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September 25, 2018

File No. 15-185-01

Iron North LP
Box 72
Split Lake, Manitoba
R0B 1P0

ATTENTION: Bob Yatkowsky

RE: Hydraulic Conductivity Test Results – Kelsey Lagoon

ENG-TECH Consulting Limited (ENG-TECH) received eight (8) Shelby tube samples from the above project on September 6, 2018 and completed the requested hydraulic conductivity testing on the four (4) samples selected by Manitoba Sustainable. The four (4) Shelby Tube samples were extracted on September 7 and 11, 2018 at ENG-TECH laboratory.

The samples labelled as ST4, ST6, ST7 and ST8 were prepared for testing in accordance with ASTM D5084-16a, *Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter*. The final hydraulic conductivity values (k_{20}) of 2.8×10^{-8} cm/sec, 2.0×10^{-7} cm/sec, 2.5×10^{-8} cm/sec and 4.1×10^{-8} cm/sec were obtained for the samples identified as ST4, ST6, ST7 and ST8, respectively. The hydraulic conductivity test data is outlined in Table 1, while the graphical representations of the hydraulic conductivity versus elapsed time are shown in Figures 1 to 4. Photographs of the samples are attached

Upon completion of testing the samples were broken open for observation. Silt pockets as well as some cracks were observed in sample ST6 during sample preparation and are likely the cause of the higher hydraulic conductivity values by creating preferential flow paths.

ENG-TECH trusts the above is all the information you require. If you have any questions, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited

Clark Hryhoruk, M.Sc., P.Eng.
President, Geotechnical Engineer

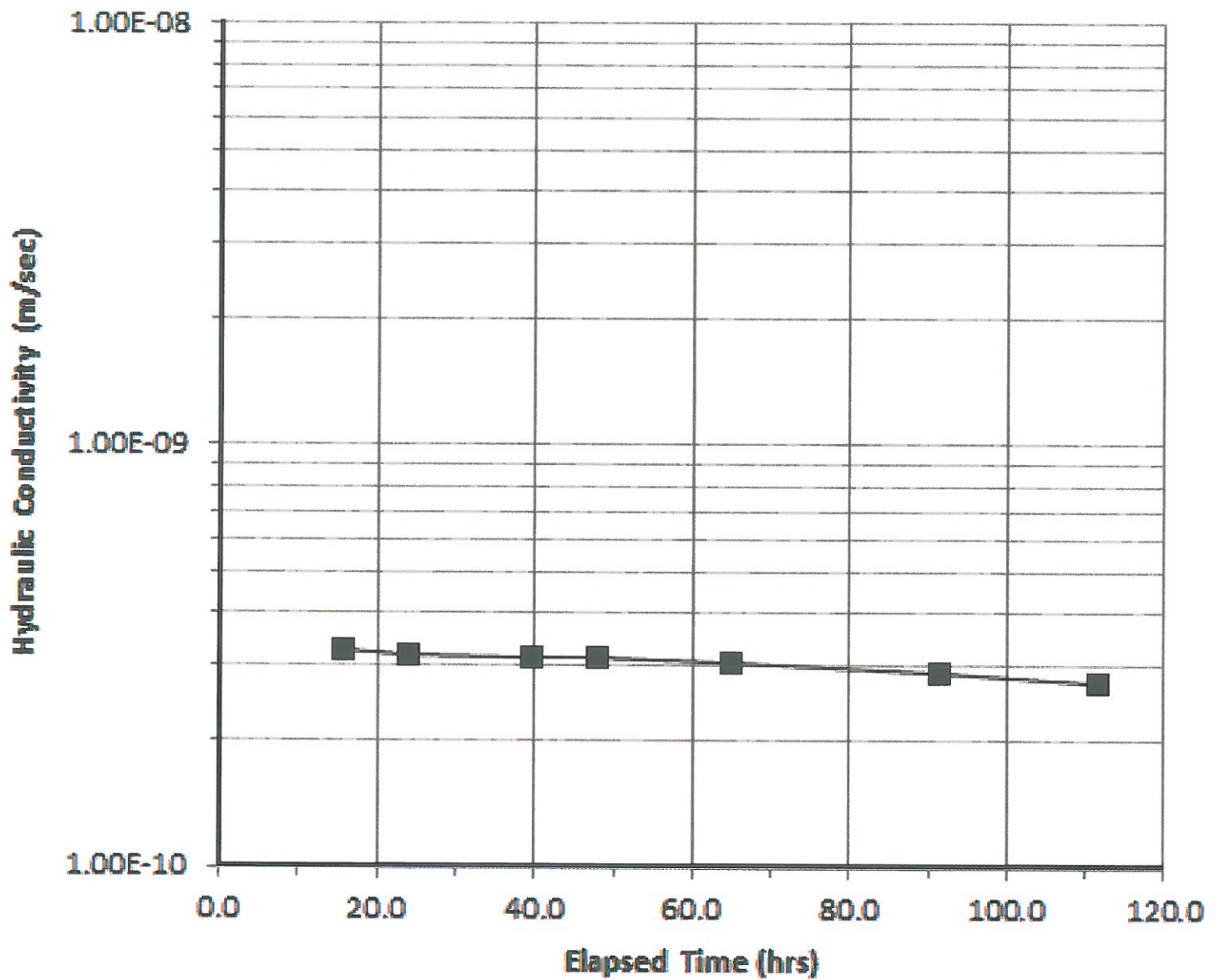
CDH/pfpc

Attachments: Table 1 – Hydraulic Conductivity Test Data (Kelsey Lagoon)
Figure 1 – Hydraulic Conductivity Versus Elapsed Time (ST4)
Figure 2 – Hydraulic Conductivity Versus Elapsed Time (ST6)
Figure 3 – Hydraulic Conductivity Versus Elapsed Time (ST7)
Figure 4 – Hydraulic Conductivity Versus Elapsed Time (ST8)
Photographs (1 to 8)

**TABLE 1
HYDRAULIC CONDUCTIVITY TEST DATA
KELSEY LAGOON**

SAMPLE IDENTIFICATION	ST4	ST6
INITIAL VALUES		
ENG-TECH Reference No.	15-185-1-41	15-185-1-42
Length of Sample in Tube (cm)	73.6	71.1
Length (cm)	6.90	6.95
Diameter (cm)	7.11	7.06
Area (cm ²)	39.7	39.1
Volume (cm ³)	273.8	271.9
Water Content (%)	27.4	24.3
Bulk Dry Density (kg/m ³)	1521	1631
Specific Gravity (G _s) (assumed)	2.70	2.70
Void Ratio	0.775	0.655
Degree of Saturation (%)	95.5	~100
FINAL VALUES		
Length (cm)	6.80	6.93
Diameter (cm)	7.12	7.04
Area (cm ²)	39.8	38.9
Volume (cm ³)	270.6	269.6
Water Content (%)	29.0	25.8
Bulk Dry Density (kg/m ³)	1526	1622
Specific Gravity (G _s) (assumed)	2.70	2.70
Void Ratio	0.769	0.665
Degree of Saturation (%)	100	100
CONSOLIDATION PHASE		
Confining Pressure (kPa)	103.4	103.4
Pore Water Pressure (kPa)	82.7	82.7
Effective Stress (kPa)	20.7	20.7
PERMEATION PHASE		
Confining Pressure (kPa)	103.4	103.4
Pore Water Pressure (kPa)	82.7	82.7
Effective Stress (kPa)	20.7	20.7
Hydraulic Gradient	16.5	16.2
Permeant Fluid	Potable Tap Water	Potable Tap Water
HYDRAULIC CONDUCTIVITY AT TEST TEMPERATURE OF 23 °C (cm/sec)	3.0×10^{-8}	2.2×10^{-7}
HYDRAULIC CONDUCTIVITY AT TEMPERATURE OF 20 °C (K₂₀) (cm/sec)	2.8×10^{-8}	2.0×10^{-7}

SAMPLE IDENTIFICATION	ST7	ST8
INITIAL VALUES		
ENG-TECH Reference No.	15-185-1-43	15-185-1-44
Length of Sample in Tube (cm)	72.3	72.3
Length (cm)	6.99	6.85
Diameter (cm)	6.93	6.97
Area (cm ²)	37.7	38.1
Volume (cm ³)	263.5	261.2
Water Content (%)	24.3	26.9
Bulk Dry Density (kg/m ³)	1650	1623
Specific Gravity (G _s) (assumed)	2.70	2.70
Void Ratio	0.636	0.664
Degree of Saturation (%)	~100	~100
FINAL VALUES		
Length (cm)	6.97	6.78
Diameter (cm)	6.95	7.02
Area (cm ²)	37.9	38.7
Volume (cm ³)	264.3	262.3
Water Content (%)	22.9	25.6
Bulk Dry Density (kg/m ³)	1672	1625
Specific Gravity (G _s) (assumed)	2.70	2.70
Void Ratio	0.614	0.662
Degree of Saturation (%)	100	100
CONSOLIDATION PHASE		
Confining Pressure (kPa)	103.4	103.4
Pore Water Pressure (kPa)	82.7	82.7
Effective Stress (kPa)	20.7	20.7
PERMEATION PHASE		
Confining Pressure (kPa)	103.4	103.4
Pore Water Pressure (kPa)	82.7	82.7
Effective Stress (kPa)	20.7	20.7
Hydraulic Gradient	16.1	16.6
Permeant Fluid	Potable Tap Water	Potable Tap Water
HYDRAULIC CONDUCTIVITY AT TEST TEMPERATURE OF 23 °C (cm/sec)	2.7 x 10 ⁻⁸	4.4 x 10 ⁻⁸
HYDRAULIC CONDUCTIVITY AT TEMPERATURE OF 20 °C (K₂₀) (cm/sec)	2.5 x 10 ⁻⁸	4.1 x 10 ⁻⁸



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DATE:

SEPTEMBER 2018

DRAWN BY:
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FIGURE No.:
1

REV.:

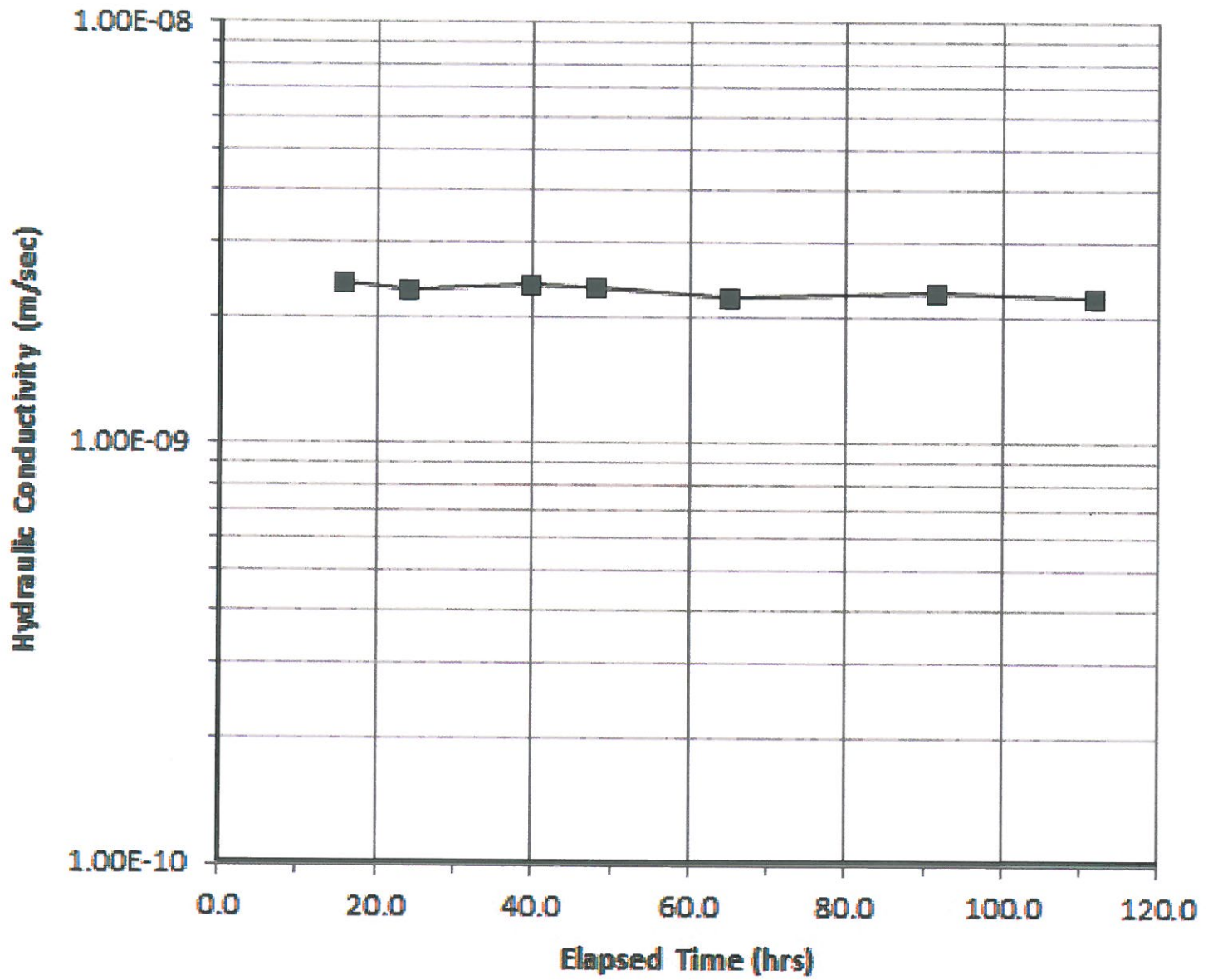
PROJECT:

KELSEY LAGOON

FILE No.:
15-185-01

SCALE:
N/A

HYDRAULIC CONDUCTIVITY
 VERSUS ELAPSED TIME
 (ST4)



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FIGURE No.:

2

REV.:

PROJECT:

KELSEY LAGOON

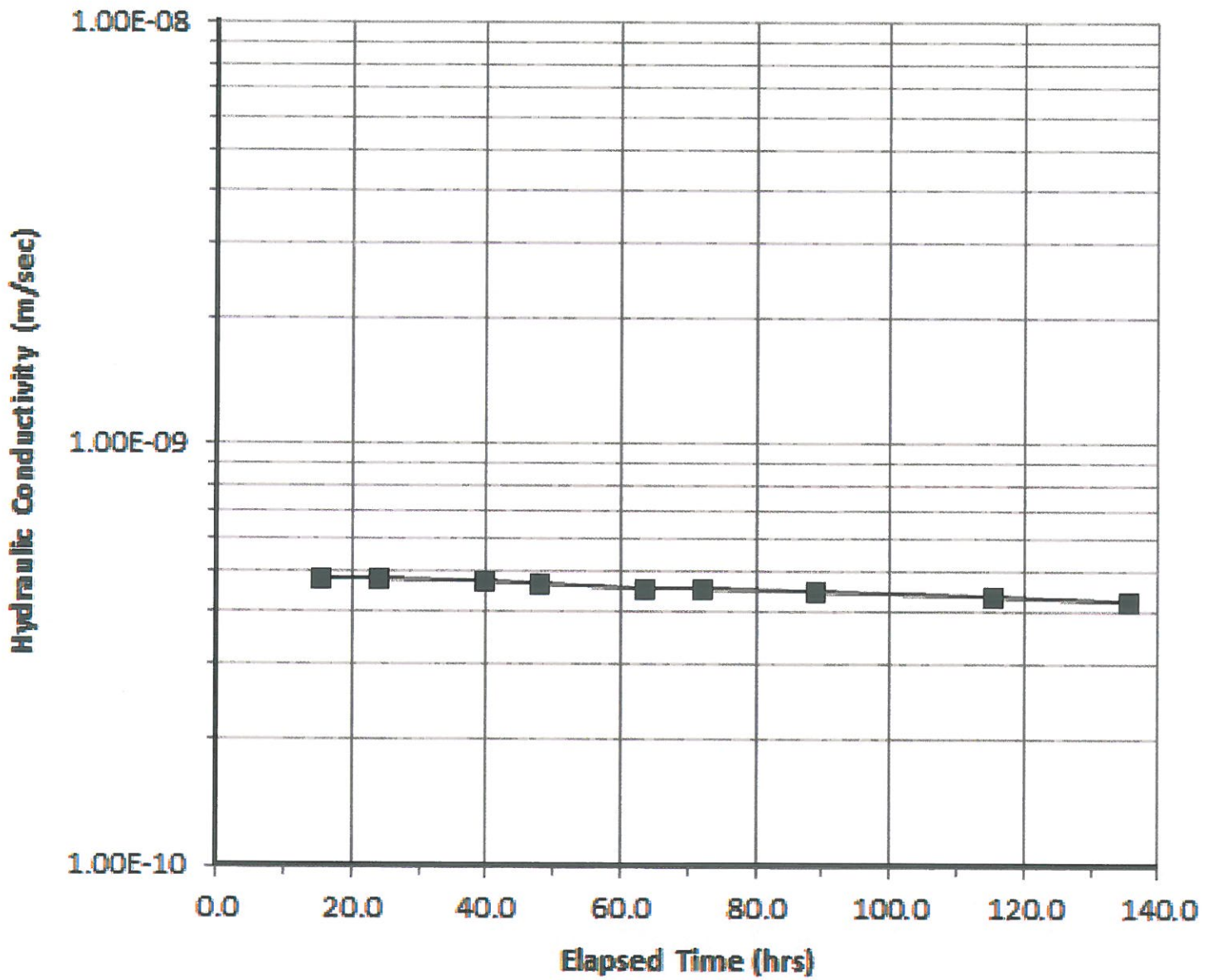
FILE No.:

15-185-01

SCALE:

N/A

HYDRAULIC CONDUCTIVITY
 VERSUS ELAPSED TIME
 (ST6)



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FIGURE No.:

4

REV.:

PROJECT:

KELSEY LAGOON

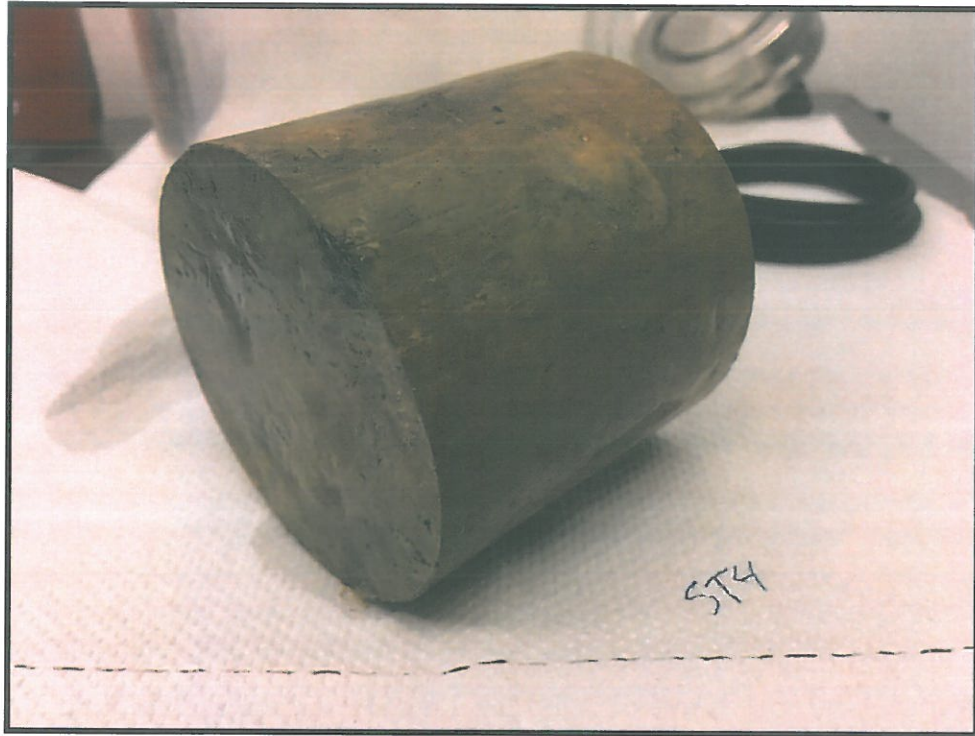
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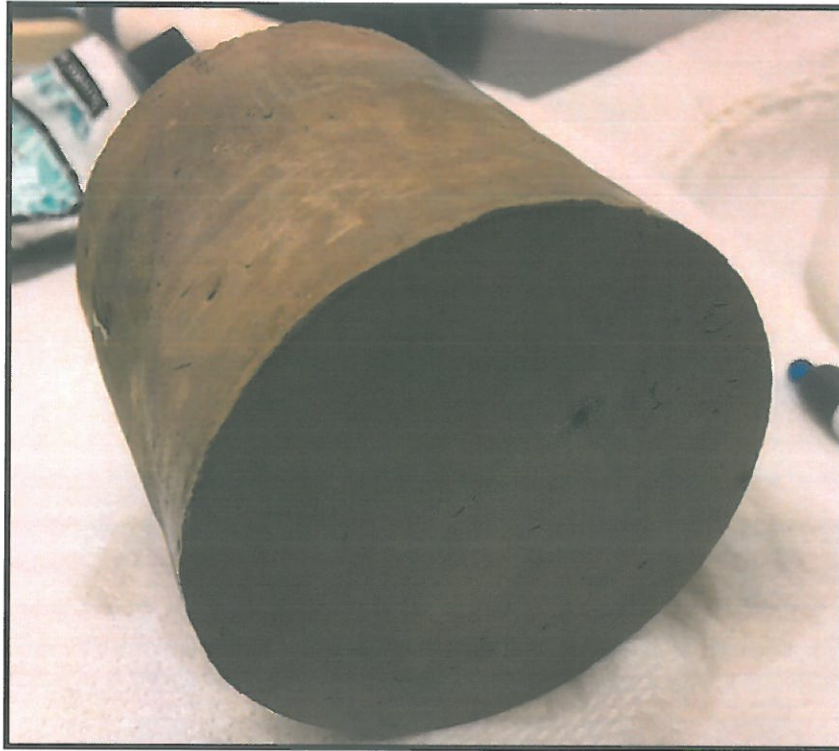
HYDRAULIC CONDUCTIVITY
 VERSUS ELAPSED TIME
 (ST8)



PHOTOGRAPH #1: Sample ST4 upon completion of test.



PHOTOGRAPH #2: Sample ST4 after breaking apart.



PHOTOGRAPH #3: Sample ST6 upon completion of test.



PHOTOGRAPH #4: Sample ST6 after breaking apart.



PHOTOGRAPH #5: Sample ST7 upon completion of test.



PHOTOGRAPH #6: Sample ST7 after breaking apart.



PHOTOGRAPH #7: Sample ST8 upon completion of test.



PHOTOGRAPH #8: Sample ST8 after breaking apart.