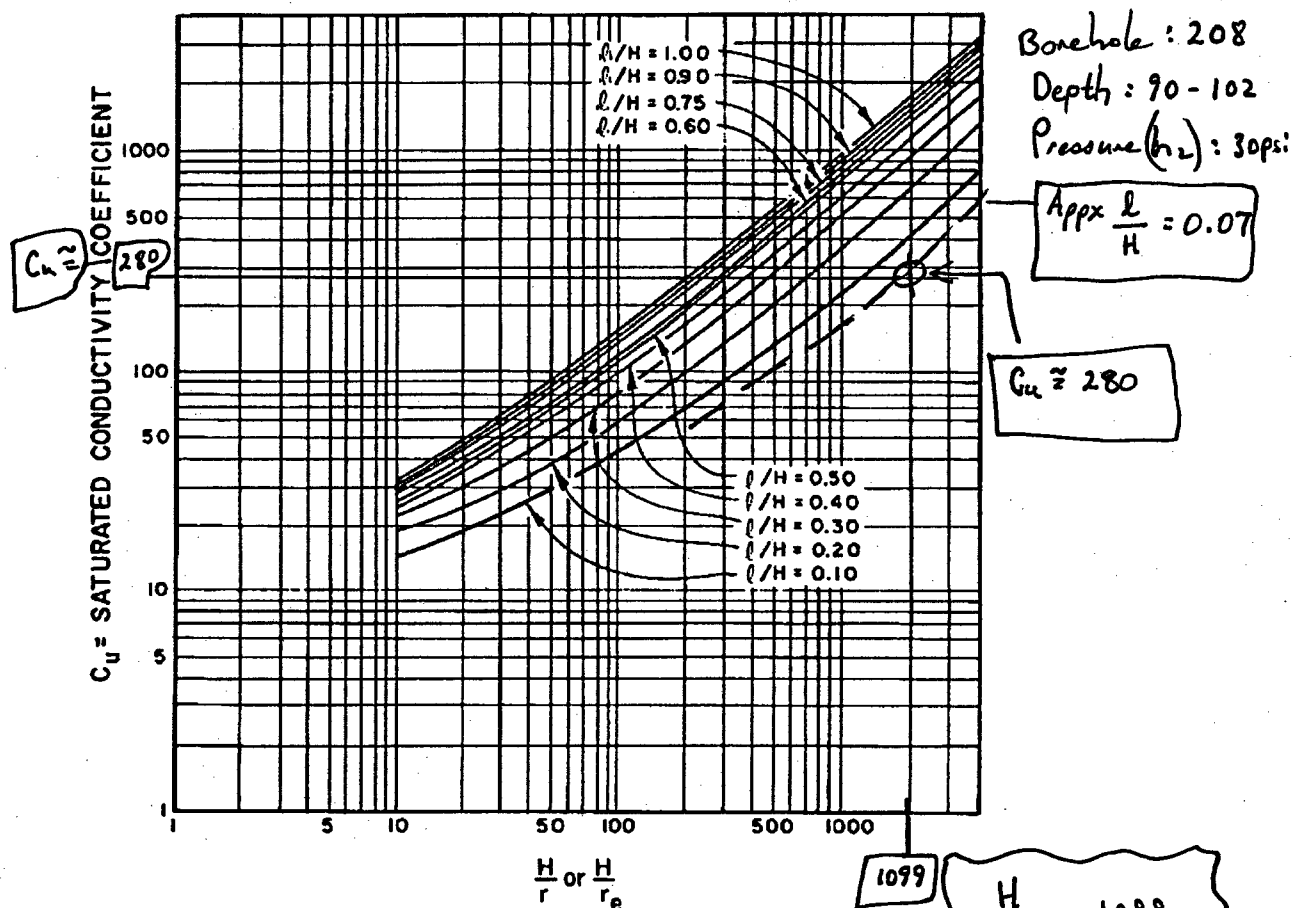


Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.

Zone 2

Given: U , l , r , h_2 , Q , and L are as given in example 1, $D = 65$ feet, and $h_1 = 72$ feet

If the distance from the gauge to the bottom of the intake pipe is 62 feet, the total L is $(6.2)(0.76) = 4.7$ feet.

$$H = 72 + 57.8 - 4.7 = 125.1 \text{ feet}$$

JOB NO. Bonehole 208

DATE

JOB NAME Depth 90-102 ft.

PREPARED: Pressure (h_2) = 30 psi (69.3 ft)

REVIEWED

SHEET NO. OF

Packer Test Set-up Sheet

For straddle packer tests in Zone 1
- Above water Table -

Injector Pipe

Obtain L (head loss coeff.)

$$L = \frac{0.0}{10} \text{ ft/10 ft}$$

(@ < 4 gpm)

from Pressure - Loss Curve

D

$$D = 102 \text{ ft}$$

$$u = 187.5 \text{ ft}$$

$$\text{gage pressure } (h_2) = \frac{69.3 \text{ ft}}{(30 \text{ psi})}$$

$$h_1 = 106.5 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$= 106.5 + 69.3 - 0$$

$$H = 175.8 \text{ ft}$$

Obtain C_u

$$C_u \approx 280$$

from fig 17.7 USBR

$$\frac{H}{u} = \frac{175.8 \text{ ft}}{187.5 \text{ ft}} = 0.93$$

$$\frac{l}{H} = \frac{12 \text{ ft}}{175.8 \text{ ft}} = 0.07$$

$$K = \frac{Q}{C_u \cdot u \cdot H}$$

$$K < \frac{(3.3 \times 10^{-4} \text{ gal/min}) (1440 \text{ min})}{(280) (0.16 \text{ ft}) (175.8 \text{ ft})} \left(\frac{\text{ft}^3}{7.48 \text{ gal}} \right)$$

$$K < 8.2 \times 10^{-6} \text{ ft/d}$$

$$K < 2.9 \times 10^{-9} \text{ cm/s}$$

Calculate K : Zone 1

$$K = \frac{Q}{C_u \cdot u \cdot H}$$

$$Q < \frac{0.01 \text{ gal}}{30 \text{ min}}$$

$$Q < 3.3 \times 10^{-4} \text{ gal/min}$$

$$l = 0.16 \text{ ft}$$

JOB NO: Borchok 208

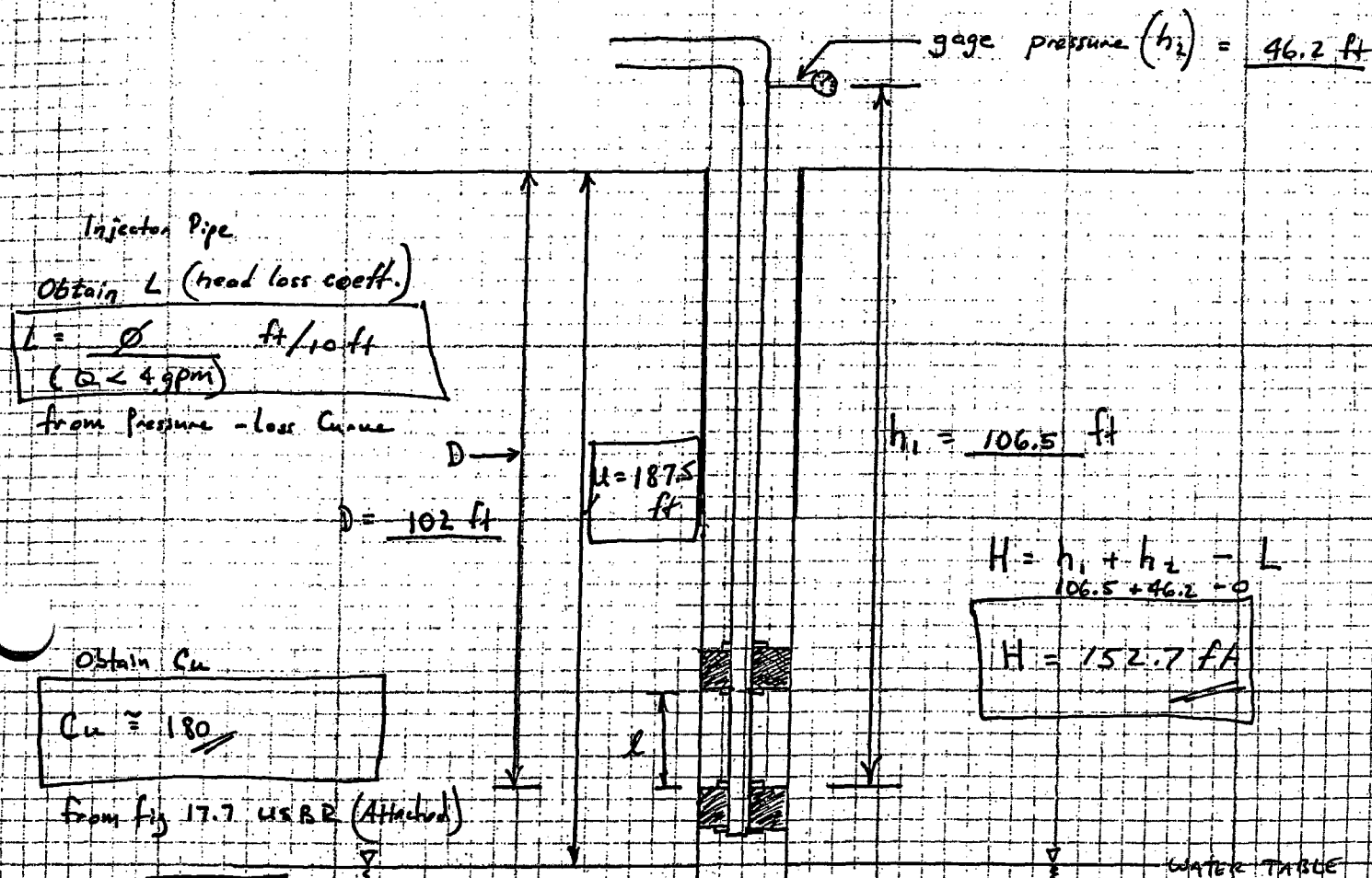
DATE:

JOB NAME: Depth 90-102 ft.

PREPARED: Pressure (h_2) = 46.2 ft (20 psi)
REVIEWED: (retest)

SHEET NO. OF

Packer Test Set-up Sheet For straddle packer tests in Zone I - Above water Table -



$$\frac{H}{L} = \frac{152.7 \text{ ft}}{0.16 \text{ ft}} = 968.2$$

$$\frac{L}{H} = \frac{12 \text{ ft}}{152.7 \text{ ft}} = 0.08$$

$$Q < 0.01 \text{ gal/20 min}$$

$$Q < 5.0 \times 10^{-4} \text{ gal/min}$$

$$K < \frac{(5.0 \times 10^{-4} \text{ gal/min}) \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(180)(0.16 \text{ ft})(152.7 \text{ ft})}$$

$$2u = 3.785''$$

$$u = 0.16 \text{ ft.}$$

Calculate K : Zone I

$$K = \frac{Q}{C_u \cdot L \cdot H}$$

$$2.2 \times 10^{-5} \text{ ft/d}$$

$$K < 7.7 \times 10 \text{ cm/a}$$

JOB NO: Borehole: 208

DATE:

JOB NAME: Depth: 90-102 ft

PREPARED: Pressure (h_2): 23.1 ft

REVIEWED:

SHEET NO. Crescent Junction Site

Packer Test Set-up Sheet For straddle packer tests in Zone I - Above water Table -

(retest)
(10 psi)
23.1 ft

gage pressure (h_2) =

Injector Pipe
Obtain L (head loss coeff.)

$$L = 0.0 \text{ ft/10 ft}$$

from Pressure - loss Curve
 $Q < 4 \text{ gpm}; L < 0$

D =

$$D = 102 \text{ ft}$$

$$u = 187.5$$

$$h_1 = 106.5 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$H = 106.5 + 23.1$$

$$H = 129.6 \text{ ft}$$

Obtain C_u

$$C_u = 180$$

from fig 17.7 USBR
(Attached)

$$\frac{H}{r} = \frac{129.6 \text{ ft}}{0.16 \text{ ft}} = 810$$

$$\frac{l}{H} = \frac{12 \text{ ft}}{129.6 \text{ ft}} = 0.09$$

$$Q < \frac{0.01 \text{ gal}}{30 \text{ min}}$$

$$Q < 3.33 \times 10^{-4} \text{ gpm}$$

$$K < \frac{3.33 \times 10^{-4} \text{ gal/min} \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(180)(0.16 \text{ ft})(129.6 \text{ ft})}$$

$$K < 1.7 \times 10^{-5} \text{ ft/d}$$

$$K < 6 \times 10^{-9} \text{ cm/d}$$

A-134

Calculate K : Zone I

$$K = \frac{Q}{C_u \cdot H}$$

$$2r = 3.785 \text{ in (0.32 ft)}$$

$$r = 0.16 \text{ ft}$$

$$K < \frac{3.33 \times 10^{-4} \text{ gal/min} \cdot 1440 \text{ min}}{(180)(0.16 \text{ ft})(129.6 \text{ ft})(7.48 \text{ gal})}$$

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RECORD COPY

established 1959

Packer-Test Record

Page 1 of 2

Project Name: Mud-Cement Jet Characterization Date: 01/15/06

Field Representative: R. Rupp Borehole No. 0208 Total Depth: 300 ft.

Depth to Water (TOC): 187.5 ft. Borehole Cleaned? Yes ☒ No ☐ Date: 1/15/06

Test Interval (BGL): from 121' to 133' ft. Swivel/Elbow Height (AGL) 4.0 ft.

Conductor Pipe, Type and Size: 1-inch ID Thin Wall Steel Tubing

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>1335</u>	<u>10 psi</u>	<u>39418.85</u>	
<u>1340</u>	<u>10</u>	<u>39418.80</u>	<u>-0.01 gpm</u>
<u>1345</u>	<u>10</u>	<u>39418.80</u>	<u>0</u>
<u>1350</u>	<u>10</u>	<u>39418.80</u>	<u>0</u>
<u>1355</u>	<u>10</u>	<u>39418.80</u>	<u>0</u>
<u>1400</u>	<u>10</u>	<u>39418.80</u>	<u>0</u>
<u>1405</u>	<u>10</u>	<u>39418.80</u>	<u>0</u>
<u>1410</u>	<u>10</u>	<u>39418.80</u>	<u>0</u>
<u>1415</u>	<u>20 psi</u>	<u>39420.05</u>	<u>0.25 gpm</u>
<u>1420</u>	<u>20</u>	<u>39420.10</u>	<u>0.01</u>
<u>1425</u>	<u>20</u>	<u>39420.10</u>	<u>0</u>
<u>1430</u>	<u>20</u>	<u>39420.15</u>	<u>0.01</u>
<u>1435</u>	<u>20</u>	<u>39420.15</u>	<u>0</u>
<u>1440</u>	<u>20</u>	<u>39420.15</u>	<u>0</u>
<u>1445</u>	<u>20</u>	<u>39420.20</u>	<u>0.01 gpm</u>
<u>1450</u>	<u>20</u>	<u>39420.25</u>	<u>0.01</u>
<u>1455</u>	<u>20</u>	<u>39420.25</u>	<u>0</u>
<u>1500</u>	<u>20</u>	<u>39420.25</u>	<u>0</u>
<u>1505</u>	<u>20</u>	<u>39420.25</u>	<u>0 gpm</u>

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RECORD COPY

established 1959

Packer-Test Record

Page 2 of 2

Project Name: Mead-Cumant Jet. Characterization Date: 01/15/06

Field Representative: R. Rupp Borehole No. 0208 Total Depth: 300'

Depth to Water (TOC): 187.5 ft. Borehole Cleaned? Yes ☒ No ☐ Date: 01/15/06

Test Interval (BGL): from 121' to 133' ft. Swivel/Elbow Height (AGL) 4.0 ft.

Conductor Pipe, Type and Size: 1-inch ID Thin Wall STEEL Tubing

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>1510</u>	<u>30 psi</u>	<u>39421.20</u>	<u>0.19 gpm</u>
<u>1515</u>	<u>30</u>	<u>39421.40</u>	<u>0.04</u>
<u>1520</u>	<u>30</u>	<u>39421.60</u>	<u>0.04</u>
<u>1525</u>	<u>30</u>	<u>39421.80</u>	<u>0.04</u>
<u>1530</u>	<u>30</u>	<u>39422.00</u>	<u>0.04</u>
<u>1535</u>	<u>30</u>	<u>39422.20</u>	<u>0.04</u>
<u>1540</u>	<u>20 psi</u>	<u>39422.15</u>	<u>-0.01 gpm</u>
<u>1545</u>	<u>20</u>	<u>39422.15</u>	<u>0</u>
<u>1550</u>	<u>20</u>	<u>39422.15</u>	<u>0</u>
<u>1555</u>	<u>20</u>	<u>39422.15</u>	<u>0</u>
<u>1600</u>	<u>20</u>	<u>39422.15</u>	<u>0</u>
<u>1605</u>	<u>20</u>	<u>39422.15</u>	<u>0 gpm</u>
<u>1610</u>	<u>10 psi</u>	<u>39422.00</u>	<u>-0.03 gpm</u>
<u>1615</u>	<u>10</u>	<u>39422.00</u>	<u>0</u>
<u>1620</u>	<u>10</u>	<u>39422.00</u>	<u>0</u>
<u>1625</u>	<u>10</u>	<u>39422.00</u>	<u>0</u>
<u>1630</u>	<u>10</u>	<u>39422.00</u>	<u>0</u>
<u>1635</u>	<u>10</u>	<u>39422.00</u>	<u>0</u>

PACKER TEST ANALYSES

BOREHOLE : 208

Depth : 121-133 ft.

Pressure (h_2) : 10 psi (23.1 ft)

Unsaturated Zone Calculation:

Definitions:

L = length of test section

$$T_u = U - D + H$$

U = Thickness of Unsaturated Material

D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

L = head loss ; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) ; \text{percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = 187.5 \text{ ft} - 133 \text{ ft} + 160.1 \text{ ft} = 205.6 \text{ ft}$$

$$\frac{T_u}{L} = \frac{205.6 \text{ ft}}{12 \text{ ft}} = \boxed{17.1}$$

$$H = h_1 + h_2 - L = 137 \text{ ft} + 23.1 \text{ ft} - 0 = 160.1 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{160.1 \text{ ft}}{205.6 \text{ ft}} (100) = \boxed{78}$$

$$h_1 = 133 \text{ ft} + 4 \text{ ft} = 137 \text{ ft.}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure: If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 208
Depth : 121-133 ft.

Pressure (h_2) : 10 psi
23.1 ft

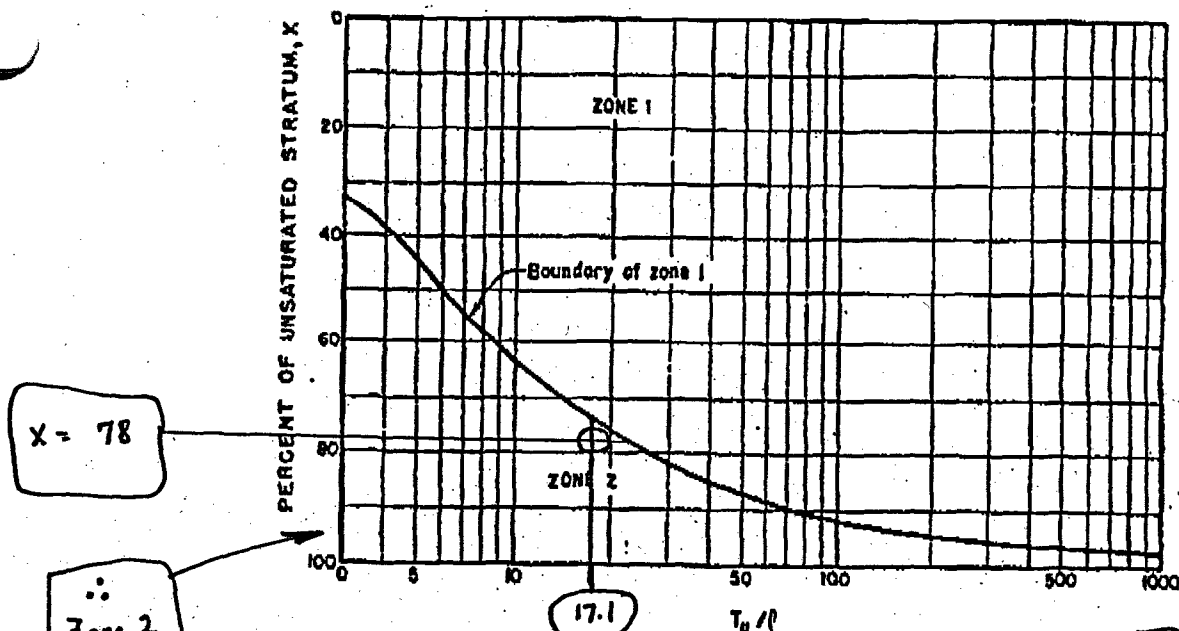


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 17.1$$

$$X = 78$$

FIELD MANUAL

$$T_u = 75 - 65 + 125.1 = 135.1 \text{ feet}$$

$$X = \frac{125.1}{135.1} (100) = 92.6\% \text{ also } \frac{T_u}{l} = \frac{135.1}{10} = 13.5$$

The test section is located in zone 2 (figure 17-6). To determine the saturated conductivity coefficient, C_s , from figure 17-8:

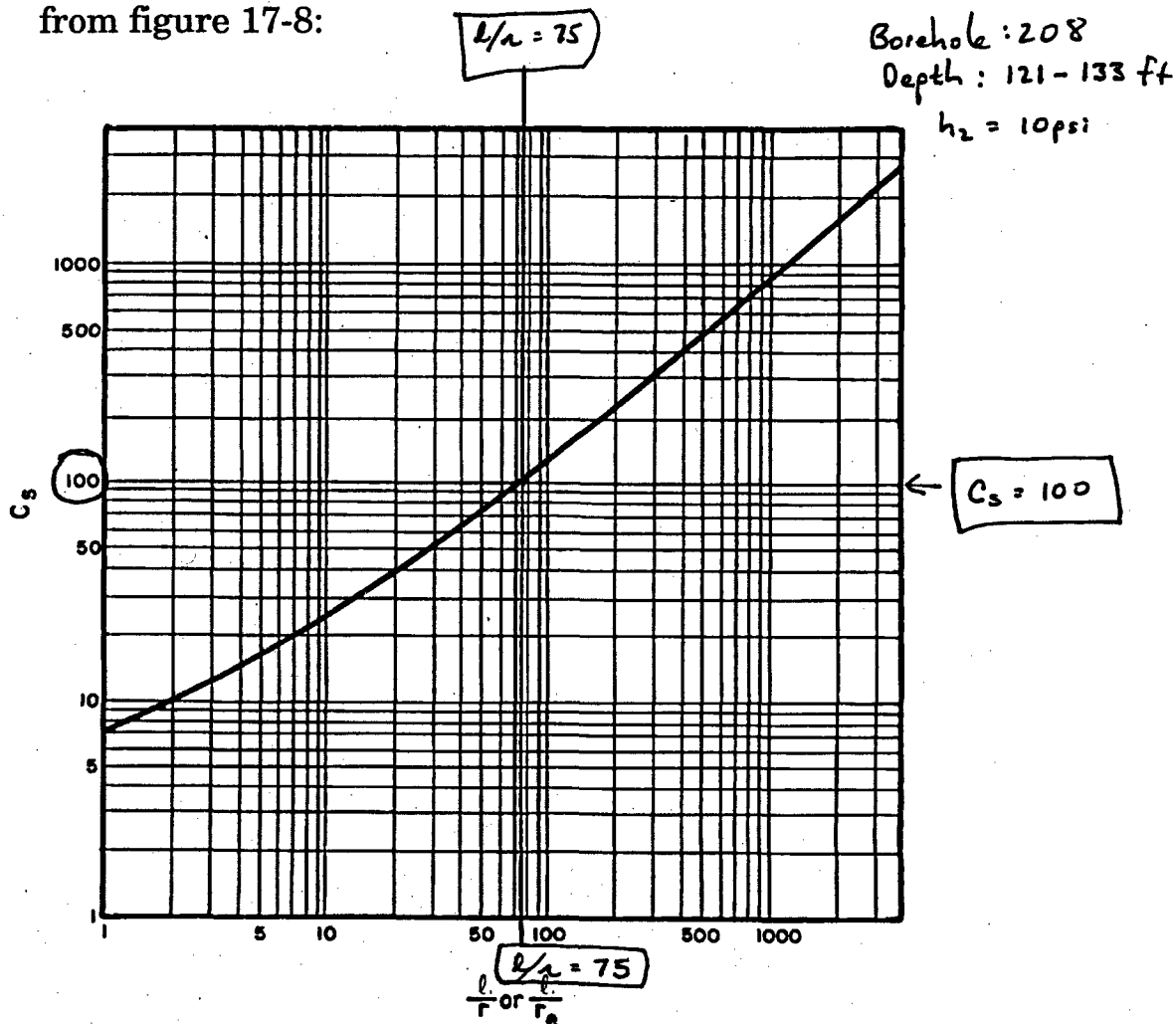


Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.

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PACKER TEST SET-UP SHEET
ZONE 2 / METHOD 2

JOB NO.: _____ DATE: 1-24-06
 JOB NAME: Crescent Junction Site
 PREPARED: M. Kautsky REVIEWED: _____
 SHEET NO.: _____ OF _____
 Borehole 208
 Depth 121-133 ft
 Pressure (h₂): 10 psi (23.1 ft)

C_s from figure 17-8

$$\frac{l}{r} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = 100$$

$$D = 133 \text{ ft}$$

Injector Pipe
Obtain L (head-loss coeff)

$$L = \frac{\phi}{Q} \text{ ft/10 ft.}$$

(Q < 4 gpm)

from Pressure-loss Curve.

Obtain T_u:

$$T_u = U - D + H$$

$$T_u = 187.5 - 133.0 + 160.1$$

$$T_u = 205.6$$

$$Q < \frac{0.01 \text{ gal}}{30 \text{ min}}$$

$$Q < 3.3 \times 10^{-4} \text{ gal/min}$$

CALCULATE K : ZONE 2

$$K = \frac{2Q}{(C_s L)(T_u + H - l)}$$

$$K < \frac{2(3.3 \times 10^{-4} \text{ gal/min})}{100(0.16)(205.6 + 160.1 - 12)}$$

$$K < 1.2 \times 10^{-7} \text{ gal/min/ft}^2$$

$$K < \left(\frac{1.2 \times 10^{-7} \text{ gal}}{\text{min} \cdot \text{ft}^2} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right) \left(\frac{1440 \text{ min}}{1} \right) = 2.27 \times 10^{-5} \text{ ft/d}$$

$$K < 8.0 \times 10^{-9} \text{ cm/s}$$

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PROJECT

DATE 1-23-06

JOB NAME Crescent Junction

PREPARED: M. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSES

Unsaturated Zone Calculation:

BOREHOLE: 208

Depth: 121-133

Pressure (h_2): 20 psi (46.2 ft)

Definitions:

 L = length of test section $T_u = U - D + H$ U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section $H = h_1 + h_2 - L$ L = head loss; ignore if $Q < 4$ gpm $X = \frac{H}{T_u} (100)$; percent unsaturated material

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = 187.5 \text{ ft} - 133 \text{ ft} + 183.2 \text{ ft} = 237.7 \text{ ft}$$

$$\frac{T_u}{L} = \frac{237.7 \text{ ft}}{12 \text{ ft}} = \boxed{19.8}$$

$$H = h_1 + h_2 - L = 137 \text{ ft} + 46.2 \text{ ft} - 0 = 183.2 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{183.2 \text{ ft}}{237.7 \text{ ft}} = 0.77 (100) = \boxed{77}$$

$$h_1 = 133 \text{ ft} + 4 \text{ ft} = 137 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 208
Depth : 121-133
Pressure (h_2) : 46.2 ft
(20 psi)

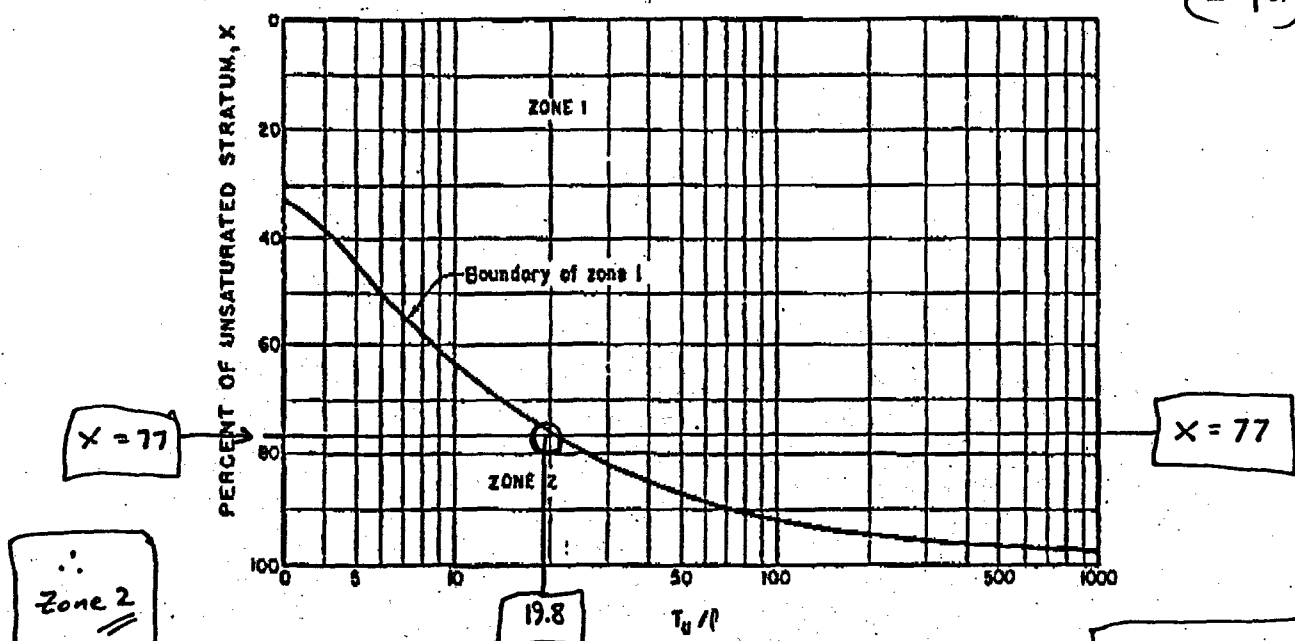


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

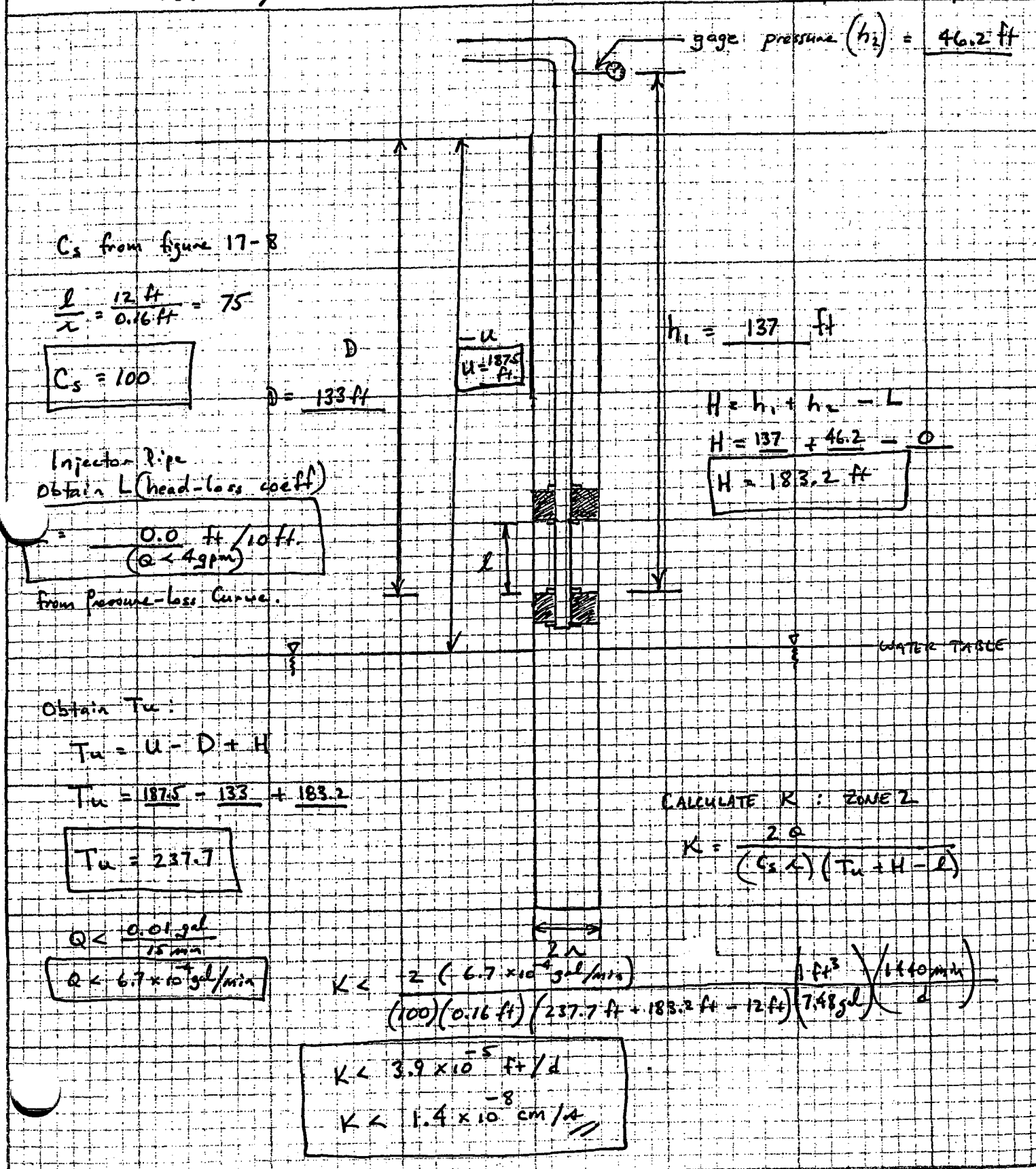
$$\frac{T_u}{l} = 19.8$$

$$X = 77$$

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PACKER TEST SET-UP SHEET
ZONE 2 / METHOD 2

JOB NO.: _____ DATE: 1-24-06
JOB NAME: Crescent Junction site
PREPARED: M. Kautsky REVIEWED: _____
SHEET NO.: _____ OF _____
Borehole 208
Depth 121-133
pressure: 20 psi



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JOB NO.

DATE 1-23-06

JOB NAME Crescent Junction

PREPARED: H. Kautsky

REVIEWED:

SHEET NO. OF

PACKER TEST ANALYSIS

BOREHOLE : 208

Depth : 121-133 ft

Pressure (h_2) : 30 psi (69.3 ft)

Unsaturated Zone Calculation:

Definitions:

 L = length of test section

$$T_u = U - D + H$$

 U = Thickness of Unsaturated Material D = distance from ground surface to bottom of test section

$$H = h_1 + h_2 - L$$

 L = head loss ; ignore if $Q < 4 \text{ gpm}$

$$X = \frac{H}{T_u} (100) ; \text{percent unsaturated material}$$

Reference Figure 17-6 U.S. Bureau of Rec. Earth Manual

$$L = 12 \text{ ft}$$

$$T_u = U - D + H = 187.5 \text{ ft} - 133 \text{ ft} + 206.3 \text{ ft} = 260.8 \text{ ft}$$

$$\frac{T_u}{L} = \frac{260.8 \text{ ft}}{12 \text{ ft}} = \boxed{21.7}$$

$$H = h_1 + h_2 - L = 137 \text{ ft} + 69.3 \text{ ft} - 0 \text{ ft} = 206.3 \text{ ft}$$

$$X = \frac{H}{T_u} (100) = \frac{206.3 \text{ ft}}{260.8 \text{ ft}} (100) = \boxed{79}$$

$$h_1 = 133 \text{ ft} + 4 \text{ ft} = 137 \text{ ft}$$

WATER TESTING FOR PERMEABILITY

- Effective head, the difference in feet (m) between the elevation of the free water surface in the pipe and the elevation of the gauge plus the applied pressure. If a pressure transducer is used, the effective head in the test section is the difference in pressure before water is pumped into the test section and the pressure readings made during the test.

The following examples show some typical calculations using Methods 1 and 2 in the different zones shown in figure 17-5. Figure 17-6 shows the location of the zone 1 lower boundary for use in unsaturated materials.

Pressure permeability tests examples using Methods 1 and 2:

Borehole : 208
Depth : 121-133 ft
Pressure (h_u) : 30 psi (69.3 ft)

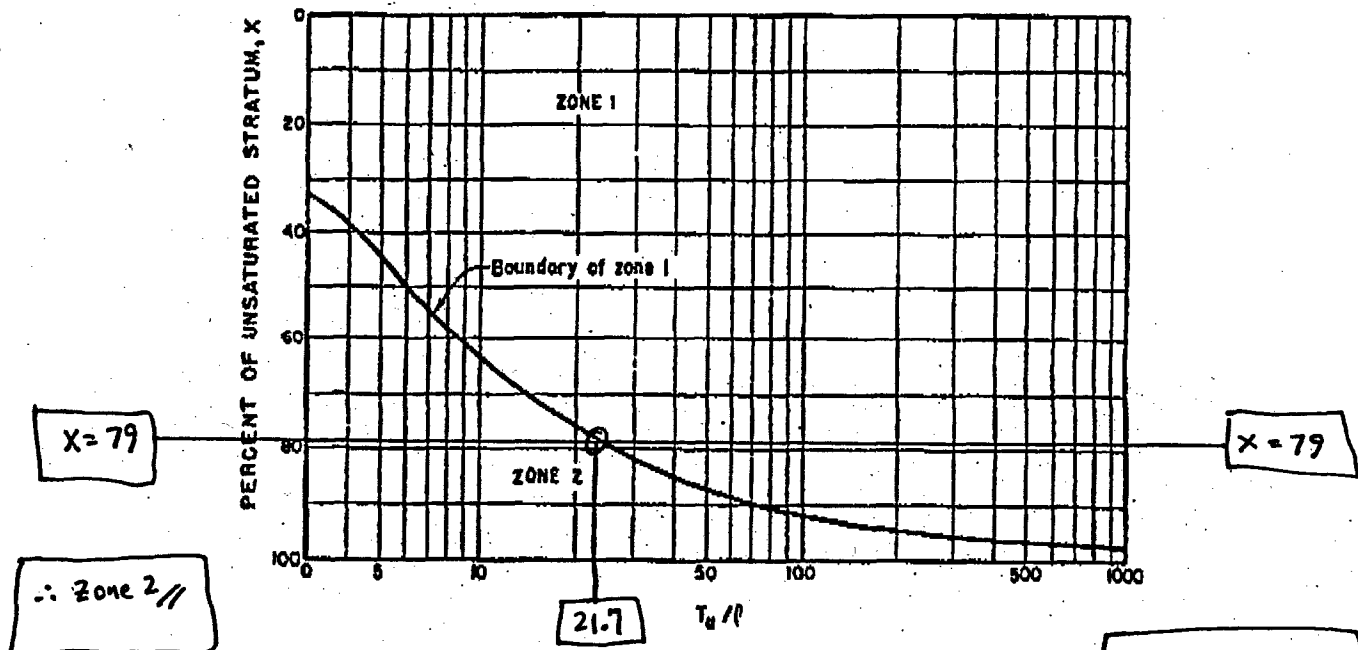


Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.

$$\frac{T_u}{l} = 21.7$$

$$X = 79$$

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PACKER TEST SET-UP SHEET
ZONE 2 / METHOD 2

JOB NO.: _____ DATE: 1-24-06

JOB NAME: Crescent Junction site

PREPARED: M. Kautsky

REVIEWED: _____
Borehole: 208

SHEET NO.: _____ OF _____
Depth: 121-133
pressure: 30 psi

C_s from figure 17-8

$$\frac{l}{\pi} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = 100$$

Injector Pipe
Obtain L (head-loss coeff)

$$L = \frac{0}{10 \text{ ft}} \text{ ft/10 ft.}$$

($Q = 4 \text{ gpm}$)
from Pressure-loss Curve.

Obtain T_u :

$$T_u = u - D + H$$

$$T_u = 187.5 - 133 + 206.3$$

$$T_u = 260.8 \text{ ft}$$

$$Q = 0.04 \text{ gpm}$$

(from data sheet)

$$K = \frac{2(0.04 \text{ gal/min})}{(100)(0.16 \text{ ft})(260.8 \text{ ft} + 206.3 \text{ ft} - 12 \text{ ft})} \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right) \left(\frac{1440 \text{ min}}{1 \text{ d}} \right)$$

$$K = 2.1 \times 10^{-3} \text{ ft/d}$$

$$K = 7.5 \times 10^{-7} \text{ cm/s}$$

gage pressure (h_2) = 69.3 ft

$$h_1 = 137 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$H = 137 + 69.3 - 0$$

$$H = 206.3 \text{ ft}$$

WATER TABLE

CALCULATE K : ZONE 2

$$K = \frac{2Q}{(C_s L)(T_u + H - L)}$$

Stoller

PACKER TEST SET-UP SHEET

ZONE 2 / METHOD 2

JOB NO.: _____ DATE: 1-24-06

JOB NAME: Crescent Junction site

PREPARED: M. Kautsky

REVIEWED: _____

SHEET NO.: _____ OF _____

Borehole 208
Depth 121-133
pressure: 20 psi
(Kautsky)

gage pressure (h_2) = 46.2 ft

C_s from figure 17-8

$$\frac{l}{r} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = 100$$

Injector Pipe
Obtain L (head-loss coeff)

$$L = \frac{0.0 \text{ ft}}{10 \text{ ft}} \quad (Q < 4 \text{ gpm})$$

from Pressure-loss Curve.

$$D = 133 \text{ ft}$$

$$u = 187.5 \text{ ft}$$

$$h_1 = 137 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$H = 137 + 46.2 - 0$$

$$H = 183.2 \text{ ft}$$

Obtain T_u :

$$T_u = u - D + H$$

$$T_u = 187.5 - 133 + 183.2$$

$$T_u = 237.7$$

CALCULATE K : ZONE 2

$$K = \frac{2Q}{(C_s L)(T_u + H - L)}$$

$$Q < \frac{0.01 \text{ gal}}{15 \text{ min}}$$

$$Q < 6.7 \times 10^{-3} \text{ gal/min}$$

$$K < \frac{2(6.7 \times 10^{-3} \text{ gal/min})}{(100)(0.16 \text{ ft})}$$

$$\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \left(\frac{1 \text{ min}}{60 \text{ sec}} \right)$$

$$K < 3.9 \times 10^{-5} \text{ ft/d}$$

$$K < 1.4 \times 10^{-8} \text{ cm/s}$$

Stoller

PACKER TEST SET-UP SHEET
ZONE 2 / METHOD 2

JOB NO.: _____ DATE: 1-24-06

JOB NAME: Crescent Junction Site

PREPARED: M. Kautsky

REVIEWED: _____

SHEET NO.: _____

OF _____

Borehole 208

Depth 121-133 ft

Pressure (h₂) 10 psi (3.1 ft)
(Retest)

gage pressure (h₂) = 23.1 ft

C_s from figure 17-8

$$\frac{l}{r} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = 100$$

D

$$D = 133 \text{ ft}$$

$$u = 187.5$$

$$h_1 = 137 \text{ ft}$$

$$H = h_1 + h_2 - L$$

$$H = 137 + 23.1 - 0$$

$$H = 160.1$$

Injector Pipe
Obtain L (head-loss coeff)

$$L = \frac{\phi}{Q} \text{ ft/10 ft.}$$

From Pressure-Loss Curve.

Obtain T_u:

$$T_u = u - D + H$$

$$T_u = 187.5 - 133.0 + 160.1$$

$$T_u = 205.6$$

$$Q < \frac{0.01 \text{ gal}}{30 \text{ min}}$$

$$Q < 3.3 \times 10^{-4} \text{ gal/min}$$

CALCULATE K : ZONE 2

$$K = \frac{2Q}{(C_s K) (T_u + H - L)}$$

$$K < \frac{2 (3.3 \times 10^{-4} \text{ gal/min})}{100 (0.16) (205.6 + 160.1 - 12)}$$

$$K < 1.2 \times 10^{-7} \text{ gal/min/ft}^2$$

$$K < \left(\frac{1.2 \times 10^{-7} \text{ gal}}{\text{min} \cdot \text{ft}^2} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right) \left(\frac{1440 \text{ min}}{1} \right) = 2.27 \times 10^{-5} \text{ ft/d}$$

$$K < 8.0 \times 10^{-9} \text{ cm/s}$$

Stoller

RECORD COPY

established 1959

Packer-Test Record

Page 1 of 2

Project Name: Moab - Crescent Jet characterization Date: 01/15/06

Field Representative: R. Rupp Borehole No. #0208 Total Depth: 360'

Depth to Water (TOC): 187.5 ft Borehole Cleaned? Yes ☒ No ☐ Date: 1/15/06

Test Interval (BGL): from 282' to 294' ft. Swivel/Elbow Height (AGL) 3.0 ft.

Conductor Pipe, Type and Size: 1-inch ID Thin Wall STEEL TUBING

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>0935</u>	<u>5 psi</u>	<u>39405.45</u>	
<u>0940</u>	<u>5 psi</u>	<u>39405.60</u>	<u>0.03 gpm</u>
<u>0945</u>	<u>5</u>	<u>39405.75</u>	<u>0.03</u>
<u>0950</u>	<u>5</u>	<u>39405.95</u>	<u>0.04</u>
<u>0955</u>	<u>5</u>	<u>39406.20</u>	<u>0.05</u>
<u>1000</u>	<u>5</u>	<u>39406.40</u>	<u>0.04</u>
<u>1005</u>	<u>5</u>	<u>39406.60</u>	<u>0.04</u>
<u>1010</u>	<u>5</u>	<u>39406.75</u>	<u>0.03</u>
<u>1015</u>	<u>5</u>	<u>39406.90</u>	<u>0.03</u>
<u>1020</u>	<u>5</u>	<u>39407.05</u>	<u>0.03 gpm</u>
<u>1025</u>	<u>10 psi</u>	<u>39407.35</u>	<u>0.06</u>
<u>1030</u>	<u>10</u>	<u>39407.55</u>	<u>0.04</u>
<u>1035</u>	<u>10</u>	<u>39407.95</u>	<u>0.04</u>
<u>1040</u>	<u>10</u>	<u>39407.90</u>	<u>0.03</u>
<u>1045</u>	<u>10</u>	<u>39408.10</u>	<u>0.04</u>
<u>1050</u>	<u>10</u>	<u>39408.25</u>	<u>0.03</u>
<u>1055</u>	<u>10</u>	<u>39408.40</u>	<u>0.03</u>
<u>1100</u>	<u>10</u>	<u>39408.55</u>	<u>0.03 gpm</u>

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RECORD COPY

established 1959

Packer-Test Record

Page 2 of 2

Project Name: Marble - Crescent Jet Characterization Date: 01/15/06

Field Representative: R. Rupp Borehole No. #0208 Total Depth: 300 ft.

Depth to Water (TOC): 187.5 ft. Borehole Cleaned? Yes ☒ No ☐ Date: 01/15/06

Test Interval (BGL): from 282' to 294' ft. Swivel/Elbow Height (AOL) 3.0 ft.

Conductor Pipe, Type and Size: 1-inch ID thin wall steel tubing

Time	Gauge Pressure	Flow Meter Reading	Flow Rate
<u>1105</u>	<u>20 psi</u>	<u>39408.80</u>	<u>0.05 gpm</u>
<u>1110</u>	<u>20</u>	<u>39408.80</u>	<u>0</u>
<u>1115</u>	<u>20</u>	<u>39408.80</u>	<u>0</u>
<u>1120</u>	<u>20</u>	<u>39408.80</u>	<u>0</u>
<u>1125</u>	<u>20</u>	<u>39408.80</u>	<u>0</u>
<u>1130</u>	<u>20</u>	<u>39408.80</u>	<u>0</u>
<u>1135</u>	<u>20</u>	<u>39408.80</u>	<u>0 2 gpm</u>
<u>1140</u>	<u>10 psi</u>	<u>39408.80</u>	<u>0</u>
<u>1145</u>	<u>10</u>	<u>39408.80</u>	<u>0</u>
<u>1150</u>	<u>10</u>	<u>39408.80</u>	<u>0</u>
<u>1155</u>	<u>10</u>	<u>39408.80</u>	<u>0</u>
<u>1200</u>	<u>10</u>	<u>39408.80</u>	<u>0</u>
<u>1205</u>	<u>10</u>	<u>39408.80</u>	<u>0</u>
<u>1210</u>	<u>10</u>	<u>39408.80</u>	<u>0</u>
<u>1215</u>	<u>10</u>	<u>39408.80</u>	<u>0 2 gpm</u>
<u>1220</u>	<u>5 psi</u>	<u>39408.85</u>	<u>0.01 gpm</u>
<u>1225</u>	<u>5</u>	<u>39408.95</u>	<u>0.02</u>
<u>1230</u>	<u>5</u>	<u>39409.05</u>	<u>0.02</u>
<u>1235</u>	<u>5</u>	<u>39409.15</u>	<u>0.02</u>
<u>1240</u>	<u>5</u>	<u>39409.25</u>	<u>0.02</u>
<u>1245</u>	<u>5</u>	<u>39409.30</u>	<u>0.01</u>
<u>1250</u>	<u>5</u>	<u>39409.35</u>	<u>0.01</u>
<u>1255</u>	<u>5 (A-150)</u>	<u>39409.40</u>	<u>0.01 gpm</u>

FIELD MANUAL

1-25-06
Borehole 208
Depth 282-294
All pressures (5, 10, 20 psi)

$$T_u = 75 - 65 + 125.1 = 135.1 \text{ feet}$$

$$X = \frac{125.1}{135.1} (100) = 92.6\% \text{ also } \frac{T_u}{l} = \frac{135.1}{10} = 13.5$$

The test section is located in zone 2 (figure 17-6). To determine the saturated conductivity coefficient, C_s , from figure 17-8:

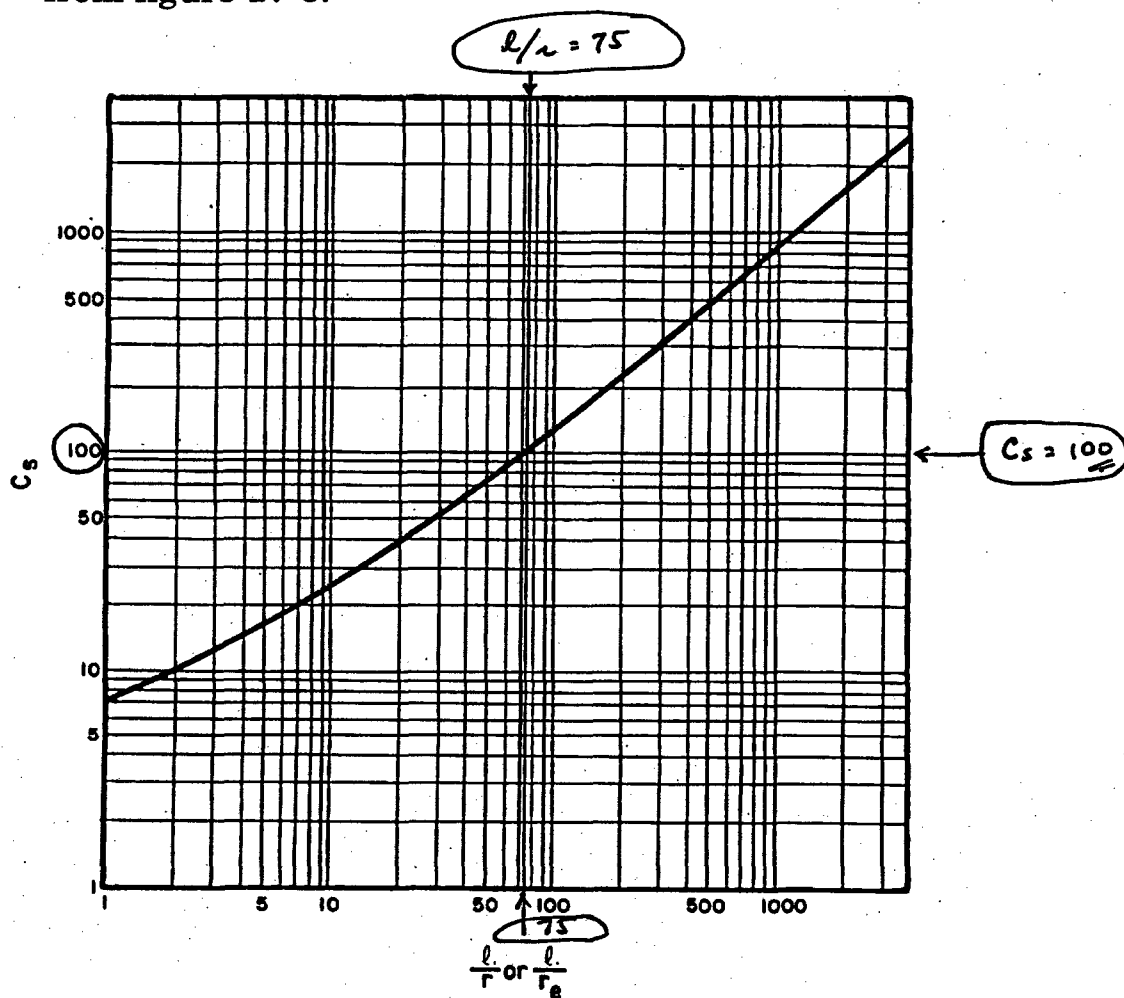


Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.

FIELD MANUAL

$$T_u = 75 - 65 + 125.1 = 135.1 \text{ feet}$$

$$X = \frac{125.1}{135.1} (100) = 92.6\% \text{ also } \frac{T_u}{l} = \frac{135.1}{10} = 13.5$$

The test section is located in zone 2 (figure 17-6). To determine the saturated conductivity coefficient, C_s , from figure 17-8:

Borehole 208
Depth: 282-294 ft
Pressure: 5 psi
1-25-06

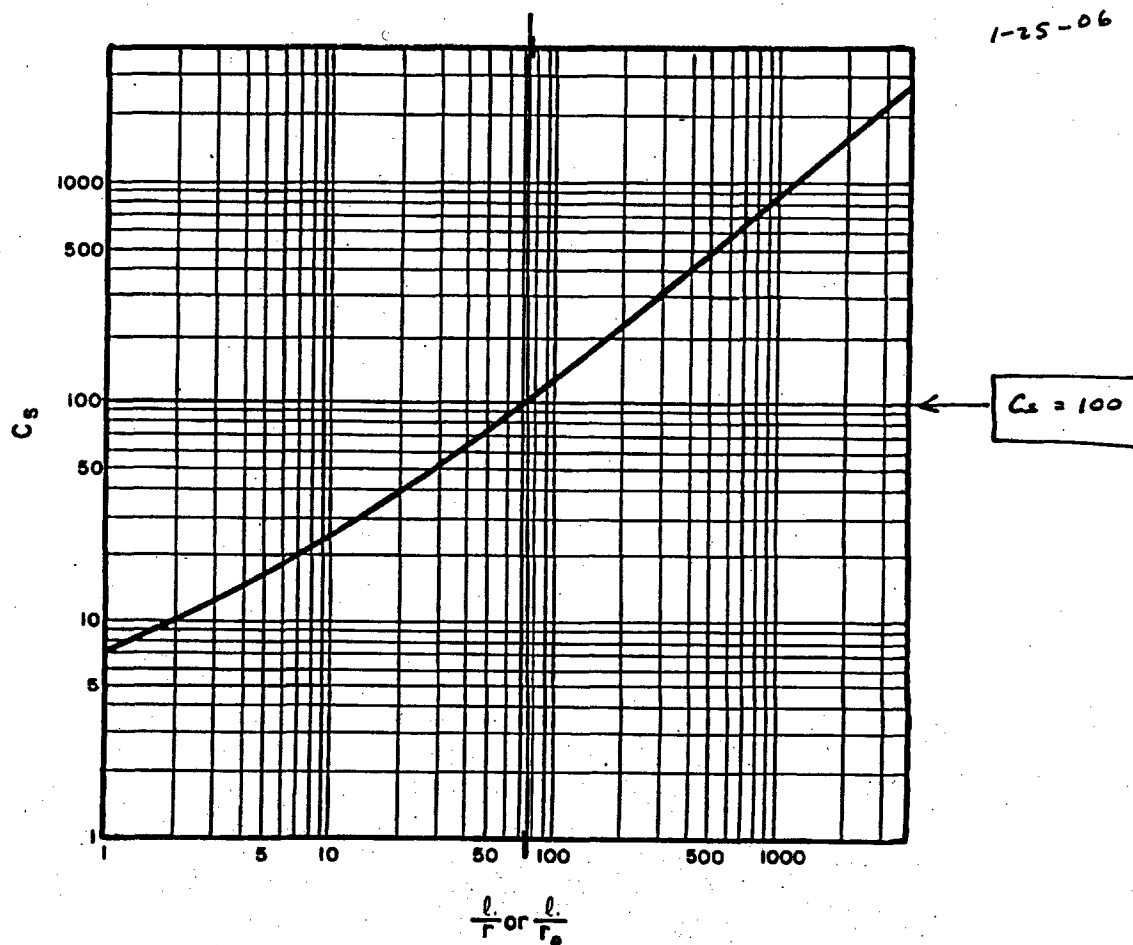


Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.

Stoller

For Straddle Packer Tests below water table
Zone 3; Method 2 USBR

JOB NO.: _____ DATE: 1-25-06

JOB NAME: Crescent Junction Site

PREPARED: M. Kautsky

REVIEWED: _____

SHEET NO.: _____ OF _____

Borehole 208

Depth 282-294

Pressure 1 Sp. 1

gage pressure (h_2) = 11.6 ft

land surface

Obtain L from
pressure-loss curve
if $Q > 4$ gpm

$$L = \boxed{\emptyset}$$

$\therefore Q < 4$ gpm

\bar{Q} from data sheet,
 $\bar{Q} = 0.03$ gal/min

$$D = \boxed{294 \text{ ft}}$$

$$H = h_1 + h_2 - L$$

$$H = 190.5 + 11.6 - \emptyset$$

$$H = \boxed{202.1 \text{ ft}}$$

$$h_1 = 190.5 \text{ ft}$$

water table

C_s from figure 17-8

$$\frac{l}{r} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = \boxed{100}$$

S

s

$$l = 12 \text{ ft}$$

$$r = 0.16 \text{ ft}$$

$$K = \frac{Q}{C_s l H}$$

$$K = \frac{(0.03 \frac{\text{gal}}{\text{min}}) (\frac{1440 \text{ min}}{d}) (\frac{1 \text{ ft}^3}{7.48 \text{ gal}})}{100 (0.16 \text{ ft}) (202.1 \text{ ft})}$$

$$K = 1.8 \times 10^{-3} \text{ ft/d}$$

$$K = 6.3 \times 10^{-7} \text{ cm/s}$$

Stoller

For Straddle Packer Tests below water table
Zone 3; Method 2 USBR

JOB NO.: _____ DATE: 1-25-06

JOB NAME: Crescent Junction site

PREPARED: M. Kautsky

REVIEWED: _____

SHEET NO.: _____ OF _____

Borehole 208

Depth 282-294 ft

Pressure: 10 psi

Obtain L from
pressure-loss curve
if $Q > 4$ gpm

$$L = \boxed{\phi}$$

($Q < 4$ gpm)

$\bar{Q} = 0.03$ gal/min
per data sheet

$$D = \boxed{294 \text{ ft}}$$

$$\text{gage pressure } (h_2) = 23.1 \text{ ft}$$

land surface

$$H = h_1 + h_2 - L$$

$$H = 190.5 + 23.1 - \phi$$

$$H = \boxed{213.6 \text{ ft}}$$

$$h_1 = 190.5 \text{ ft}$$

C_s from Figure 17-8

$$\frac{l}{r} = \frac{12 \text{ ft}}{0.14 \text{ ft}} = 75$$

$$C_s = \boxed{100}$$

S_c

$$l = 12 \text{ ft}$$

$$r = 0.16 \text{ ft}$$

$$K = \frac{Q}{C_s \lambda H}$$

$$K = \frac{0.03 \frac{\text{gal}}{\text{min}} \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{\text{ft}^3}{7.48 \text{ gal}} \right)}{(100) (0.16 \text{ ft}) (213.6 \text{ ft})} =$$

$$1.7 \times 10^{-3} \text{ ft/d}$$

$$6.0 \times 10^{-7} \text{ cm/a}$$

Stoller

For Straddle Packer Tests below water table
Zone 3; Method 2 USBR

JOB NO.: _____ DATE: 125-06

JOB NAME: Crescent Junction Site

PREPARED: M. Kautsky

REVIEWED: _____

Borehole: 208

SHEET NO.: _____ OF _____

Depth: 282-294

Pressure: 20 psi

Obtain L from
pressure-loss curve
if $Q > 4 \text{ gpm}$

$$L = \boxed{\emptyset}$$

($Q < 4 \text{ gpm}$)

$$Q < 0.01 \text{ gal/30 min}$$

$$Q < 3.33 \times 10^{-4} \text{ gal/min}$$

per data sheet

C_s from Figure 17-8

$$\frac{l}{r} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = \boxed{100}$$

$$D = \boxed{294 \text{ ft}}$$

$$\text{gage pressure } (h_2) = 46.2 \text{ ft}$$

land surface

$$H = h_1 + h_2 - L$$

$$H = 190.5 + 46.2 - \emptyset$$

$$H = \boxed{236.7 \text{ ft}}$$

$$h_1 = 190.5 \text{ ft}$$

water table

S

s

$$l = 12 \text{ ft}$$

$$r = 0.16 \text{ ft}$$

$$K = \frac{Q}{C_s \cdot l \cdot H}$$

$$K < \frac{(3.33 \times 10^{-4} \text{ gal/min}) \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{\text{ft}^3}{7.48 \text{ gal}} \right)}{(100) (0.16 \text{ ft}) (236.7 \text{ ft})} = 1.7 \times 10^{-5} \text{ ft/d}$$

$$K < 1.7 \times 10^{-5} \text{ ft/d} ; K < 6.0 \times 10^{-9} \text{ cm/s}$$

Stoller

For Straddle Packer Tests below water table
Zone 3; Method 2 USBR

JOB NO.: _____ DATE: 1-25-06

JOB NAME: Crescent Junction Site

PREPARED: M. Kautsky

REVIEWED: _____

SHEET NO.: _____ OF _____

Borehole 208

Depth: 282-294

pressure: 10 psi
retest

Obtain L from
pressure-loss curve
if $Q > 4 \text{ gpm}$

$$L = \boxed{\phi}$$

$Q < 4 \text{ gpm}$

$$Q < \frac{0.01 \text{ gal}}{35 \text{ min}}$$

$$Q < 2.86 \times 10^{-4} \text{ gal/min}$$

(per data sheet)

C_s from figure 17-8

$$\frac{h}{r} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = \boxed{100}$$

$$D = \boxed{294 \text{ ft}}$$

$$\text{gage pressure } (h_2) = 23.1 \text{ ft}$$

land surface

$$H = h_1 + h_2 - L$$

$$H = 190.5 + 23.1 - \phi$$

$$H = \boxed{213.6 \text{ ft}}$$

$$h_1 = 190.5 \text{ ft}$$

water table

S

sc

$$h = 12 \text{ ft}$$

$$r = 0.16 \text{ ft}$$

$$K = \frac{Q}{C_s \lambda H}$$

$$K < \frac{(2.86 \times 10^{-4} \text{ gal/min}) \left(\frac{1440 \text{ min}}{d} \right) \left(\frac{1 \text{ ft}^3}{7.48 \text{ gal}} \right)}{(100) (0.16 \text{ ft}) (213.6 \text{ ft})}$$

$$K < 1.6 \times 10^{-5} \text{ ft/d} ; K < 5.7 \times 10^{-9} \text{ cm/a}$$

Stoller

For Straddle Pecker Tests below water table
Zone 3; Method 2 USBR

JOB NO.: _____ DATE: 1-25-06

JOB NAME: Crescent Junction site

PREPARED: M. Kautsky REVIEWED: _____

SHEET NO.: _____ OF _____
Borehole 208
Depth: 282-294
pressure: 5 psi refect

Obtain L from
pressure-loss curve
if $Q > 4 \text{ gpm}$

$$L = 0$$

$\bar{a} = 0.01 \text{ gal/min}$
from data sheet

$$D = 294 \text{ ft}$$

$$\text{gage pressure } (h_2) = 11.6 \text{ ft}$$

land surface

$$H = h_1 + h_2 - L$$

$$H = 190.5 + 11.6 - 0$$

$$H = 202.5 \text{ ft}$$

$$h_1 = 190.5 \text{ ft}$$

C_s from figure 17-8

$$\frac{l}{\lambda} = \frac{12 \text{ ft}}{0.16 \text{ ft}} = 75$$

$$C_s = 100$$

S

S

$$l = 12 \text{ ft}$$

$$\lambda = 0.16 \text{ ft}$$

$$K = \frac{Q}{C_s \lambda H}$$

$$K = \frac{(0.01 \frac{\text{gal}}{\text{min}}) (\frac{1440 \text{ min}}{d}) (\frac{\text{ft}^3}{7.48 \text{ gal}})}{(100) (0.16 \text{ ft}) (202.5 \text{ ft})}$$

$$K = 6.0 \times 10^{-4} \text{ ft/d} ; K = 2.1 \times 10^{-7} \text{ cm/s}$$

U.S. Department of Energy—Grand Junction, Colorado

Calculation Cover Sheet

Calc. No. MOA-02-03-2006-2-03-00 Discipline: Hydrologic Properties No. of Sheets: 7

Project: Moab UMTRA Project

Site: Crescent Junction Disposal Site, Utah

Feature: Hydrologic Characterization – Ground Water Pumping Records

Sources of Data:

Field records of ground water pumping (Copies furnished in Appendix A)

Sources of Formulae and References:

DOE 2005. Work Plan for Characterization of the Crescent Junction, Utah, Disposal Site, DOE-EM/GJ912-2005

Preliminary Calc. ☐

Final Calc. ☐

Supersedes Calc. No.

Author:

Mark Kautsky 3-24-06
Name Date

Checked
by:

Craig Goodby 3/24/06
Name Date

Approved
by:

K. Karpf 3-29-06
Name Date

Dave Peterson 3/28/06
Name Date

K. Karpf
R. Heydenberg 3-29-06
Name Date

R. H. Burt 3/31/06
Name Date

Problem Statement:

Preliminary site selection performed jointly by the U.S. Department of Energy (DOE) and the Contractor has identified a 2,300-acre withdrawal area in the Crescent Flat area just northeast of Crescent Junction, Utah, as a possible site for a final disposal cell for the Moab uranium mill tailings. The proposed disposal cell would cover approximately 300 acres. Based on the preliminary site-selection process, the suitability of the Crescent Junction disposal site is being evaluated from several technical aspects, including geomorphic, geologic, hydrologic, seismic, geochemical, and geotechnical. The objective of this calculation is to impart the volume of ground water pumped from the Mancos Shale during the investigation of subsurface conditions at the Crescent Junction disposal site.

This calculation will be incorporated into Attachment 3 (Hydrology) of the *Remedial Action Plan and Site Design for Stabilization of Moab Title I Uranium Mill Tailings at the Crescent Junction, Utah, Disposal Site*, and summarized in the appropriate sections of the *Remedial Action Selection* report for the Moab site.

DOE (2005; p. 3–1) stated, "There are likely discontinuous saturated units within the Mancos Shale, but they are not anticipated to have significant lateral extent or interconnection, or contain usable ground water." During site characterization, a total of ten coreholes were drilled to a depth of 300 feet at the locations shown in Figure 1, and ground water was encountered in seven of them. In five of the coreholes (0201, 0202, 0203, 0204, 0208) the ground water was found to be highly saline, possibly exceeding the salinity levels found in seawater (Total Dissolved Solids [TDS] approximately 34,500 milligrams per liter [mg/L]). Based on its occurrence and composition, the water intersected by these coreholes appears to be *connate water*, or in other words, water that has been trapped in the pores of the rock since the rock (Mancos Shale) was formed.

In the two other coreholes containing ground water at the site (0205 and 0210), water-level recovery rates are very slow; consequently, ground water has not been pumped systematically from either location. One water sample collected from corehole 0210 was found to be very saline (TDS = 37,000 mg/L). Ground water from corehole 0205 has not been sampled but is also expected to be saline.

Pumping began in October 2005 at corehole 0208 and was followed shortly thereafter with pumping from the remaining coreholes. This calculation documents the volume of ground water extracted between October 31, 2005 and March 15, 2006.

Method of Solution:

Submersible pumps, which were powered with a portable generator, were installed in coreholes 0201, 0202, 0203, 0204, and 0208 shortly after the coreholes were drilled. Locations of the coreholes are shown in Figure 1. Discharge from each corehole was piped through a flow meter prior to being released at the land surface. Flow-meter readings were taken each time a corehole was evacuated. The incremental flow-meter readings were entered into an Excel spreadsheet, and the cumulative flows were determined by summation.

Assumptions:

- Per the assumption stated in the work plan (DOE 2005; p. 3–1), ground water at the site was anticipated to occur in discontinuous water-bearing conduits within the Mancos Shale.
- If the submersible pump is set at a fixed elevation in a formation with discontinuous water-bearing conduits, systematic pumping through time will gradually yield lesser volumes of ground water.

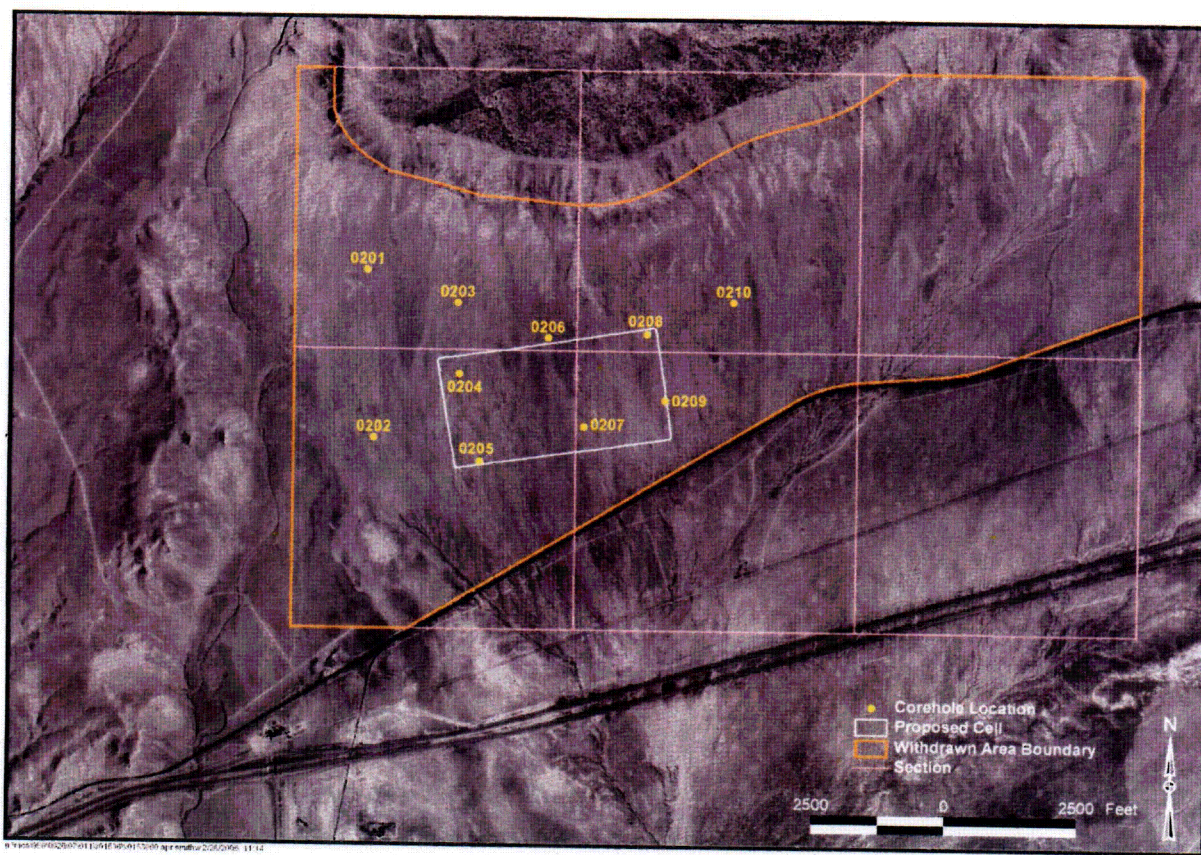


Figure 1. Map of Corehole Locations at the Crescent Junction Site

Calculation:

The objective of ground water pumping at the Crescent Junction site has been to test the hypothesis that the ground water occurs in discontinuous water-bearing conduits within the Mancos Shale. It was reasoned that systematic pumping of the ground water would gradually deplete the source of connate water entering the coreholes if the ground water occurs in discontinuous water-bearing conduits.

Figures 2 through 6 present the incremental and cumulative pumping results to date for each corehole. As of March 17, 2006, a total of approximately 8,270 gallons had been removed from the five coreholes that contain connate water. The extracted amounts range from approximately 569 gallons from corehole 0204 to approximately 3,395 gallons from corehole 0203.

Analysis of the pumping curves in Figures 2 through 6 and the pumping data in Appendix A show that pumping first began in corehole 0208 and was followed with pumping from corehole 0203. A hiatus occurred from December 2, 2005, to mid-January 2006, during which time no pumping occurred. During the second week of January 2006, pumps were installed in coreholes 0201, 0202, and 0204, and regular systematic pumping began at all five coreholes.

A qualitative analysis presented in Figures 2 through 6 shows that the incremental pumping volumes remained steady and the slope of the cumulative pumping curves remained unchanged at coreholes 0201, 0203, 0204, and 0208. This observation contrasts with an apparent decrease in incremental pumping volumes at corehole 0202 and a reduction in the slope of the cumulative pumping curve, which began at the end of January 2006. The qualitative results may indicate that the source of connate water to corehole 0202 is being depleted; however, the same cannot be said for coreholes 0201, 0203, 0204, and 0208.

Discussion:

N/A

Conclusion and Recommendations:

The purpose of pumping connate water from the coreholes at the Crescent Junction disposal site has been to test the concept that the water occurs in discontinuous and isolated zones or porous compartments. Persistent pumping from zones containing limited volumes of trapped water should eventually yield decreased volumes of produced water and a flattening of the cumulative recovery curve. Such behavior would typify incipient source depletion.

As of March 17, 2006, the pumping data have shown that the incremental pumping volumes have declined, and the cumulative recovery curve has begun to flatten at corehole 0202. Coreholes 0201, 0203, 0204, and 0208 have continued to yield water at relatively constant rates, signifying that the connate water intercepted by these coreholes is stored in larger compartments, which will require more pumping to deplete. The continued pumping from these larger compartments is deemed unnecessary because the concept that the connate water is trapped in porous zones with limited volume was already demonstrated at corehole 0202. In addition, coreholes 0206, 0207, and 0209 have never contained any water since the holes were drilled, which further supports the position that the connate water is present in discontinuous pockets.

Other important aspects of the ground water hydrology that should be considered are the static water levels, the ground water chemistry, and the effect that repeated pumping has had on them. Therefore, we recommend that systematic pumping from the coreholes should be permanently discontinued to allow static water levels to recover and to collect additional baseline water samples.

Computer Source:

Microsoft Excel

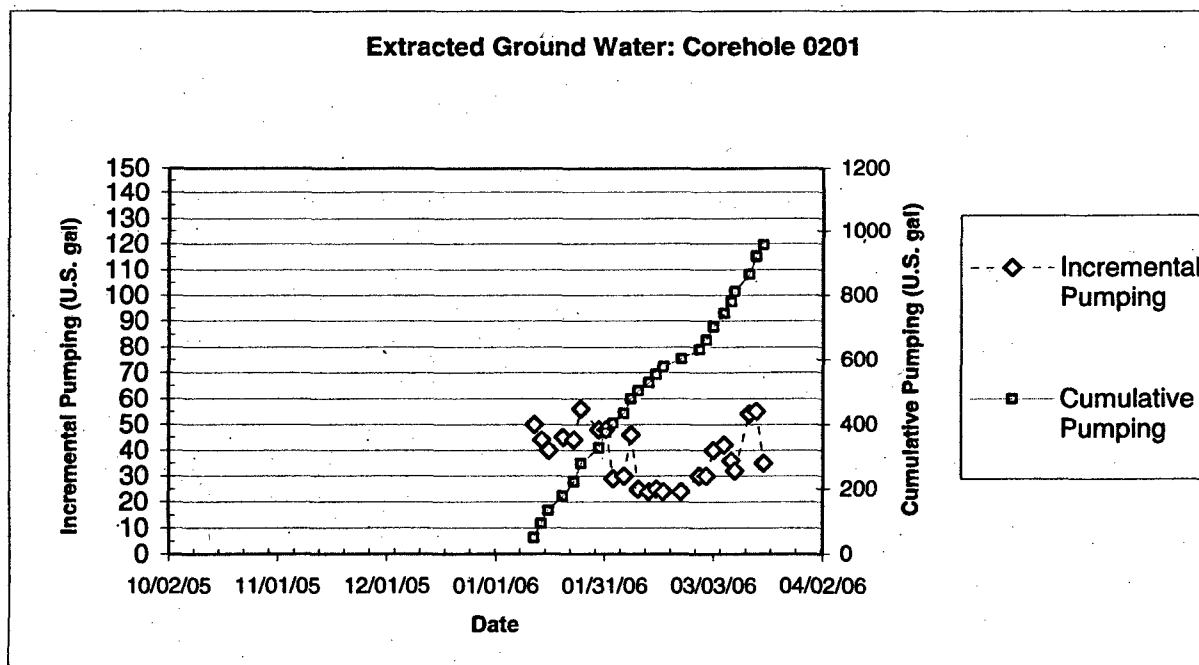


Figure 2. Ground Water Withdrawal from Corehole 0201, Crescent Junction, Utah, Disposal Site

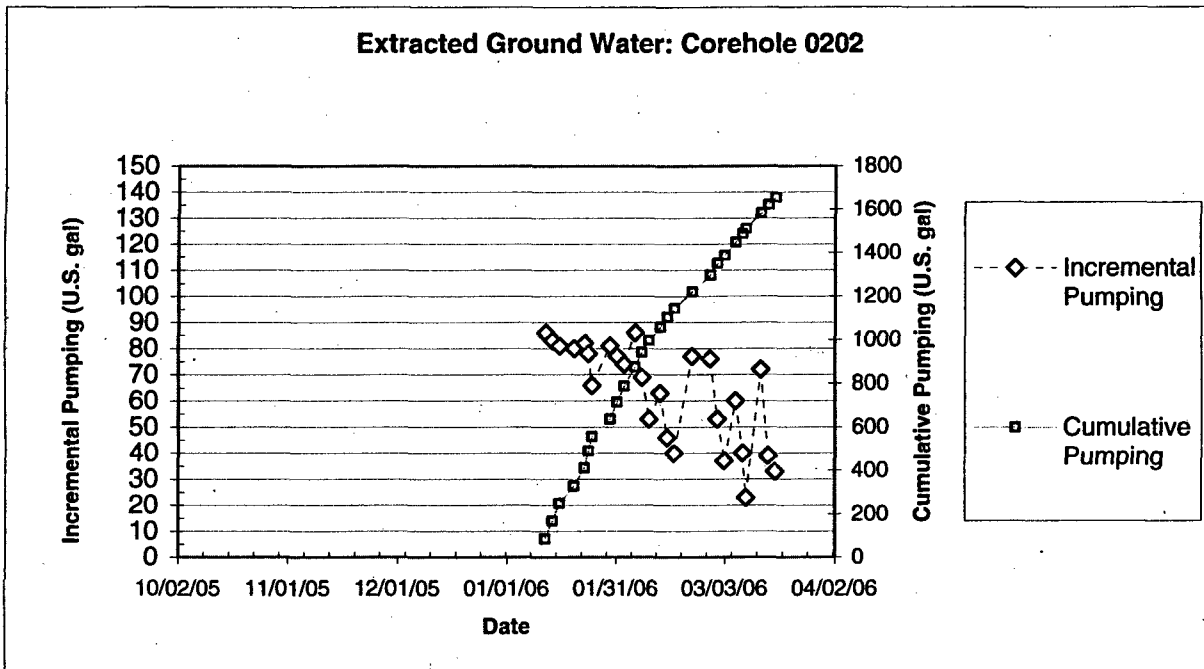


Figure 3. Ground Water Withdrawal from Corehole 0202, Crescent Junction, Utah, Disposal Site

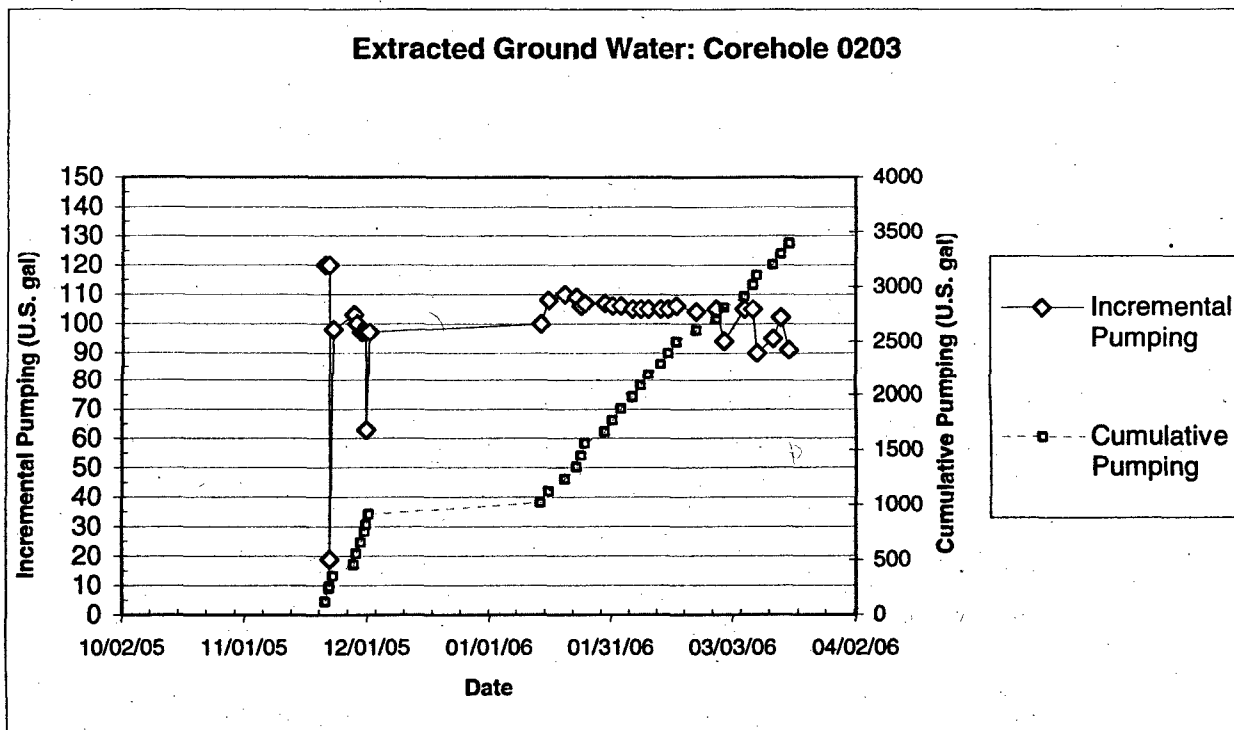


Figure 4. Ground Water Withdrawal from Corehole 0203, Crescent Junction, Utah, Disposal Site

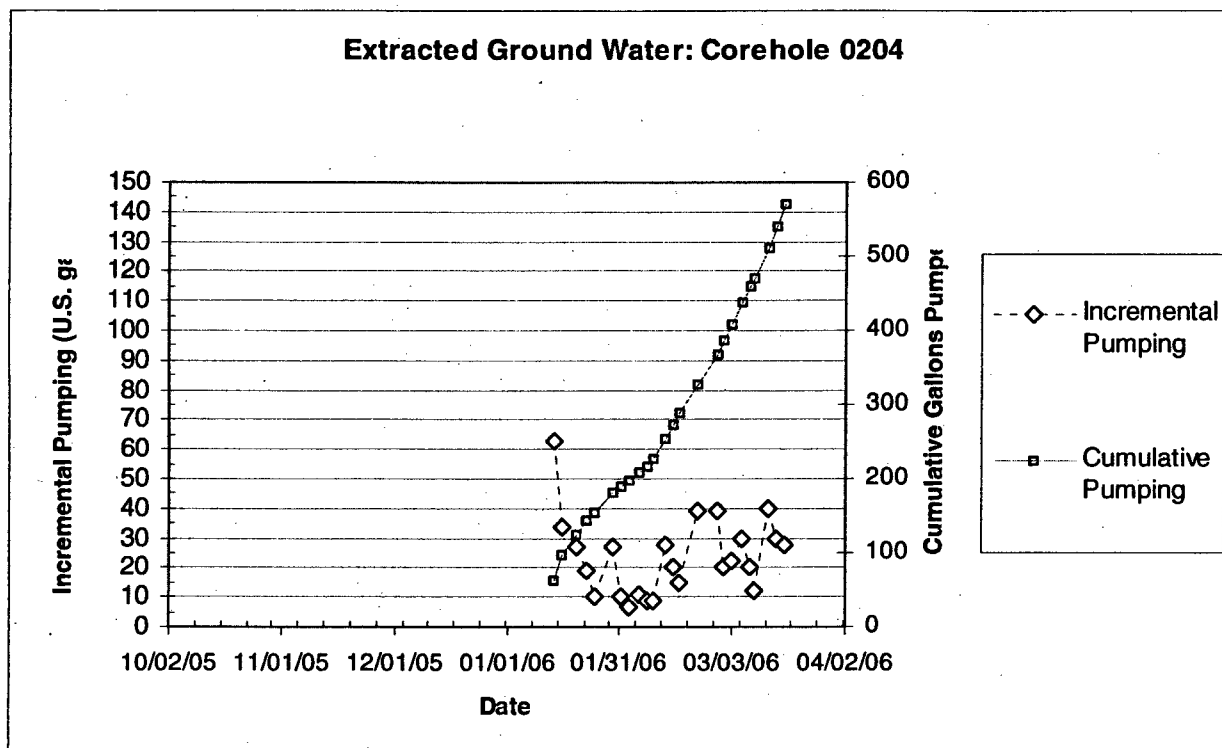


Figure 5. Ground Water Withdrawal from Corehole 0204, Crescent Junction, Utah, Disposal Site

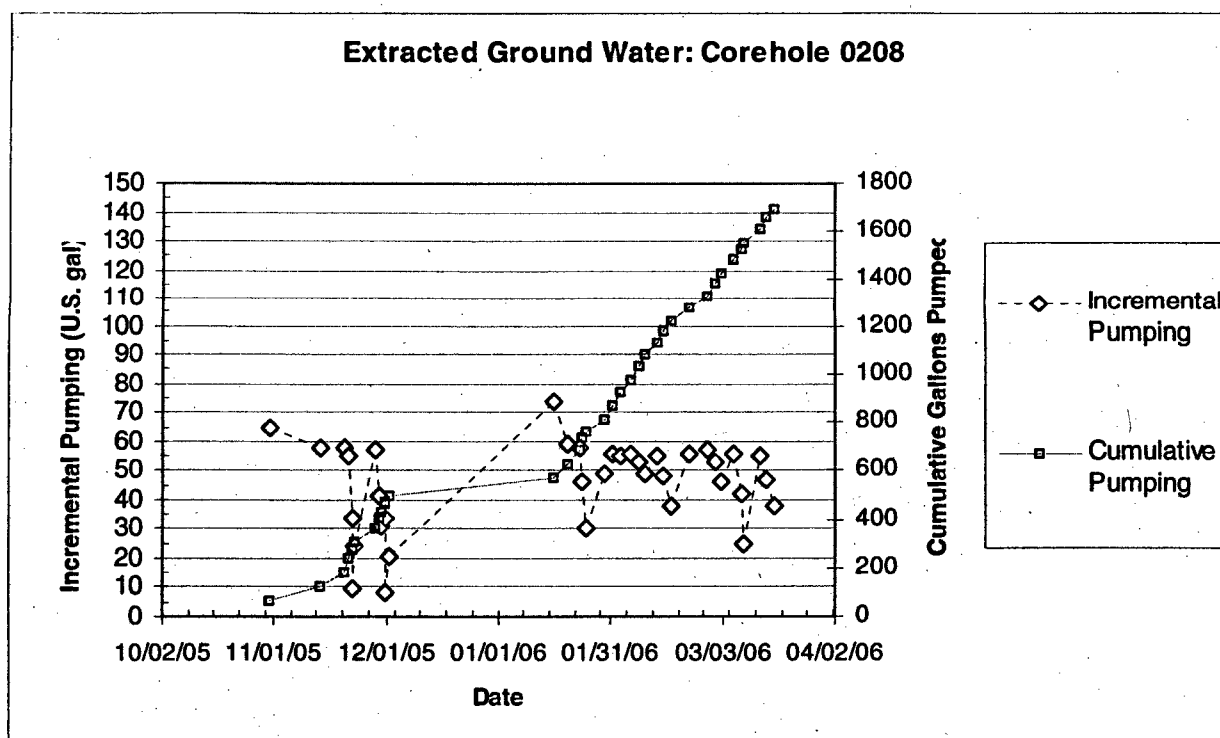


Figure 6. Ground Water Withdrawal from Corehole 0208, Crescent Junction, Utah, Disposal Site

Appendix A

Field Records of Ground Water Pumping

Well #	Date	Gallons Purged	Cumulative Purged
201	01/12/06	50	50
	01/14/06	44	94
	01/16/06	40	134
	01/20/06	45	179
	01/23/06	44	223
	01/25/06	56	279
	01/30/06	48	327
	02/01/06	48	375
	02/03/06	29	404
	02/06/06	30	434
	02/08/06	46	480
	02/10/06	25	505
	02/13/06	24	529
	02/15/06	25	554
	02/17/06	24	578
	02/22/06	24	602
	02/27/06	30	632
	03/01/06	30	662
	03/03/06	40	702
	03/06/06	42	744
	03/08/06	36	780
	03/09/06	32	812
	03/13/06	54	866
	03/15/06	55	921
	03/17/06	35	956

Well #	Date	Gallons Purged	Cumulative Purged
202	01/12/06	86	86
	01/14/06	83	169
	01/16/06	81	250
	01/20/06	80	330
	01/23/06	82	412
	01/24/06	78	490
	01/25/06	66	556
	01/30/06	81	637
	02/01/06	77	714
	02/03/06	74	788
	02/06/06	86	874
	02/08/06	69	943
	02/10/06	53	996
	02/13/06	63	1059
	02/15/06	46	1105
	02/17/06	40	1145
	02/22/06	77	1222
	02/27/06	76	1298
	03/01/06	53	1351
	03/03/06	37	1388
	03/06/06	60	1448
	03/08/06	40	1488
	03/09/06	23	1511
	03/13/06	72	1583
	03/15/06	39	1622
	03/17/06	33	1655

Well #	Date	Gallons Purged	Cumulative Purged
203	11/21/05	120	120
	11/22/05	120	240
	11/22/05	19	259
	11/23/05	98	357
	11/28/05	103	460
	11/29/05	100	560
	11/30/05	97	657
	12/01/05	97	754
	12/01/05	63	817
	12/02/05	97	914
	01/14/06	100	1014
	01/16/06	108	1122
	01/20/06	110	1232
	01/23/06	109	1341
	01/24/06	106	1447
	01/25/06	107	1554
	01/30/06	107	1661
	02/01/06	106	1767
	02/03/06	106	1873
	02/06/06	105	1978
	02/08/06	105	2083
	02/10/06	105	2188
	02/13/06	105	2293
	02/15/06	105	2398
	02/17/06	106	2504
	02/22/06	104	2608
	02/27/06	105	2713
	03/01/06	94	2807
	03/06/06	105	2912
	03/08/06	105	3017
	03/09/06	90	3107
	03/13/06	95	3202
	03/15/06	102	3304
	03/17/06	91	3395

Well #	Date	Gallons Purged	Cumulative Purged
204	01/14/06	63	63
	01/16/06	34	97
	01/20/06	27	124
	01/23/06	19	143
	01/25/06	10	153
	01/30/06	27	180
	02/01/06	10	190
	02/03/06	7	197
	02/06/06	11	208
	02/08/06	9	217
	02/10/06	9	226
	02/13/06	28	254
	02/15/06	20	274
	02/17/06	15	289
	02/22/06	39	328
	02/27/06	39	367
	03/01/06	20	387
	03/03/06	22	409
	03/06/06	30	439
	03/08/06	20	459
	03/09/06	12	471
	03/13/06	40	511
	03/15/06	30	541
	03/17/06	28	569

Well #	Date	Gallons Purged	Cumulative Purged
208	10/31/05	65	65
	11/14/05	58	123
	11/20/05	57.5	180.5
	11/21/05	54.9	235.4
	11/22/05	33.4	268.8
	11/22/05	9.5	278.3
	11/23/05	24	302.3
	11/28/05	57.3	359.6
	11/29/05	41	400.6
	11/30/05	31.1	431.7
	12/01/05	33.6	465.3
	12/01/05	8.3	473.6
	12/02/05	20.8	494.4
	01/16/06	73.6	568
	01/20/06	59	627
	01/23/06	58	685
	01/24/06	46	731
	01/25/06	30	761
	01/30/06	49	810
	02/01/06	56	866
	02/03/06	55	921
	02/06/06	56	977
	02/08/06	53	1030
	02/10/06	49	1079
	02/13/06	55	1134
	02/15/06	48	1182
	02/17/06	38	1220
	02/22/06	56	1276
	02/27/06	57	1333
	03/01/06	53	1386
	03/03/06	46	1432
	03/06/06	56	1488
	03/08/06	42	1530
	03/09/06	25	1555
	03/13/06	55	1610
	03/15/06	47	1657
	03/17/06	38	1695