S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-84**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 1
Boring Depth (ft): **15.0**	Elevation (ft): **657.0**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **3/28/07**
Logged By: **Julie Petersen**	Water Level: **Stabilized Water Level at 6.94 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
655			SOIL/SAPROLITE (M1): Red, Medium to Fine Sandy, Silty, **CLAY** With Mica		
	5				
650			SOIL/SAPROLITE (M1): Red, Medium to Fine Sandy, Clayey, **SILT**		
	10		SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)		
645			WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)		
			SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)		
	15		WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)		
			SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)		
			WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)		
			SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)		
			Boring Terminated at 15.00 ft bls		
			Lithologic Descriptions Obtained From M-84R		

COMPLETION REPORT OF WELL No. M-84

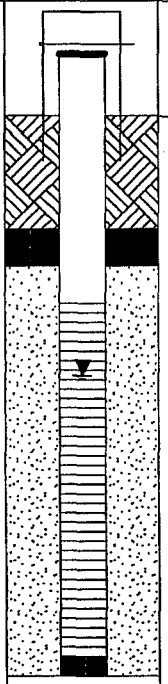
PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 6.94 ft bls**
LATITUDE: **35 25 50.04**
LONGITUDE: **80 57 18.93**
TOP OF CASING ELEVATION: **659.80**
DATUM: **MSL**
LOGGED BY: **Julie Petersen**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **3/28/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)
SOIL/SAPROLITE (M1): Red, Medium to Fine Sandy, Silty, **CLAY** With Mica		0
SOIL/SAPROLITE (M1): Red, Medium to Fine Sandy, Clayey, **SILT**		5
SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)		10
WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)		15
SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)		
WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)		
SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)		
WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)		
SOIL/SAPROLITE		

WELL DETAILS



DEPTH (ft.)	LEGEND	ELEVATION (ft.)
0.00		656.95
3.00		653.95
4.00		652.95
14.50		642.45
15.00		641.95

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 5 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 3 ft bls**

SEAL
Type: **Bentonite**
Interval: **3 to 4 ft bls**

FILTERPACK
Type: **#1 Filter Sand**
Interval: **4 to 15 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **5 to 15 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-84

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION: **657.0**
LOGGED BY: **Julie Petersen**
CHECKED BY:

STRATA			WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
DESCRIPTION	SYMBOL	DEPTH (ft.)					
							(See Page 1)
(M1): Gray, Silty, Medium to Fine SAND (Granitic)							

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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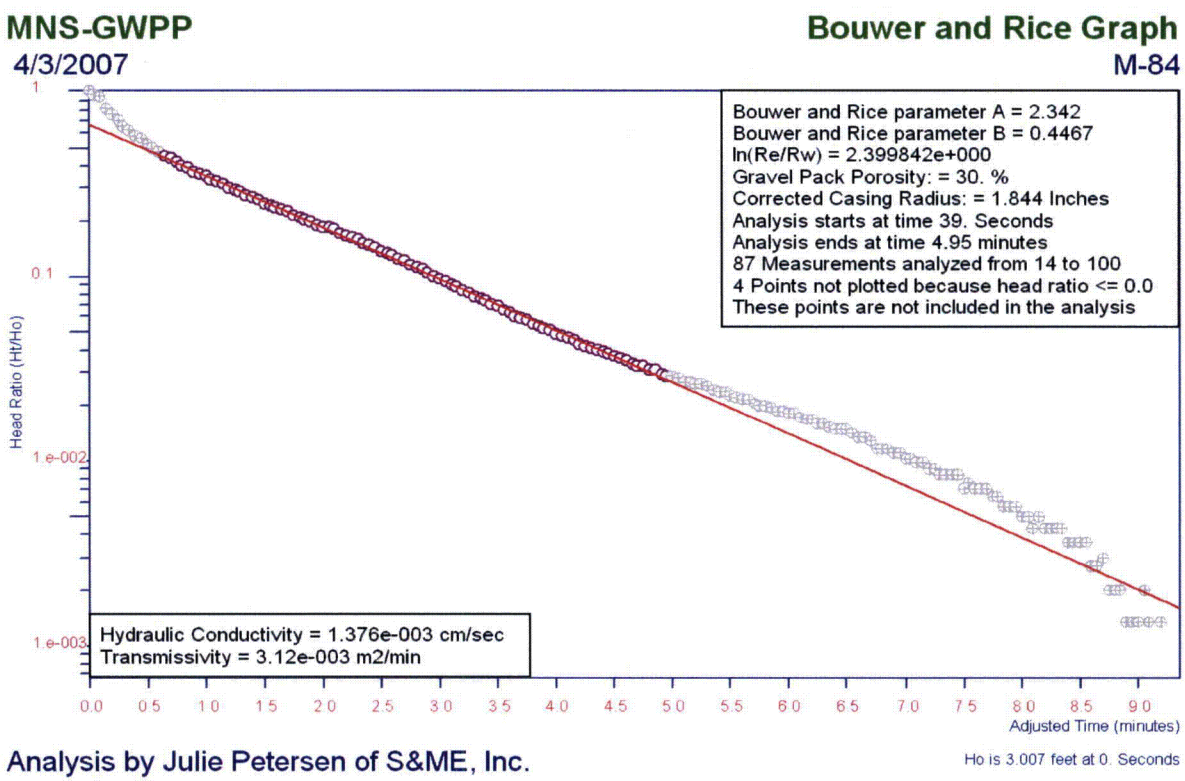
COMPLETION REPORT OF WELL No. M-84

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	4/3/2007
Well Label:	M-84
Aquifer Thickness:	12.4 feet
Screen Length:	10. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	7.6 feet
Water Table to Screen Bottom:	7.4 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 188 time and drawdown measurements
Maximum head is 3.007 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

1.38E-03 cm/sec

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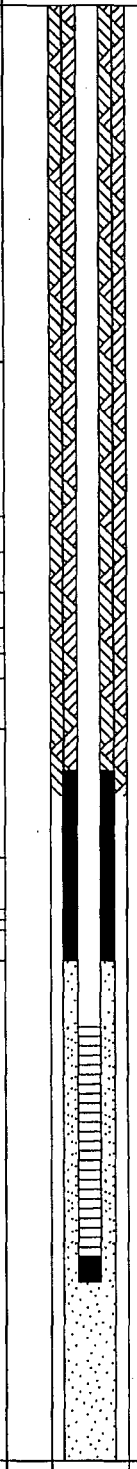
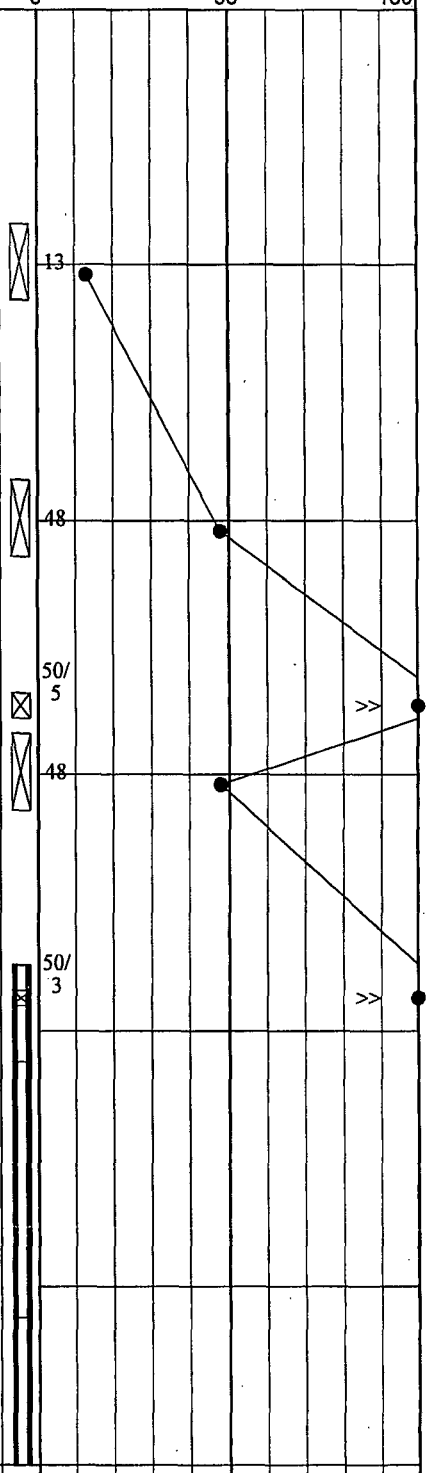
Project: **MNS - Groundwater Protection Project**			**Boring No. M-84R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 1
Boring Depth (ft): **28.5**	Elevation (ft): **657.8**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **3/22/07**
Logged By: **Julie Petersen**	Water Level: **Stabilized Water Level at 7.90 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description
655	5		SOIL/SAPROLITE (M1): Red, Medium to Fine Sandy, Silty, **CLAY** With Mica
650	10		SOIL/SAPROLITE (M1): Red, Medium to Fine Sandy, Clayey, **SILT**
			SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)
			WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)
645			SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)
	15		WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)
			SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)
640			WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)
	20		SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)
			WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)
635			SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)
			WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)
	25		SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)
			Roller Cone Refusal at 18.7 ft bls
630			SOUND ROCK (D): Fine-grained **GRANITE**, Slightly Fractured
			Boring Terminated at 28.50 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



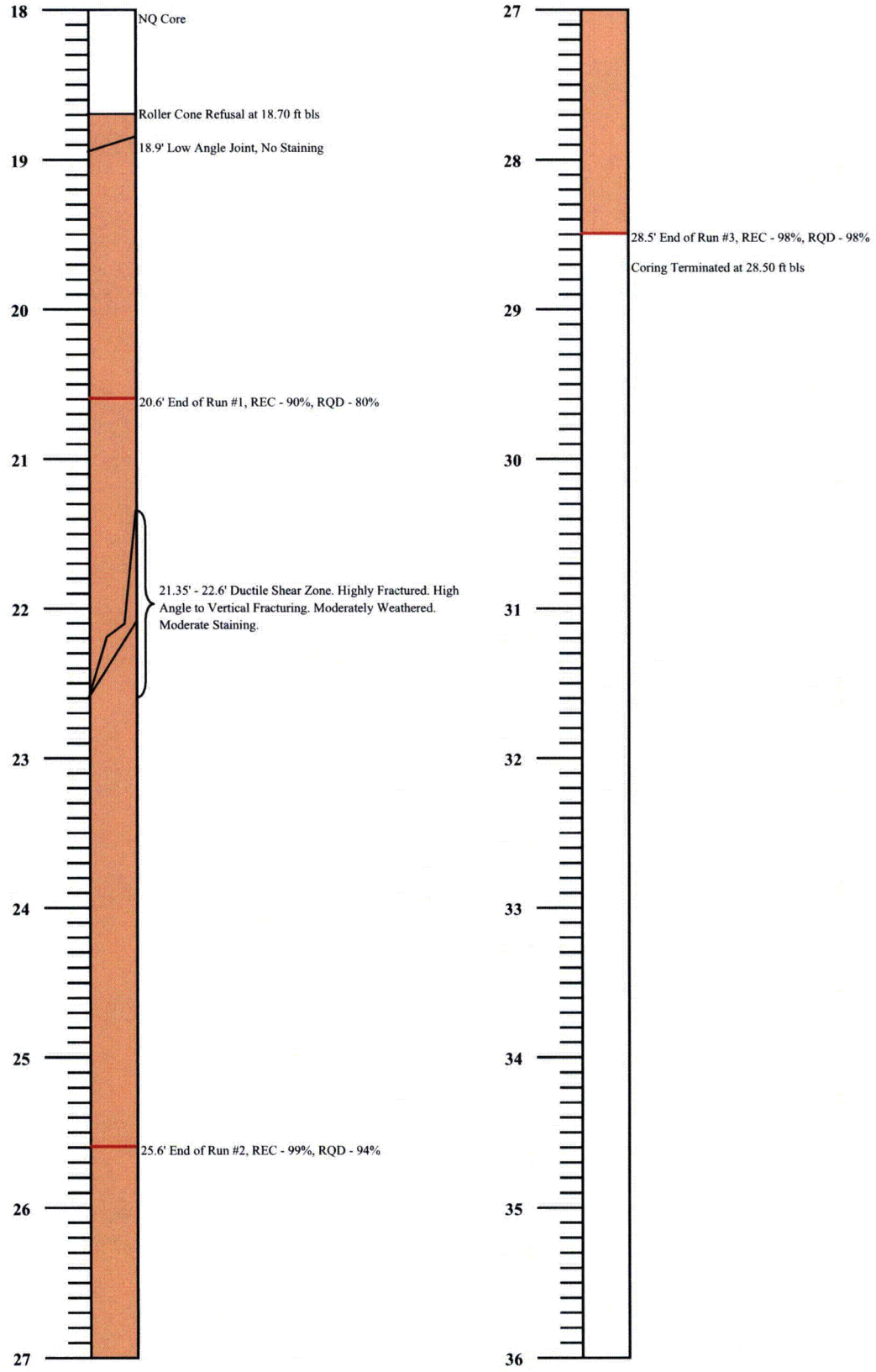
BORING LOG WITH WELL MNSLOG.GPJ LAGWGN01.GDT 3/26/08

FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-84R



EXPLANATION

- Meta Gabbro
- Quartz Diorite
- Diorite
- Granite
- Core Loss
- Intense Fracturing
- Fractures
- End of Run
- Contact
- Healed Joint

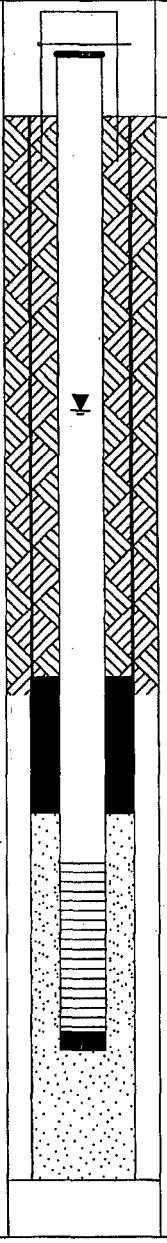
COMPLETION REPORT OF WELL No. M-84R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 7.90 ft bls**
LATITUDE: **35 25 50.09**
LONGITUDE: **80 57 18.91**
TOP OF CASING ELEVATION: **660.78**
DATUM: **MSL**
LOGGED BY: **Julie Petersen**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **3/22/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		657.75
SOIL/SAPROLITE (M1): Red, Medium to Fine Sandy, Silty, **CLAY** With Mica		0, 5				
SOIL/SAPROLITE (M1): Red, Medium to Fine Sandy, Clayey, **SILT**						
SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)		10				
WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)		15		15.50		642.25
SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)				18.70		639.05
WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)		20				
SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)				24.50		633.25
		25		25.00		632.75
WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)				28.50		629.25
SOIL/SAPROLITE						



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **6" X 6"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **4" and 2"**
Type: **Sch. 40 PVC**
Interval: **4": 0 to 15.50 ft bls 2": 0 to 20 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 15 ft bls**

SEAL
Type: **Bentonite**
Interval: **15 to 18.7 ft bls**

FILTERPACK
Type: **#2 Filter Sand**
Interval: **18.7 to 28.5 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **20 to 25 ft bls**

LEGEND

FILTER PACK
BENTONITE
CEMENT GROUT
CUTTINGS / BACKFILL
STATIC WATER LEVEL

TOC TOP OF CASING
GS GROUND SURFACE
BS BENTONITE SEAL
FP FILTER PACK
TSC TOP OF SCREEN
BSC BOTTOM OF SCREEN
TD TOTAL DEPTH
CG CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-84R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION: **657.8**
LOGGED BY: **Julie Petersen**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
(M1): Gray, Silty, Medium to Fine **SAND** (Granitic)							
WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)							
SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic)							
WEATHERED ROCK (M2): When Sampled Becomes Gray, Silty, Coarse to Fine **SAND** With Rock Fragments (Granitic)							
SOIL/SAPROLITE (M1): Gray, Silty, Medium to Fine **SAND** (Granitic) **Roller Cone Refusal at 18.7 ft bls**							
SOUND ROCK (D): Fine-grained **GRANITE**, Slightly Fractured							

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-84R

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: M-84R

Sample No: 1
Depth (ft-bls): 4.2 - 5.7
Blow Count: 5 * 6 * 7

Sample No: 2
Depth (ft-bls): 9.2 - 10.7
Blow Count: 5 * 8 * 40

Sample No: 3
Depth (ft-bls): 13.4 - 13.9
Blow Count: 50/5

Sample No: 4
Depth (ft-bls): 14.2 - 15.7
Blow Count: 38 * 28 * 20

No Recovery

Sample No: 5
Depth (ft-bls): 19.2 - 19.7
Blow Count: 50/3

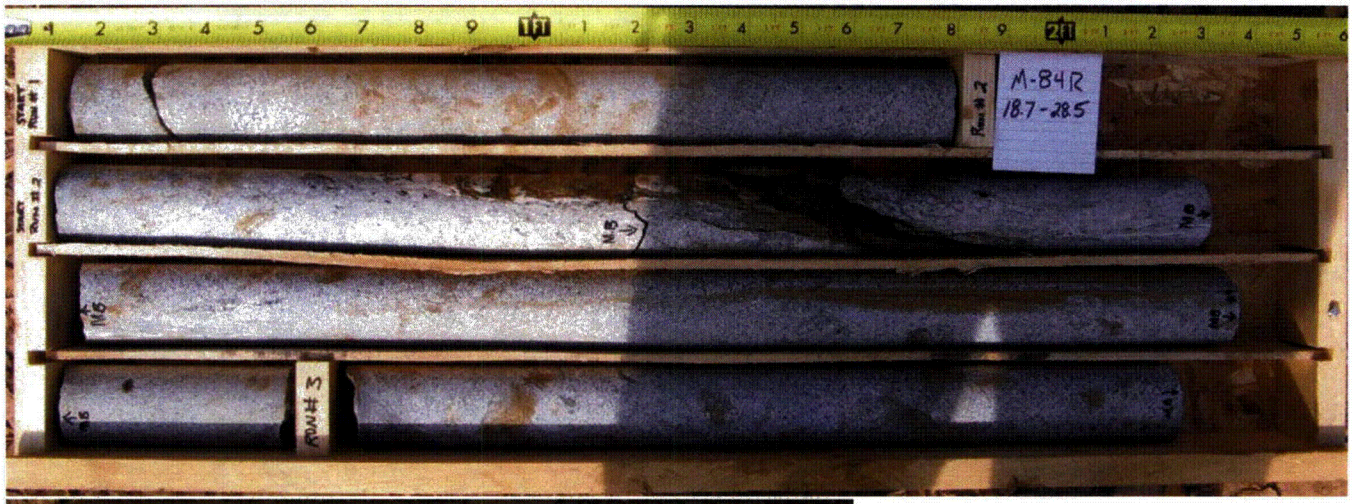
No Recovery

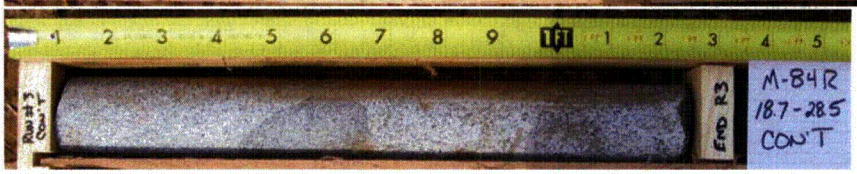
ROCK CORE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-84R





CLASSIFICATION:

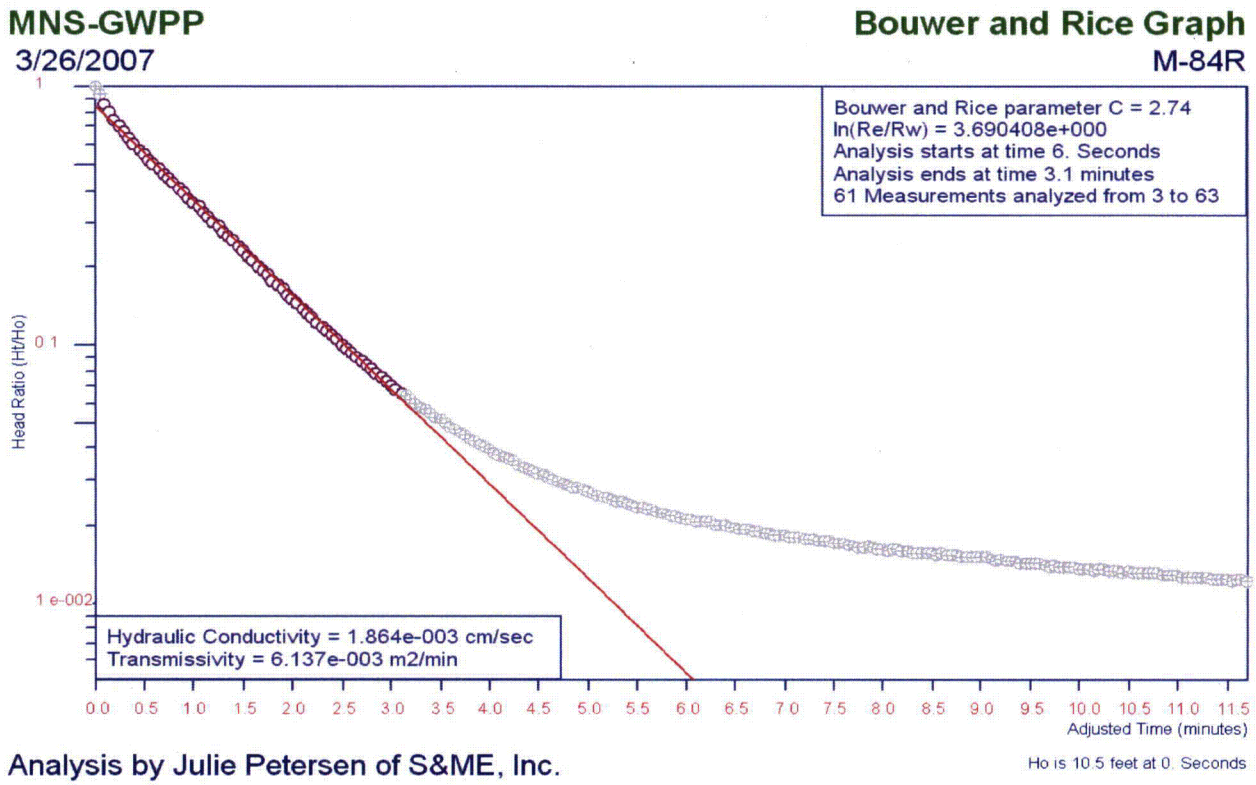
18.7' - 28.5' Fine Grained Granite with a Ductile Shear Zone from 21.35' - 22.6'

Calculation of Permeability By The Falling Head Method (Open Hole in Uniform Material)

Site Name:	MNS-GWPP	
Test Date:	3/26/2007	
Well Label:	M-84R	
Test Interval:	18.7 to 25.6 ft bls	(Sound Rock)
Length of Open Hole:	6.9 ft	
Borehole Radius:	1.5 Inches	
Effective Radius:	1.5 Inches	
Anisotropy Ratio:	1	

Test starts with trial 0
There are 235 time and drawdown measurements
Maximum head is 10.5 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

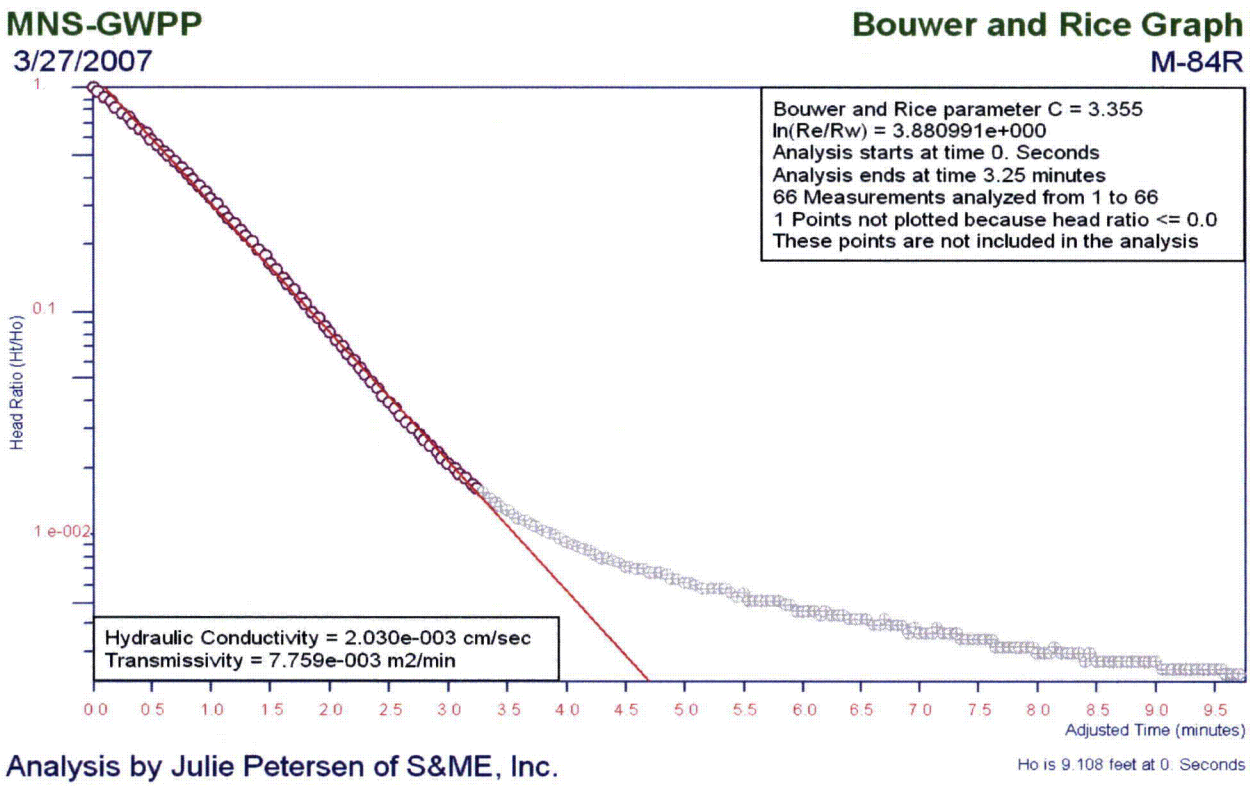
PERMEABILITY
1.86E-03 cm/sec

Calculation of Permeability By The Falling Head Method (Open Hole in Uniform Material)

Site Name:	MNS-GWPP	
Test Date:	3/27/2007	
Well Label:	M-84R	
Test Interval:	18.7 to 28.5 ft bls	(Sound Rock)
Length of Open Hole:	9.8 feet	
Borehole Radius:	1.5 Inches	
Effective Radius:	1.5 Inches	
Anisotropy Ratio:	1	

Test starts with trial 0
There are 196 time and drawdown measurements
Maximum head is 9.108 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY
2.03E-03 cm/sec

BOREHOLE PERMEABILITY TEST USING PACKERS
FIELD DATA SHEET

S&ME

PROJECT NAME AND NO.:	MNS - GWPP	**BOREHOLE NO.:**	M-84R				
LOCATION:	Huntersville, NC	**TEST INTERVAL:**	20.0	to	25.0	bgs	
TEST DATE:	3/27/2007	**TEST INTERVAL:**	637.5	to	632.5	EL	
TESTED BY:	Jay Little and Julie Petersen						
GROUND ELEV (ft MSL):	657.5						

TEST METHOD: Double Packer Method using Multiple Pressure Tests
METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

TEST DATA (Enter data in underlined cells):

Rock Description of test interval:	Granite - Sound Rock. Fine grained with high angle to verticle fracturing along ductile shear zone from 21.35 to 22.6 ft bls.			
Source of test water and clarity:	Catawba River - Slightly Turbid			
Method of cleaning hole prior to testing:	Flushed			
Drilling Fluid (water or type of drilling mud)	Water			
Packer Brand and Model:				
Packer Inflation Pressure	160	psi		
Packer Length:	2.00	feet		
Method: Single (1) or double (2) packer (Enter 1 or 2):	2			
Interval below base of packer for Method 1 (single packer test), A_1:	-	feet		
Interval between packers for Method 2 (double packer test), A_2:	5.0	feet		
Depth of hole at time of test:	28.5	feet below ground surface (bgs)		
Diameter of borehole, d:	3.0	inches	0.3	feet
Radius of the borehole, r	0.13	feet		
Depth to water table (thickness of unsaturated material above water table, U):	7.7	feet		
Height above ground surface of pressure gauge:	2.8	feet ags		
Top of test section (bottom of upper packer), h_t:	20.0	feet bgs		
Bottom of test section (top of lower packer if double packer used, bottom of hole for a single packer, D):	25.0	feet bgs		
Is test section above or below water table?	below			
For tests below the water table determine h_1, the distance between the gauge and the water table:	10.5	feet		
Length of pipe over which head loss occurs (distance from gauge to outlet of pipe in test section):	25.3	feet		
Diameter and type of pipe used:	1.25-inch I.D.			

BOREHOLE PERMEABILITY TEST USING PACKERS
FIELD DATA SHEET

S&ME

PROJECT NAME AND NO.:	MNS - GWPP	**BOREHOLE NO.:**	M-84R				
LOCATION:	Huntersville, NC	**TEST INTERVAL:**	20	to	25	bgs	
TEST DATE:	3/27/07	**TEST INTERVAL:**	637.48	to	632.48	EL	

Gauge Pressure (h_2) in psi	Elapsed Time (minutes)	Water Level (feet bgs)	Flow Rate (total flow in gal)	Flow Rate (gpm)
Step 1				
5	0		568.50	
5	1		569.00	0.50
5	2		569.40	0.40
5	5		570.30	0.30
5	10		571.90	0.32
5	15		573.50	0.32
5	20		575.00	0.30
		Average	0.33	0.36
		Selected stabilized flow rate to be used in calculations		0.36
Step 2				
10	0		575.20	
10	1		575.30	0.10
10	2		575.90	0.60
10	5		577.20	0.43
10	10		579.30	0.42
10	15		581.40	0.42
10	20		583.50	0.42
		Average	0.41	0.40
		Selected stabilized flow rate to be used in calculations		0.40
Step 3				
15	0		583.80	
15	1		584.50	0.70
15	2		585.10	0.60
15	5		586.70	0.53
15	10		589.40	0.54
15	15		592.00	0.52
15	20		594.70	0.54
		Average	0.55	0.57
		Selected stabilized flow rate to be used in calculations		0.57
Step 4				
10	0		595.00	
10	1		595.40	0.40
10	3		596.20	0.40
10	5		597.00	0.40
		Average	0.40	0.40
		Selected stabilized flow rate to be used in calculations		0.40
Step 5				
5	0		597.10	
5	1		597.40	0.30
5	3		598.00	0.30
5	5		598.50	0.25
		Average	0.28	0.28
		Selected stabilized flow rate to be used in calculations		0.28

NOTES:

BOREHOLE PERMEABILITY TEST USING PACKERS CALCULATIONS

S&ME

PROJECT NAME AND NO.:	MNS - GWPP	**BOREHOLE NO.:**	M-84R
LOCATION:	Huntersville, NC	**TEST INTERVAL:**	20.0 to 25.0 bgs
TEST DATE:	3/27/2007	**TEST INTERVAL:**	637.5 to 632.5 EL
TESTED BY:	Jay Little and Julie Petersen		
GROUND ELEV (ft MSL):	657.5		

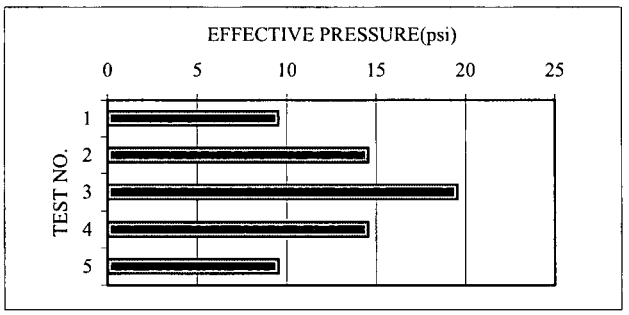
TEST METHOD: Double Packer Method using Multiple Pressure Tests
METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

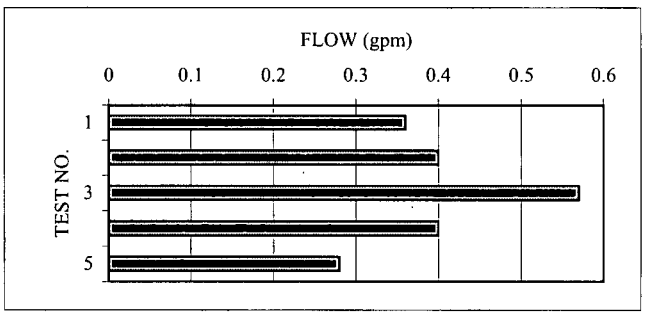
RESULTS OF PERMEABILITY CALCULATIONS
MULTIPLE STEP TEST

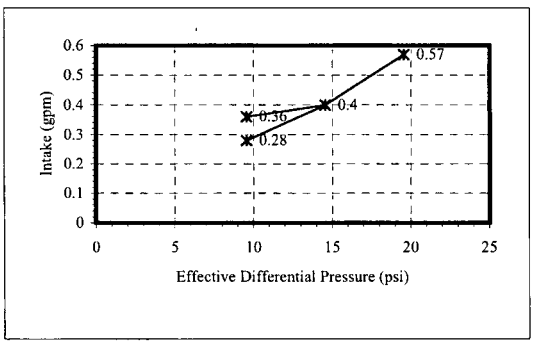
Step	Flow (Q) (gpm)	Pressure (psi) Gauge	Pressure (psi) Effective	Lugeons	Permeability (ft/sec)	Permeability (cm/sec)
1	0.36	5	10	14	4.55E-06	1.4E-04
2	0.4	10	15	10	3.3E-06	1.0E-04
3	0.57	15	20	11	3.5E-06	1.1E-04
4	0.4	10	15	10	3.3E-06	1.0E-04
5	0.28	5	10	11	3.5E-06	1.1E-04
			AVERAGE	11	3.6E-06	1.1E-04
			SELECTED VALUES			

Rock Description of Tested Interval:
Granite - Sound Rock. Fine grained with high angle to verticle fracturing along ductile shear zone from 21.35 to 22.6 ft bls.

TEST INTERPRETATION
Text here
Text here







PERMEABILITY CALCULATIONS FOR EACH STEP OF TEST

S&ME

CALCULATED PERMEABILITY FOR STEP 1

Gauge Pressure, **h2**:	5	psi	11.5	feet of water
Flow Rate, **Q**:	0.36	gpm	0.001	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	10.5	feet		
Value of $\mathbf{h_1}$:	10.5	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	22.0	feet	9.5	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	4.7	feet		
X = (H/Tu)*100	464.4	%		
Tu/A	0.9			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	4.55E-06	ft/sec	1.39E-04	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 2

Gauge Pressure, **h2**:	10	psi	23.1	feet of water
Flow Rate, **Q**:	0.40	gpm	0.001	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	10.5	feet		
Value of h_1:	10.5	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	33.6	feet	14.5	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	16.3	feet		
X = (H/Tu)*100	206.2	%		
Tu/A	3.3			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	3.32E-06	ft/sec	1.01E-04	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 3

Gauge Pressure, **h2**:	15	psi	34.6	feet of water
Flow Rate, **Q**:	0.57	gpm	0.001	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	10.5	feet		
Value of h_1:	10.5	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	45.1	feet	19.5	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	27.8	feet		
X = (H/Tu)*100	162.1	%		
Tu/A	5.6			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	3.52E-06	ft/sec	1.07E-04	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 4

Gauge Pressure, **h2**:	10	psi	23.1	feet of water
Flow Rate, **Q**:	0.40	gpm	0.001	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	10.5	feet		
Value of h_1:	10.5	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	33.6	feet	14.5	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	16.3	feet		
X = (H/Tu)*100	206.2	%		
Tu/A	3.3			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	3.32E-06	ft/sec	1.01E-04	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 5				
Gauge Pressure, **h2**:	5	psi	11.5	feet of water
Flow Rate, **Q**:	0.28	gpm	0.001	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	10.5	feet		
Value of h_1:	10.5	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	22.0	feet	9.5	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	4.7	feet		
X = (H/Tu)*100	464.4	%		
Tu/A	0.9			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	3.54E-06	ft/sec	1.08E-04	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

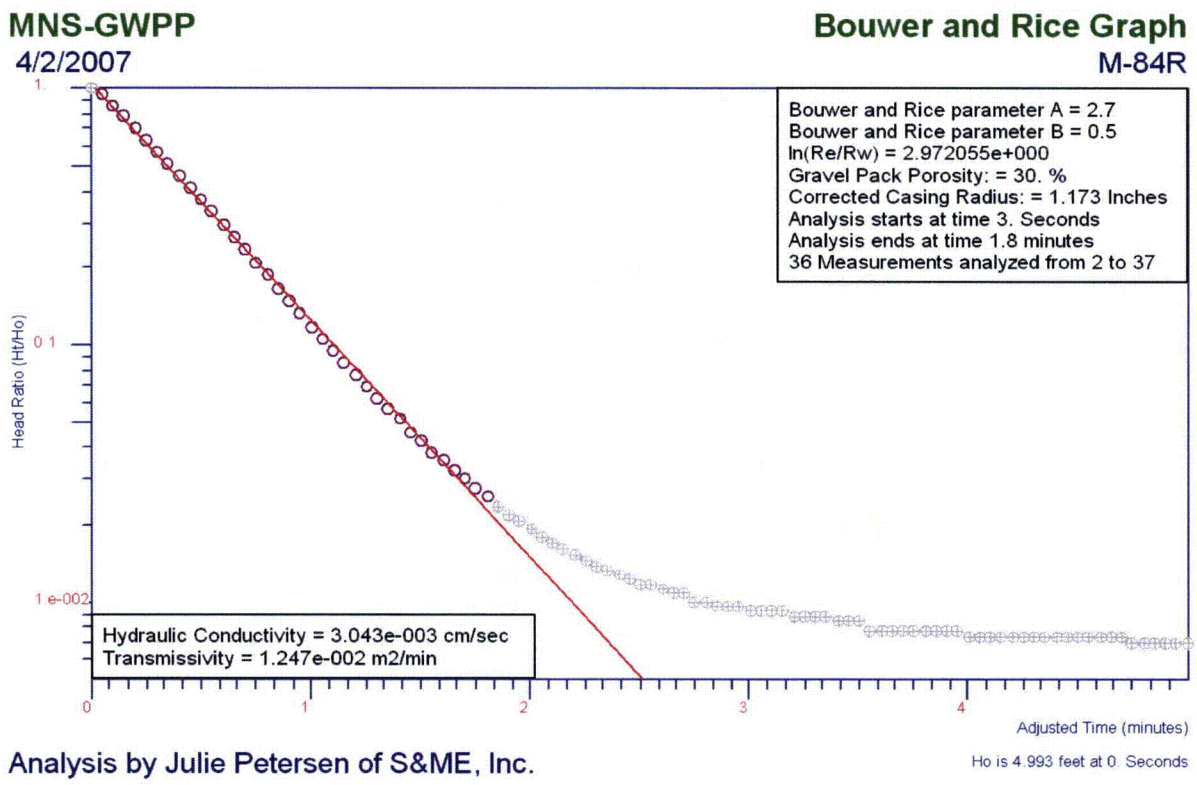
Is Q/a * (estimated porosity) > 10?? True, Test Valid

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	4/2/2007
Well Label:	M-84R
Aquifer Thickness:	22.4 feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.173 Inches
Static Water Level:	7.6 feet
Water Table to Screen Bottom:	17.4 feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds

Test starts with trial 0
There are 101 time and drawdown measurements
Maximum head is 4.993 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

3.04E-03 cm/sec

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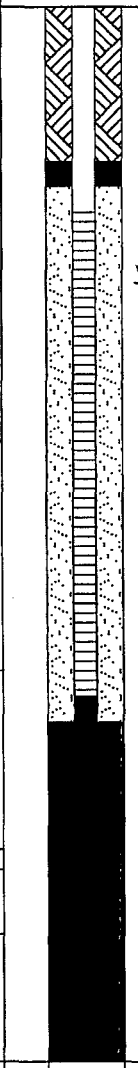
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

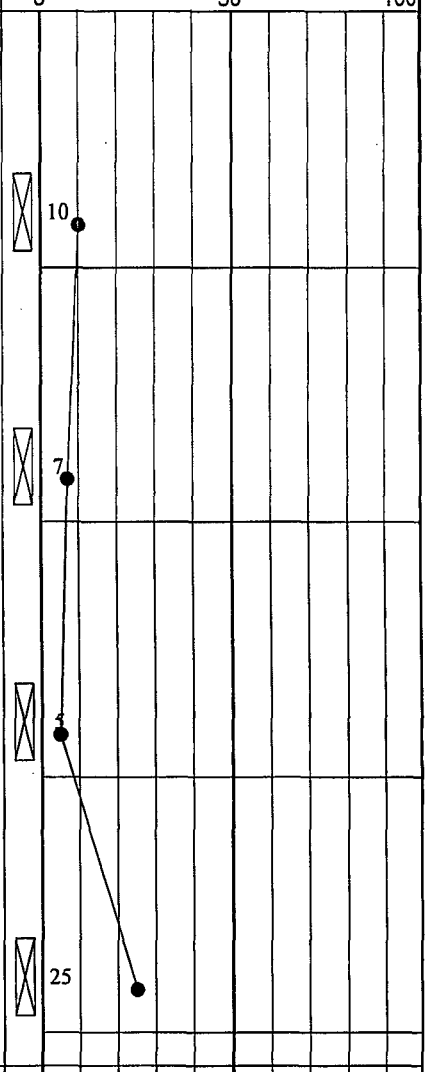
Project: **MNS - Groundwater Protection Project**			**Boring No. M-85**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 1
Boring Depth (ft): **20.7**	Elevation (ft): **659.5**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **3/23/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 5.39 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
655	5		SOIL/SAPROLITE (M1): Reddish-Brown, Medium to Fine Sandy, Silty, **CLAY**
650	10		SOIL/SAPROLITE (M1): Red and Tan, Micaceous, Medium to Fine Sandy, **SILT**
645	15		SOIL/SAPROLITE (M1): Tan, Micaceous, Clayey, **SILT**
640	20		WEATHERED ROCK (M2): When Sampled Becomes Brown, Black, Green, and White, Micaceous, Fine Sandy, **SILT** With Coarse Sandy, Quartz Veins and Rock Fragments (Granitic)
			SOIL/SAPROLITE (M1): Brown, Black, Green, and White, Micaceous, Fine Sandy, **SILT** With Coarse Sandy, Quartz Veins and Rock Fragments (Granitic)
			WEATHERED ROCK (M2): When Sampled Becomes Brown, Black, Green, and White, Micaceous, Fine Sandy, **SILT** With Coarse Sandy, Quartz Veins and Rock Fragments (Granitic)
			Roller Cone Refusal at 20.65 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



COMPLETION REPORT OF WELL No. M-85

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 5.39 ft bls**

LATITUDE: **35 25 53.23**
LONGITUDE: **80 57 19.72**
TOP OF CASING ELEVATION: **662.72**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **3/23/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		659.50
SOIL/SAPROLITE (M1): Reddish-Brown, Medium to Fine Sandy, Silty, **CLAY**		0		3.00		656.50
				3.50		656.00
		5				
SOIL/SAPROLITE (M1): Red and Tan, Micaceous, Medium to Fine Sandy, **SILT**		10				
SOIL/SAPROLITE (M1): Tan, Micaceous, Clayey, **SILT**				13.50		646.00
				14.00		645.50
		15				
WEATHERED ROCK (M2): When Sampled Becomes Brown, Black, Green, and White, Micaceous, Fine Sandy, **SILT** With Coarse Sandy, Quartz Veins and Rock Fragments (Granitic)		20		20.65		638.85
SOIL/SAPROLITE (M1): Brown, Black, Green, and White, Micaceous, Fine Sandy, **SILT** With Coarse Sandy, Quartz Veins and Rock Fragments (Granitic)						
WEATHERED ROCK (M2): When Sampled Becomes Brown,						

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 4 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 3 ft bls**

SEAL
Type: **Bentonite**
Interval: **3 to 3.5 ft bls**

FILTERPACK
Type: **#1 Filter Sand**
Interval: **3.5 to 14 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **4 to 14 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-85

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION:
LOGGED BY: **659.5**
CHECKED BY: **Courtney Wither**

STRATA			WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
DESCRIPTION	SYMBOL	DEPTH (ft.)					
							(See Page 1)
Black, Green, and White, Micaceous, Fine Sandy, **SILT** With Coarse Sandy, Quartz Veins and Rock Fragments (Granitic)							

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-85

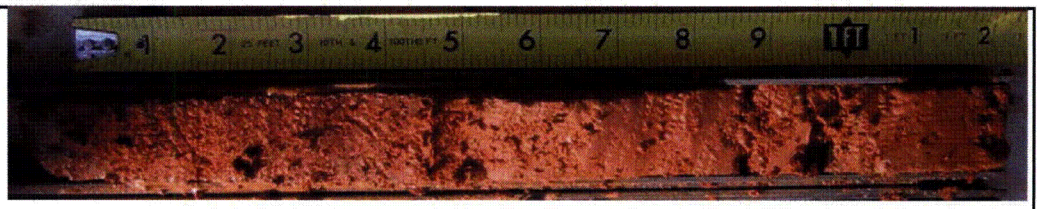
SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

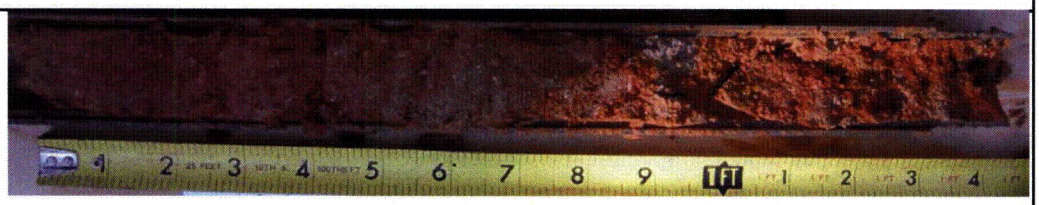
S&ME Project No: 1264-06-724

Boring Number: M-85

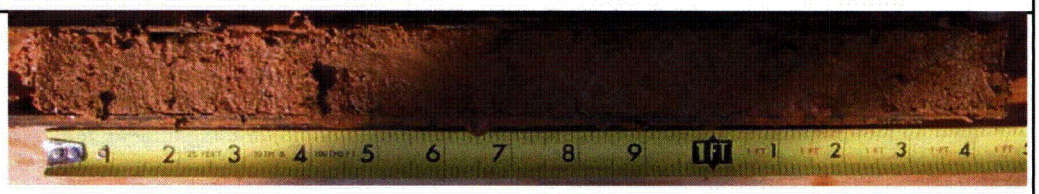
Sample No: 1
Depth (ft-bls): 3.17 - 4.67
Blow Count: 3 * 4 * 6



Sample No: 2
Depth (ft-bls): 8.17 - 9.67
Blow Count: 2 * 3 * 4



Sample No: 3
Depth (ft-bls): 13.17 - 14.67
Blow Count: 2 * 2 * 3



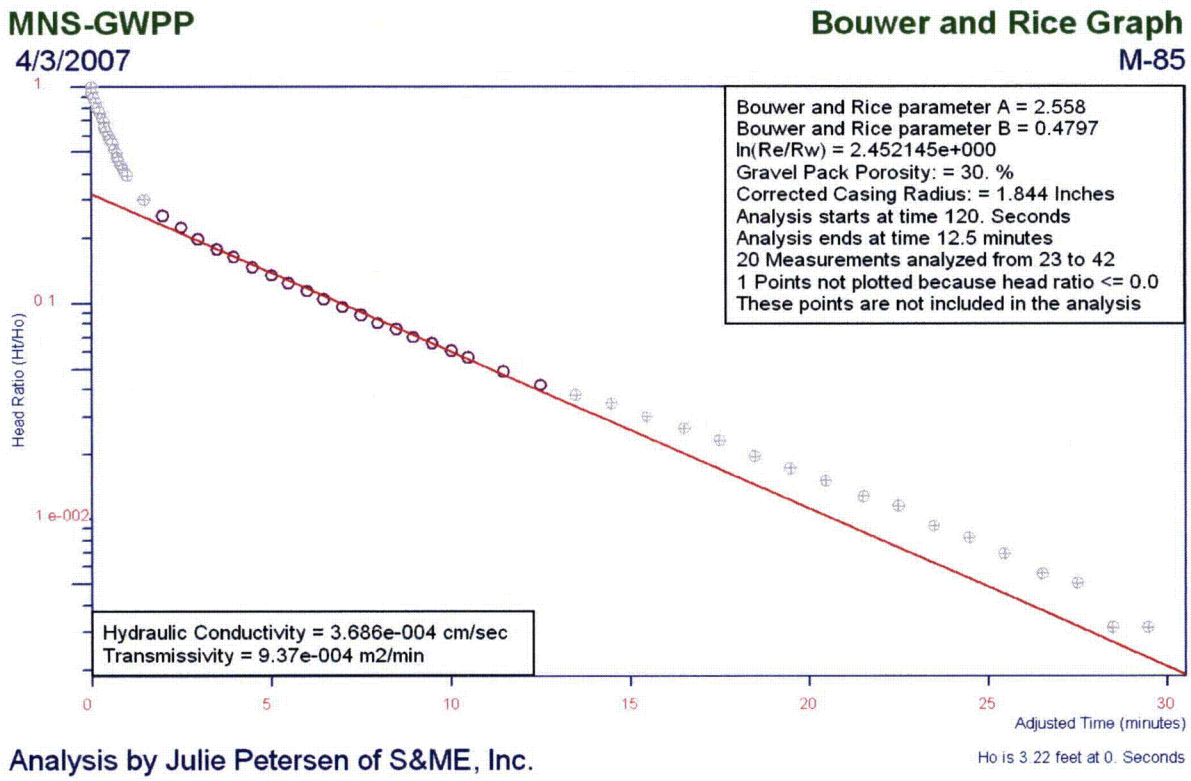
Sample No: 4
Depth (ft-bls): 18.17 - 19.67
Blow Count: 13 * 11 * 14

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	4/3/2007
Well Label:	M-85
Aquifer Thickness:	13.9 feet
Screen Length:	10. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	5.1 feet
Water Table to Screen Bottom:	8.9 feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds

Test starts with trial 0
There are 60 time and drawdown measurements
Maximum head is 3.22 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

3.69E-04 cm/sec

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Project: **MNS - Groundwater Protection Project**			**Boring No. M-91**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 2
Boring Depth (ft): **39.0**	Elevation (ft): **745.7**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **1/8/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 28.50 ft bls**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
745			**GRASS/ROOTMAT**		
			SOIL/SAPROLITE (M1): Red, Yellow, and Tan, Micaceous, Slightly Sandy, Clayey, **SILT**		
	5				
740					
			ALLUVIAL (S): Red, Micaceous, Silty, **CLAY** With Pebbles		
	10				
735					
			SOIL/SAPROLITE (M1): Reddish-Yellow, Micaceous, Clayey, **SILT** With Manganese Staining		
	15				
730					
			SOIL/SAPROLITE (M1): Red and Yellow Mottled, Micaceous, **SILT** With Manganese Staining		
	20				
725					
	25				
720					
			SOIL/SAPROLITE (M1): Reddish-Brown, Tan, and White, Fine Sandy, **SILT** With Manganese Staining and Rock Fragments		
	30				
715					

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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-91**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 2 of 2
Boring Depth (ft): **39.0**	Elevation (ft): **745.7**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **1/8/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 28.50 ft bls**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
710	35				
			Boring Terminated at 39.00 ft bls **Lithologic Descriptions Obtained From M-91R**		

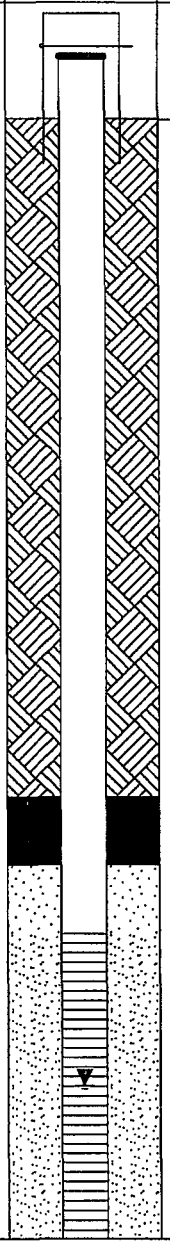
COMPLETION REPORT OF WELL No. M-91

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 28.50 ft bls**
LATITUDE: **35 25 54.79**
LONGITUDE: **80 57 08.40**
TOP OF CASING ELEVATION: **748.77**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **1/8/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		745.72
GRASS/ROOTMAT		0				
SOIL/SAPROLITE (M1): Red, Yellow, and Tan, Micaceous, Slightly Sandy, Clayey, **SILT**		5				
ALLUVIAL (S): Red, Micaceous, Silty, **CLAY** With Pebbles		10				
SOIL/SAPROLITE (M1): Reddish-Yellow, Micaceous, Clayey, **SILT** With Manganese Staining		15				
SOIL/SAPROLITE (M1): Red and Yellow Mottled, Micaceous, **SILT** With Manganese Staining		20		20.00		725.72
				22.00		723.72
		25				
SOIL/SAPROLITE (M1): Reddish-Brown, Tan, and White, Fine Sandy, **SILT** With Manganese Staining and Rock Fragments		30				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 24 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 20 ft bls**

SEAL
Type: **Bentonite**
Interval: **20 to 22 ft bls**

FILTERPACK
Type: **#1 Filter Sand**
Interval: **22 to 39 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **24 to 39 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-91

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION: **745.7**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOIL/SAPROLITE (M1): Reddish-Brown, Tan, and White, Fine Sandy, **SILT** With Manganese Staining and Rock Fragments *(continued)*		35		38.50 39.00		707.22 706.72	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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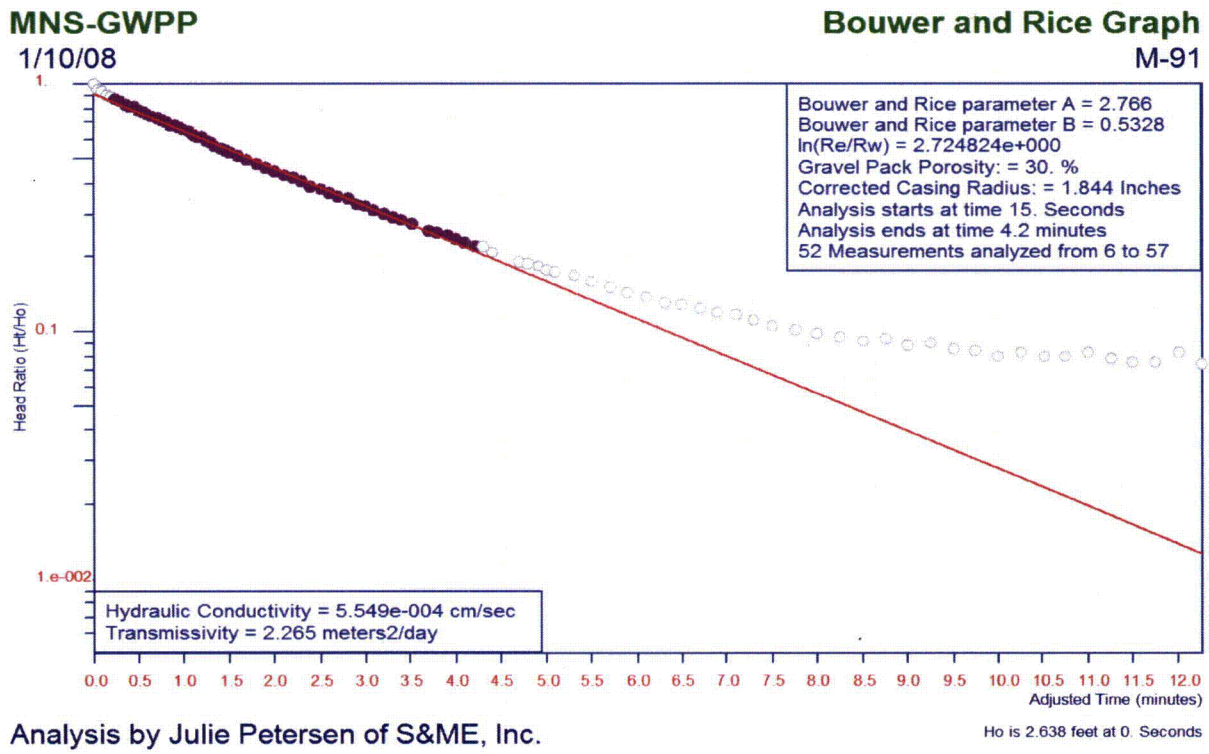
COMPLETION REPORT OF WELL No. M-91

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	1/10/2008
Well Label:	M-91
Aquifer Thickness:	15.5 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	28.5 feet
Water Table to Screen Bottom:	10.5 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 95 time and drawdown measurements
Maximum head is 2.638 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

Ho is 2.638 feet at 0. Seconds

PERMEABILITY

5.55×10^{-04} cm/sec

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S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-91R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 2
Boring Depth (ft): **69.8**	Elevation (ft): **745.9**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **1/2/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 41.60 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
745			**GRASS/ROOTMAT**		
			SOIL/SAPROLITE (M1): Red, Yellow, and Tan, Micaceous, Slightly Sandy, Clayey, **SILT**		16
	5				
740					
			ALLUVIAL (S): Red, Micaceous, Silty, **CLAY** With Pebbles		11
	10				
735					
			SOIL/SAPROLITE (M1): Reddish-Yellow, Micaceous, Clayey, **SILT** With Manganese Staining		9
	15				
730					
			SOIL/SAPROLITE (M1): Red and Yellow Mottled, Micaceous, **SILT** With Manganese Staining		7
	20				
725					
					5
	25				
720					
			SOIL/SAPROLITE (M1): Reddish-Brown, Tan, and White, Fine Sandy, **SILT** With Manganese Staining and Rock Fragments		4
	30				
715					
					8
	35				

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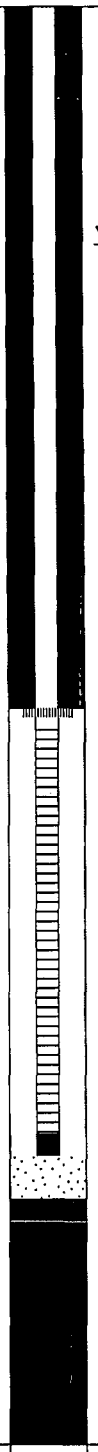
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

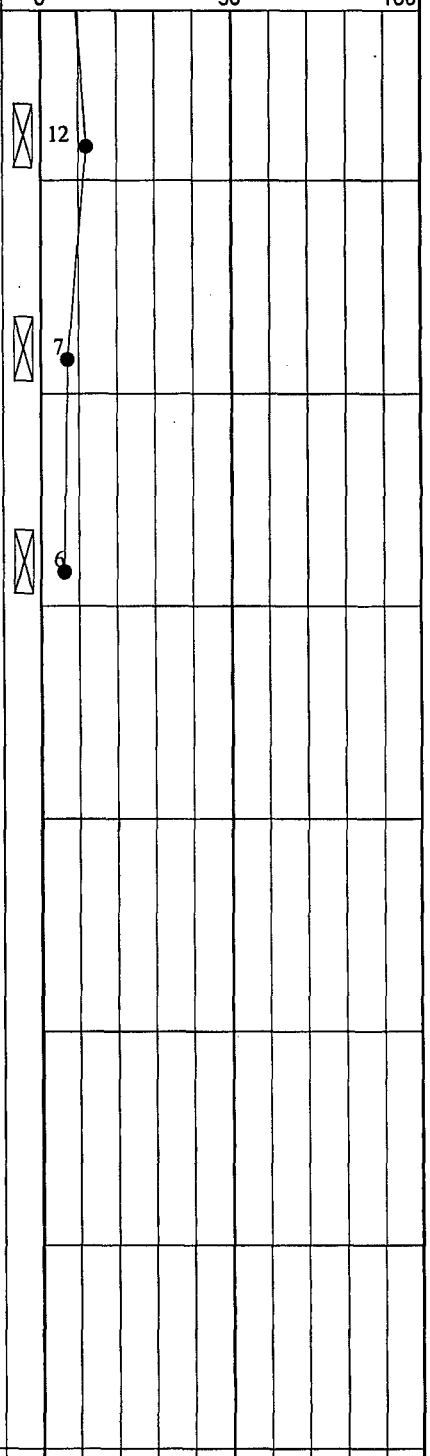
Project: **MNS - Groundwater Protection Project**			**Boring No. M-91R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 2 of 2
Boring Depth (ft): **69.8**	Elevation (ft): **745.9**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **1/2/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 41.60 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Material Description
	40	
705		
	45	SOIL/SAPROLITE (M1): Black, White, and Tan, Very Fine Sandy, **SILT** With Mica and Manganese Staining
700		
	50	SOIL/SAPROLITE (M1): Brownish-Orange and Black, Micaceous, Very Fine Sandy, **SILT** With Manganese Staining
695		**Roller Cone Refusal at 52.50 ft bls**
	55	SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**; Moderately Fractured, Low Angle and High Angle Joints With Slight to Moderate Staining; Intensely Fractured Zone From 52.50 ft to 52.90 ft bls
690		SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**; Slightly Fractured, Low Angle, High Angle, and Horizontal Joints With No Staining
	60	
685		
	65	
680		
		Boring Terminated at 69.80 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



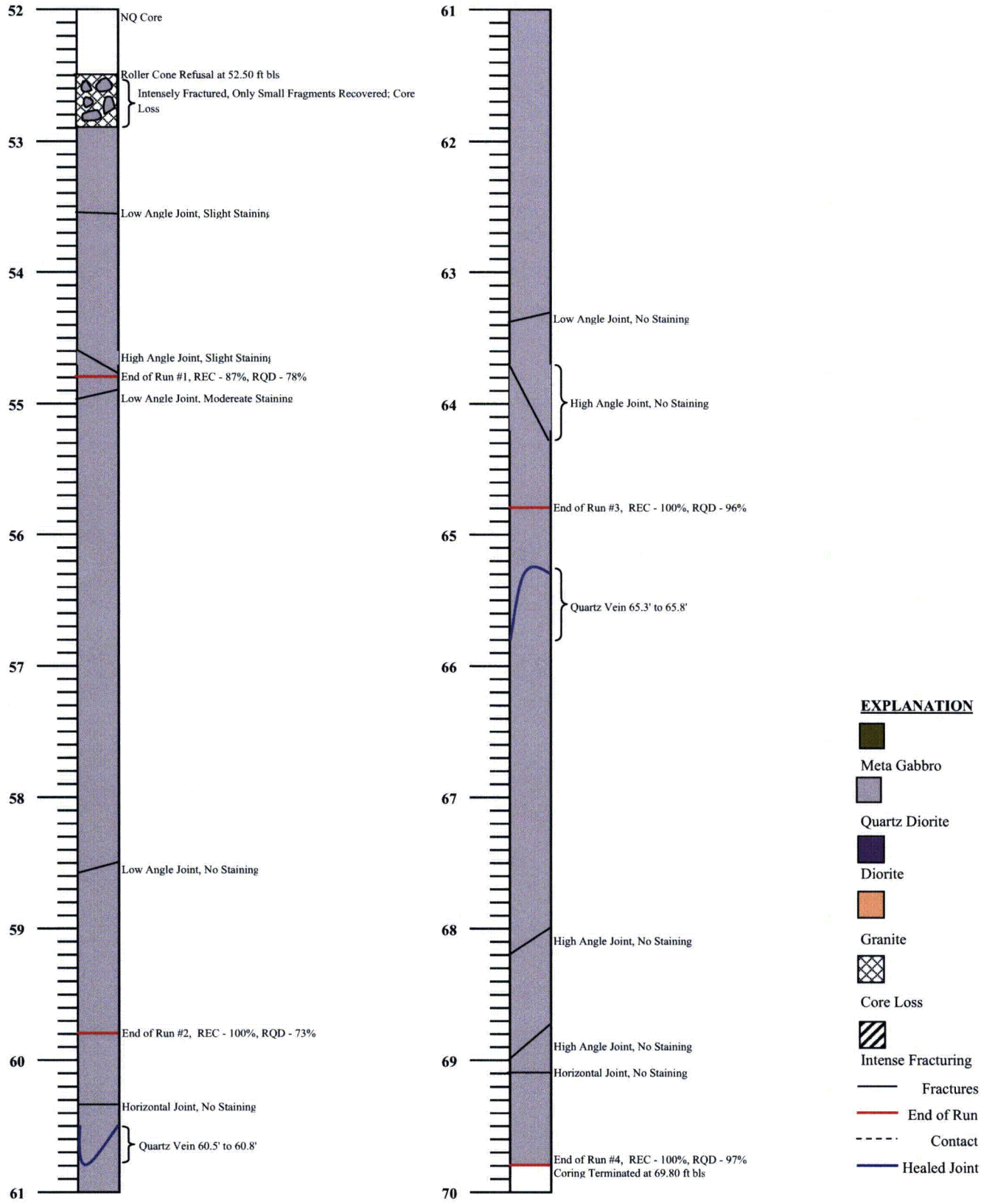
BORING LOG WITH WELL MNSLOG.GPJ LAGWGN01.GDT 3/26/08

FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-91R



COMPLETION REPORT OF WELL No. M-91R

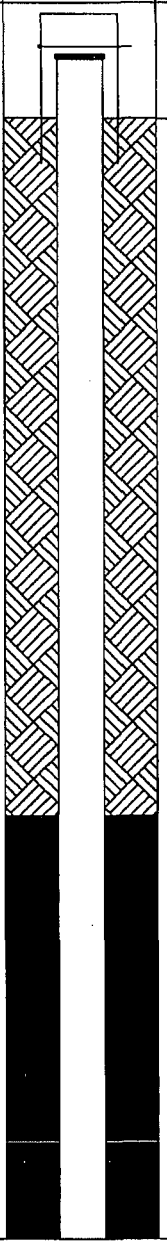
PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 41.60 ft bls**

LATITUDE: **35 25 54.79**
LONGITUDE: **80 57 08.47**
TOP OF CASING ELEVATION: **748.79**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **1/2/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
GRASS/ROOTMAT		0		0.00		745.92
SOIL/SAPROLITE (M1): Red, Yellow, and Tan, Micaceous, Slightly Sandy, Clayey, **SILT**		5				
ALLUVIAL (S): Red, Micaceous, Silty, **CLAY** With Pebbles		10				
SOIL/SAPROLITE (M1): Reddish-Yellow, Micaceous, Clayey, **SILT** With Manganese Staining		15				
SOIL/SAPROLITE (M1): Red and Yellow Mottled, Micaceous, **SILT** With Manganese Staining		20		22.40		723.52
		25				
SOIL/SAPROLITE (M1): Reddish-Brown, Tan, and White, Fine Sandy, **SILT** With Manganese Staining and Rock Fragments		30				
		35				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 63 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 22.4 ft bls**

SEAL
Type: **K-Packer**
Interval: **52.5 to 52.7 ft bls**

FILTERPACK
Type: **N/A**
Interval: **N/A**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **53 to 63 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-91R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION: **745.9**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOIL/SAPROLITE (M1): Reddish-Brown, Tan, and White, Fine Sandy, **SILT** With Manganese Staining and Rock Fragments *(continued)*		40					
SOIL/SAPROLITE (M1): Black, White, and Tan, Very Fine Sandy, **SILT** With Mica and Manganese Staining		45					
SOIL/SAPROLITE (M1): Brownish-Orange and Black, Micaceous, Very Fine Sandy, **SILT** With Manganese Staining		50		52.50		693.42	
SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**; Moderately Fractured, Low Angle and High Angle Joints With Slight to Moderate Staining; Intensely Fractured Zone From 52.50 ft to 52.90 ft bls		55		52.70 53.00		693.22 692.92	
SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**; Slightly Fractured, Low Angle, High Angle, and Horizontal Joints With No Staining		60 65		62.50 63.00 64.00 69.80		683.42 682.92 681.92 676.12	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-91R

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

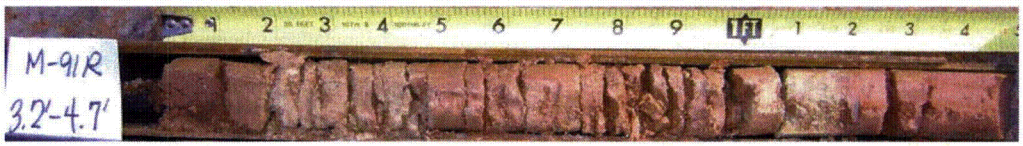
SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

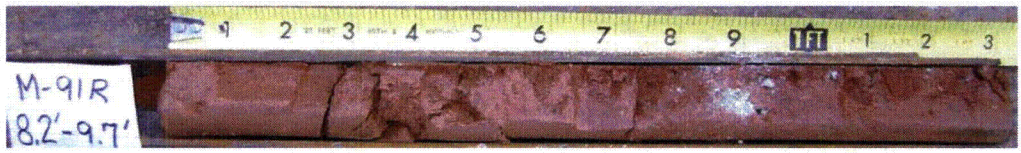
S&ME Project No: 1264-06-724

Boring Number: M-91R

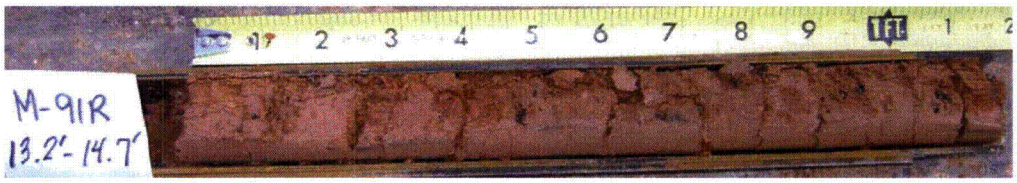
Sample No: 1
Depth (ft-bls): 3.2 - 4.7
Blow Count: 6 * 8 * 8



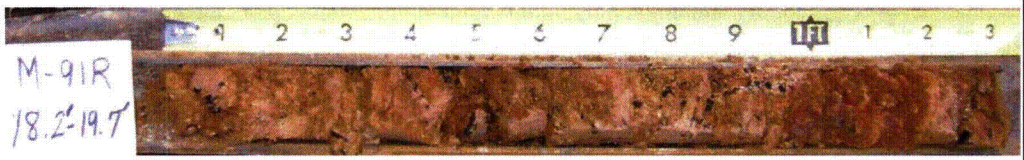
Sample No: 2
Depth (ft-bls): 8.2 - 9.7
Blow Count: 4 * 5 * 6



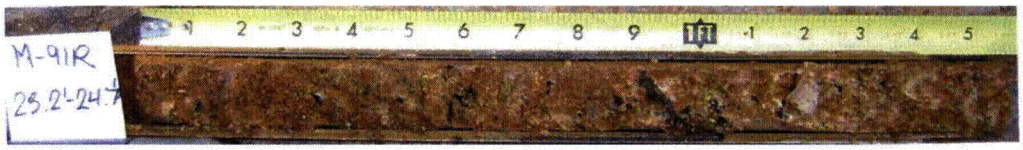
Sample No: 3
Depth (ft-bls): 13.2 - 14.7
Blow Count: 4 * 3 * 6



Sample No: 4
Depth (ft-bls): 18.2 - 19.7
Blow Count: 2 * 4 * 3



Sample No: 5
Depth (ft-bls): 23.2 - 24.7
Blow Count: 2 * 2 * 3



Sample No: 6
Depth (ft-bls): 28.2 - 29.7
Blow Count: 1 * 2 * 2

SPLIT SPOON SAMPLE PICTURES

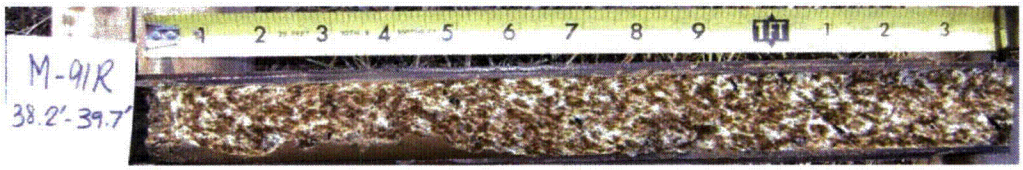
McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: M-91R

Sample No: 7
Depth (ft-bls): 33.2 - 34.7
Blow Count: 3 * 3 * 5

Sample No: 8
Depth (ft-bls): 38.2 - 39.7
Blow Count: 3 * 5 * 7



Sample No: 9
Depth (ft-bls): 43.2 - 44.7
Blow Count: 2 * 3 * 4

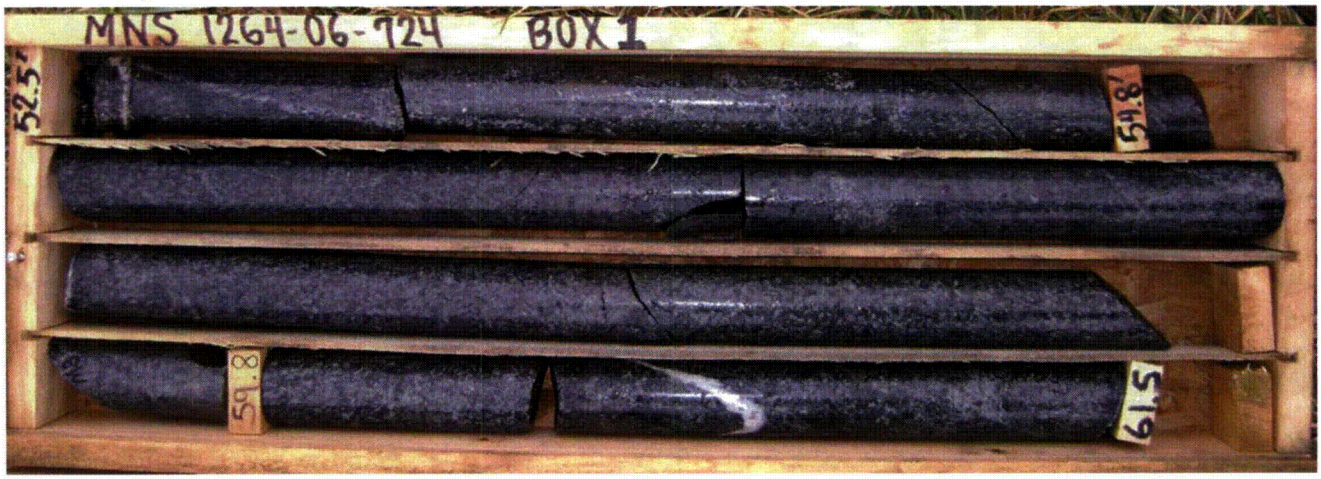
Sample No: 10
Depth (ft-bls): 48.2 - 49.7
Blow Count: 2 * 2 * 4

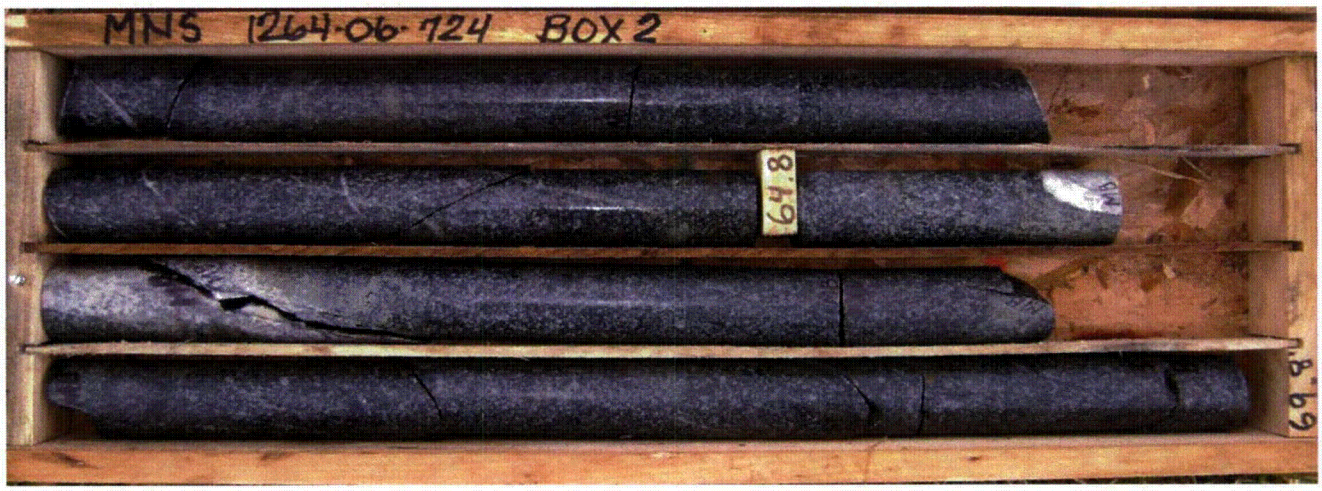
ROCK CORE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-91R





CLASSIFICATION:

52.5' to 69.8': Medium-Grained Quartz Diorite

CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

S&ME

Site Name:	MNS - GWPP	
Date:	1/3/2008	
Boring I.D.	M-91R	
Test Interval:	35.4' to 38.4'	(Soil/Saprolite)
Total Depth of Hole:	38.4 ft bls	1170.73 cm
Length of Open Hole:	3 ft	91.46 cm
Transformation Ratio m=	1	
Performed by:	Courtney Withers	

Time (sec)	Head (cm)	Permeability (cm/sec)
0	758.93	
60	756.68	1.25E-05
120	755.09	8.82E-06
180	753.48	9.01E-06
240	752.16	7.32E-06
300	750.58	8.87E-06
360	748.38	1.23E-05
420	746.77	9.09E-06
480	744.66	1.19E-05
540	743.32	7.58E-06
600	741.92	7.94E-06
900	733.78	9.28E-06
1200	727.01	7.79E-06
1500	720.58	7.47E-06
1800	713.75	8.01E-06
2400	701.04	7.56E-06
3000	688.41	7.64E-06

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

$$\frac{mL}{D} \rangle 4$$

Where:

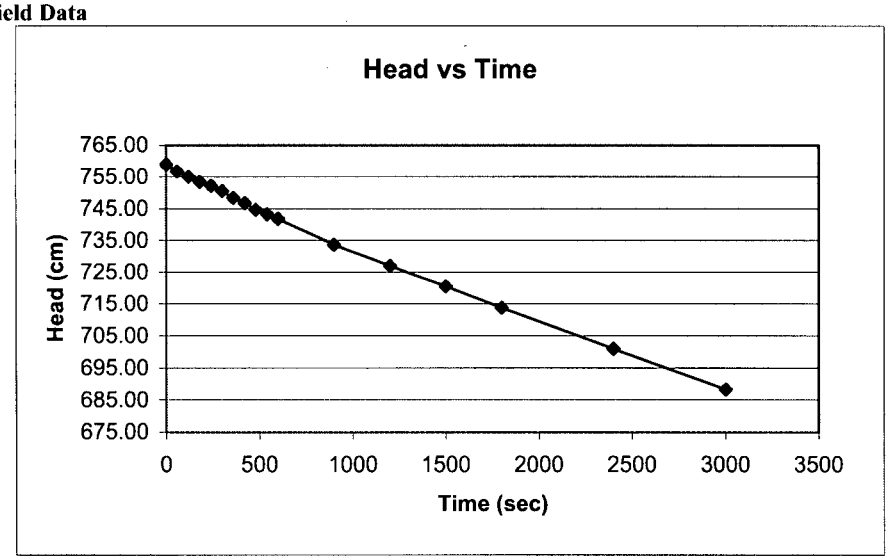
K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where
	$m = \sqrt{K_h / K_v}$ — K_h is the Horizontal Permeability; K_v is the Vertical Permeability
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec)

8.94E-06

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

S&ME

Site Name:	MNS - GWPP	
Date:	1/7/2008	
Boring I.D.	M-91R	
Test Interval:	52.5' to 59.8'	(Sound Rock)
Total Depth of Hole:	59.8 ft bls	1823.17 cm
Length of Open Hole:	7.3 ft	222.56 cm
Transformation Ratio m=	1	
Performed by:	Courtney Withers	

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1793.48	
60	1786.31	8.85E-06
120	1778.75	9.38E-06
180	1763.99	1.84E-05
240	1747.35	2.10E-05
300	1733.29	1.79E-05
360	1718.63	1.88E-05
420	1703.93	1.90E-05
480	1688.81	1.97E-05
540	1677.20	1.53E-05
600	1669.39	1.03E-05
900	1620.34	1.32E-05
1200	1569.51	1.41E-05
1500	1527.53	1.20E-05
1800	1483.11	1.30E-05
2400	1407.80	1.15E-05
3000	1342.38	1.05E-05
3600	1286.68	9.37E-06

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} > 4$

Where:

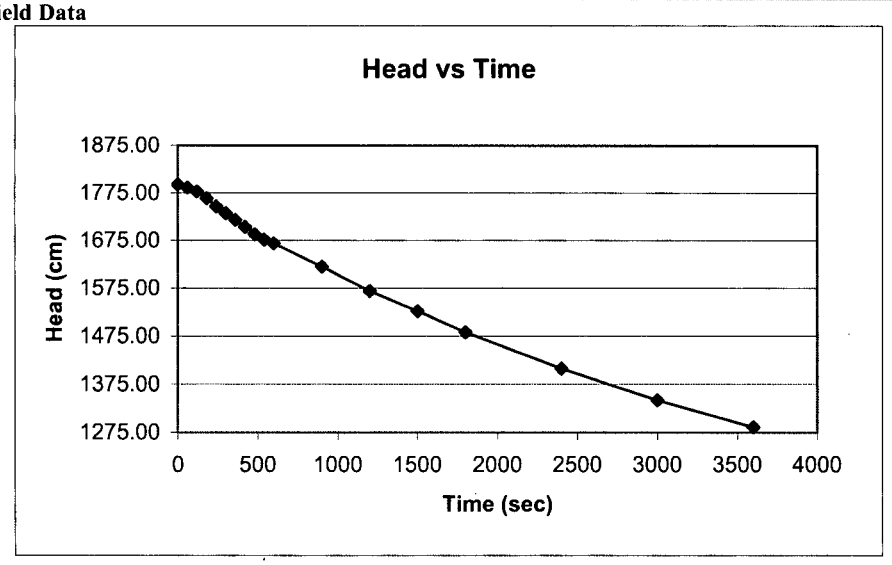
K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where $m = \sqrt{K_h / K_v}$ — K_h is the Horizontal Permeability; K_v is the Vertical Permeability
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec)

1.42E-05

Graph of Field Data

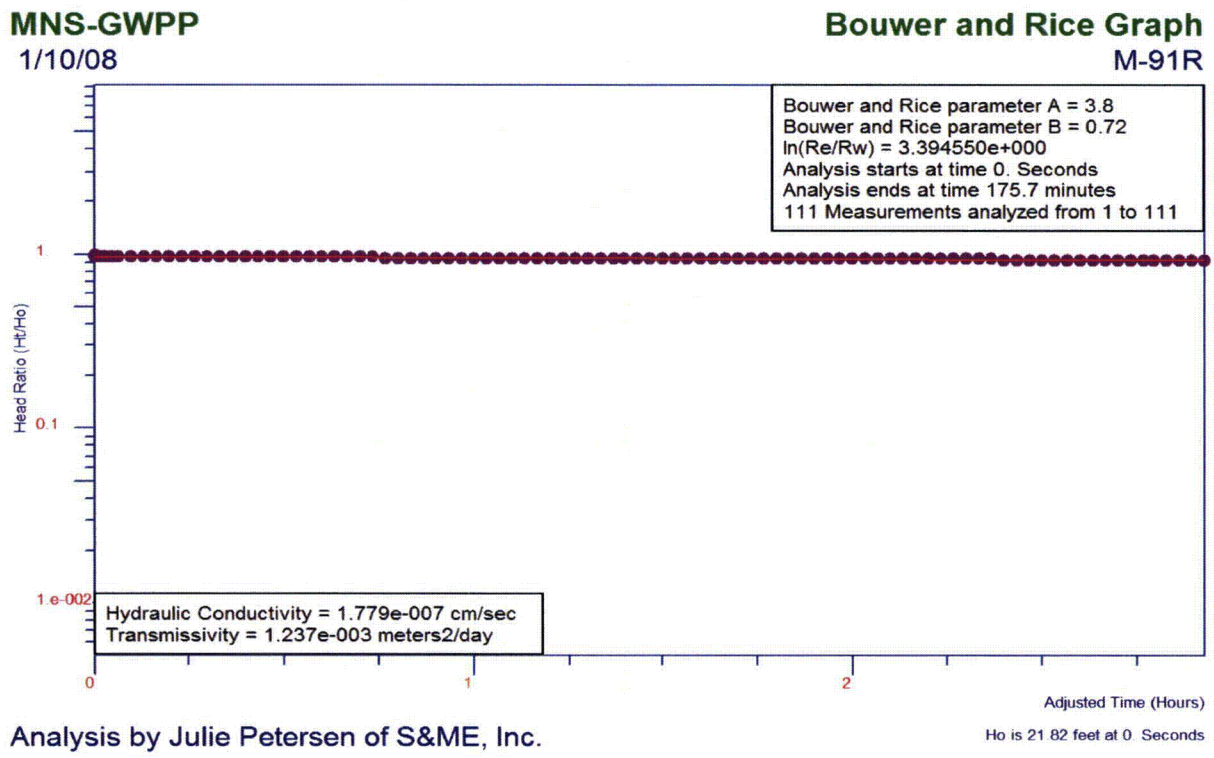


Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	1/10/2008
Well Label:	M-91R
Aquifer Thickness:	26.4 feet
Screen Length:	10. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	21.4 feet
Water Table to Screen Bottom:	21.4 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 111 time and drawdown measurements
Maximum head is 21.82 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

1.78×10^{-07} cm/sec

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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
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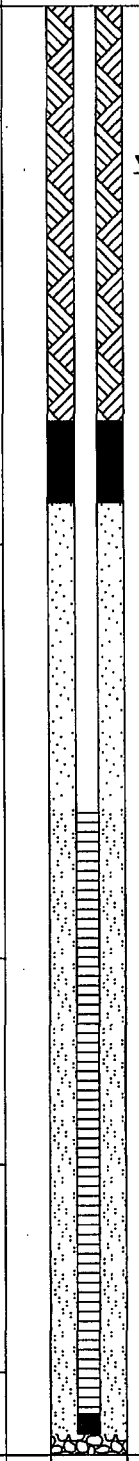
Project: **MNS - Groundwater Protection Project**			**Boring No. M-92**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 1
Boring Depth (ft): **35.0**	Elevation (ft): **728.4**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **4/17/07**
Logged By: **Julie Petersen**	Water Level: **Stabilized Water Level at 4.05 ft bls**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
725	5		FILL (F): Gray to Red, Fine Sandy, Silty, **CLAY** With Gravel Layers		
720	10				
715	15		FILL (F): Yellowish-Red, Micaceous, Fine Sandy, Silty, **CLAY** With Gravel Fragments and Manganese Staining		
710	20				
705	25		ALLUVIUM (S): Gray, Red, and Brown Striated, Fine Sandy, Silty, **CLAY** With Organics		
700	30		ALLUVIUM (S): Reddish-Brown, Silty, **CLAY** With Medium to Fine Sand, Mica, Organics, and Gravel		
695	35		SOIL/SAPROLITE (M1): Tannish-Red, Fine Sandy, Silty, **CLAY** With White, High Plasticity, Clay Inclusions		
			Boring Terminated at 35.00 ft bls **Lithologic Descriptions Obtained From M-92R**		



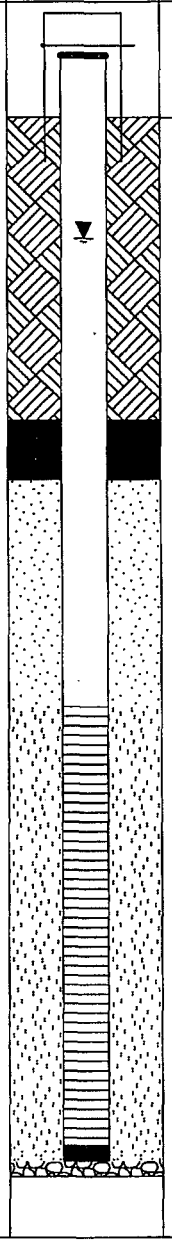
COMPLETION REPORT OF WELL No. M-92

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 4.05 ft bls**
LATITUDE: **35 25 58.20**
LONGITUDE: **80 57 10.07**
TOP OF CASING ELEVATION: **731.35**
DATUM: **MSL**
LOGGED BY: **Julie Petersen**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **4/17/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		728.41
FILL (F): Gray to Red, Fine Sandy, Silty, **CLAY** With Gravel Layers		0, 5, 10		10.00		718.41
				12.00		716.41
FILL (F): Yellowish-Red, Micaceous, Fine Sandy, Silty, **CLAY** With Gravel Fragments and Manganese Staining		15, 20				
ALLUVIUM (S): Gray, Red, and Brown Striated, Fine Sandy, Silty, **CLAY** With Organics		25				
ALLUVIUM (S): Reddish-Brown, Silty, **CLAY** With Medium to Fine Sand, Mica, Organics, and Gravel		30				
SOIL/SAPROLITE (M1): Tannish-Red, Fine Sandy, Silty, **CLAY** With White, High Plasticity, Clay		35		34.00		694.41
				34.50		693.91
				35.00		693.41



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 19.5 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 10 ft bls**

SEAL
Type: **Bentonite**
Interval: **10 to 12 ft bls**

FILTERPACK
Type: **#1 Filter Sand**
Interval: **12 to 34.5 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **19.5 to 34.5 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-92

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION:
LOGGED BY: **728.4**
CHECKED BY: **Julie Petersen**

STRATA			WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
DESCRIPTION	SYMBOL	DEPTH (ft.)					
							(See Page 1)
Inclusions							

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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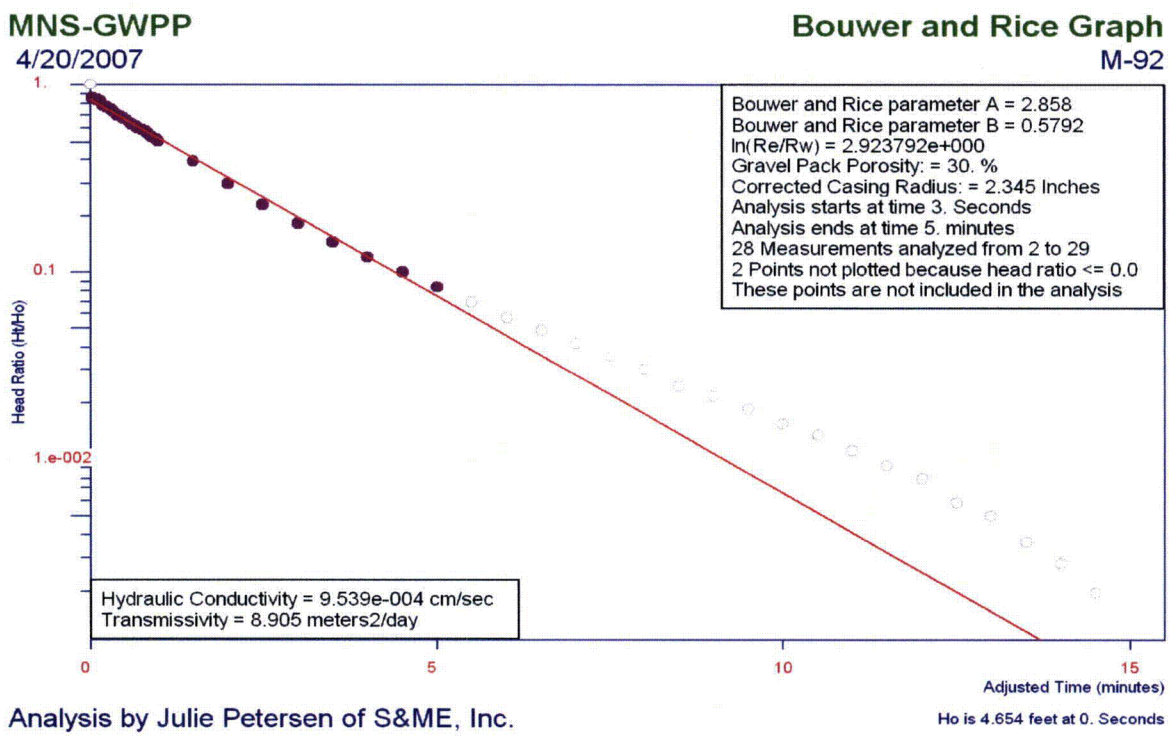
COMPLETION REPORT OF WELL No. M-92

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	4/20/2007
Well Label:	M-92
Aquifer Thickness:	35.45 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	4. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.345 Inches
Static Water Level:	4.05 feet
Water Table to Screen Bottom:	30.45 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 50 time and drawdown measurements
Maximum head is 4.654 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

9.54E-04 cm/sec

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Project: **MNS - Groundwater Protection Project**			**Boring No. M-92R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 3
Boring Depth (ft): **79.9**	Elevation (ft): **728.3**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **4/6/07**
Logged By: **Julie Petersen**	Water Level: **Stabilized Water Level at 6.13 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
725	5		FILL (F): Gray to Red, Fine Sandy, Silty, **CLAY** With Gravel Layers		12
720	10				4
715	15		FILL (F): Yellowish-Red, Micaceous, Fine Sandy, Silty, **CLAY** With Gravel Fragments and Manganese Staining		6
710	20				5
705	25		ALLUVIUM (S): Gray, Red, and Brown Striated, Fine Sandy, Silty, **CLAY** With Organics		6
700	30		ALLUVIUM (S): Reddish-Brown, Silty, **CLAY** With Medium to Fine Sand, Mica, Organics, and Gravel		11
695			SOIL/SAPROLITE (M1): Tannish-Red, Fine Sandy, Silty, **CLAY** With White, High Plasticity, Clay Inclusions		12

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2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-92R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 2 of 3
Boring Depth (ft): **79.9**	Elevation (ft): **728.3**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **4/6/07**
Logged By: **Julie Petersen**	Water Level: **Stabilized Water Level at 6.13 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
690					19
	40		SOIL/SAPROLITE (M1): Black and White, Micaceous, Silty, Coarse to Fine **SAND** (Granitic)		
685					26
	45				
680					56
	50				
675					64
	55		**Roller Cone Refusal at 58.40 ft bls**		
670			SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**, Slightly Fractured		50/0 >>
	60				
665					
	65				
660					

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Project: **MNS - Groundwater Protection Project**			**Boring No. M-92R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 3 of 3
Boring Depth (ft): **79.9**	Elevation (ft): **728.3**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **4/6/07**
Logged By: **Julie Petersen**	Water Level: **Stabilized Water Level at 6.13 ft bls**		Drilling Method: **Mud Rotary**

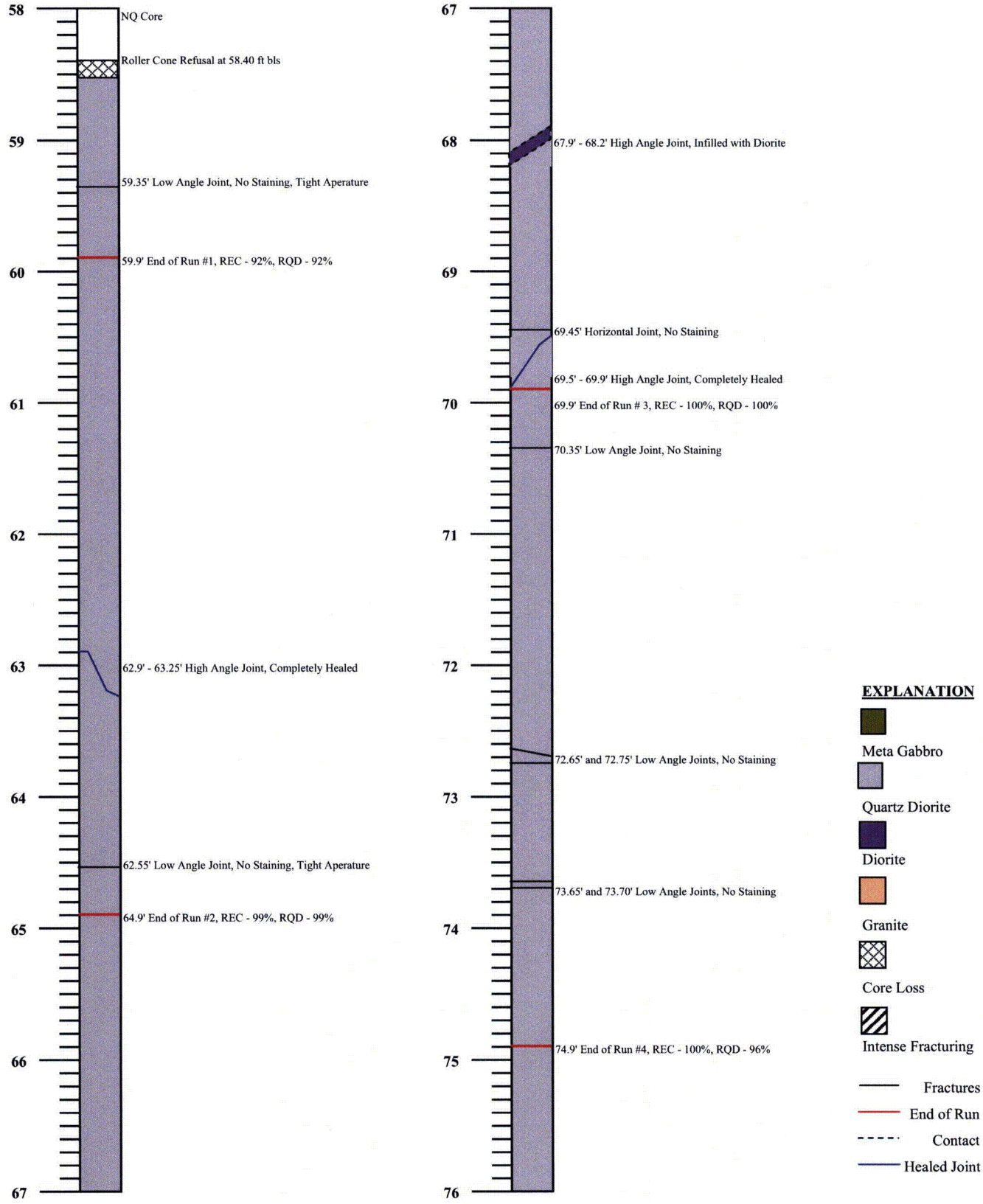
Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
655					
	75				
650			SOUND ROCK (D): Fine-Grained **DIORITE**, Slightly Fractured		
			SOUND ROCK (D): Fine-Grained **GRANITE**, Unfractured		
			Boring Terminated at 79.90 ft bls		

FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-92R

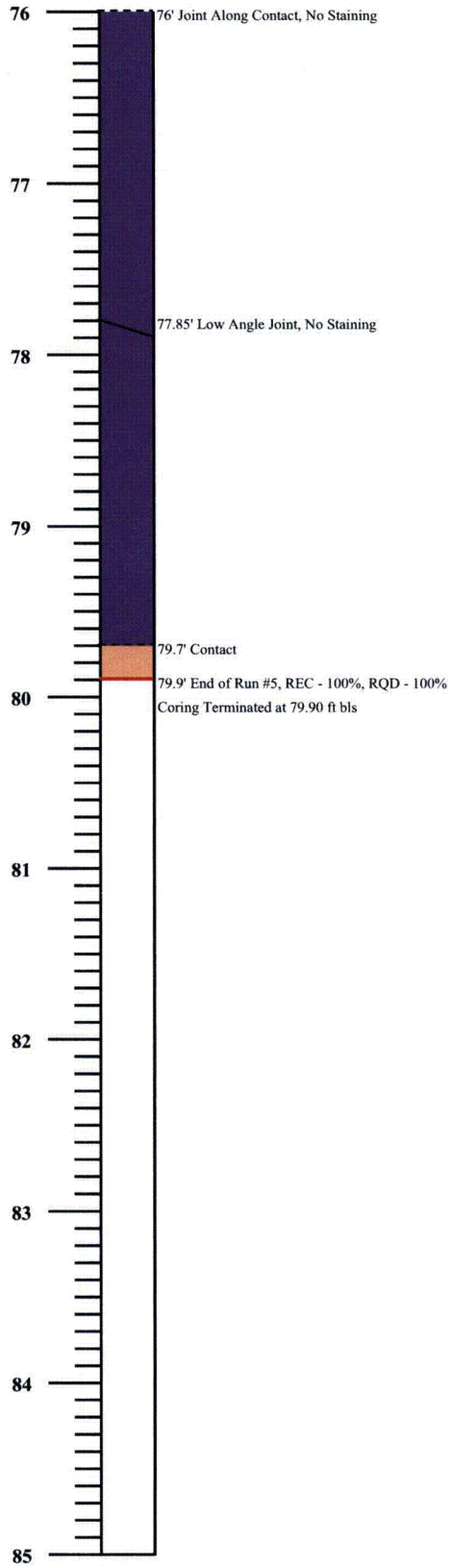


FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location:



EXPLANATION

- Meta Gabbro
- Quartz Diorite
- Diorite
- Granite
- Core Loss
- Intense Fracturing
- Fractures
- End of Run
- Contact
- Healed Joint

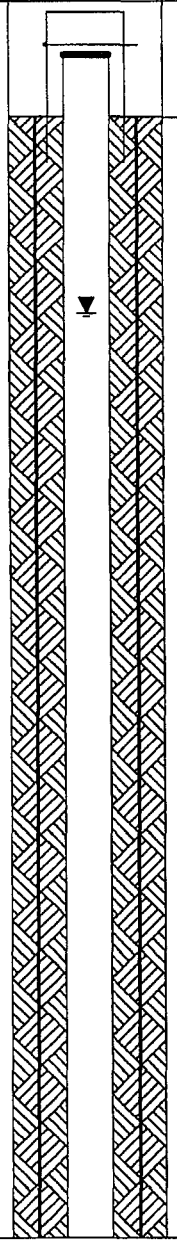
COMPLETION REPORT OF WELL No. M-92R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 6.13 ft bls**
LATITUDE: **35 25 58.18**
LONGITUDE: **80 57 10.13**
TOP OF CASING ELEVATION: **731.37**
DATUM: **MSL**
LOGGED BY: **Julie Petersen**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **4/6/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		728.31
FILL (F): Gray to Red, Fine Sandy, Silty, **CLAY** With Gravel Layers		0, 5, 10				
FILL (F): Yellowish-Red, Micaceous, Fine Sandy, Silty, **CLAY** With Gravel Fragments and Manganese Staining		15, 20				
ALLUVIUM (S): Gray, Red, and Brown Striated, Fine Sandy, Silty, **CLAY** With Organics		25				
ALLUVIUM (S): Reddish-Brown, Silty, **CLAY** With Medium to Fine Sand, Mica, Organics, and Gravel		30				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **6" X 6"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **4" and 2"**
Type: **Sch. 40 PVC**
Interval: **4": 0 to 58.40 ft bls 2": 0 to 70 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 59 ft bls**

SEAL
Type: **Bentonite**
Interval: **59 to 67.5 ft bls**

FILTERPACK
Type: **#2 Filter Sand**
Interval: **67.5 to 75 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **70 to 75 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-92R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION:
LOGGED BY: **728.3**
CHECKED BY: **Julie Petersen**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOIL/SAPROLITE (M1): Tannish-Red, Fine Sandy, Silty, **CLAY** With White, High Plasticity, Clay Inclusions *(continued)*		35					
SOIL/SAPROLITE (M1): Black and White, Micaceous, Silty, Coarse to Fine **SAND** (Granitic)		40, 45, 50, 55					
				58.40		669.91	
SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**, Slightly Fractured		60, 65, 70, 75		59.00		669.31	
				67.50		660.81	
				74.50		653.81	
				75.00		653.31	
SOUND ROCK (D): Fine-Grained **DIORITE**, Slightly Fractured				75.50		652.81	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-92R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION:
LOGGED BY: **728.3**
CHECKED BY: **Julie Petersen**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOUND ROCK (D): Fine-Grained **GRANITE**, Unfractured				79.90		648.41	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-92R

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: M-92R

Sample No: 1
Depth (ft-bls): 3.2 - 4.7
Blow Count: 5 * 6 * 6

Sample No: 2
Depth (ft-bls): 8.2 - 9.7
Blow Count: 2 * 2 * 2

No Recovery

Sample No: 3
Depth (ft-bls): 13.2 - 14.7
Blow Count: 1 * 4 * 2

Sample No: 4
Depth (ft-bls): 18.2 - 19.7
Blow Count: 2 * 2 * 3

Sample No: 5
Depth (ft-bls): 23.2 - 24.7
Blow Count: 2 * 2 * 4

Sample No: 6
Depth (ft-bls): 28.2 - 29.7
Blow Count: 3 * 4 * 7

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: M-92R

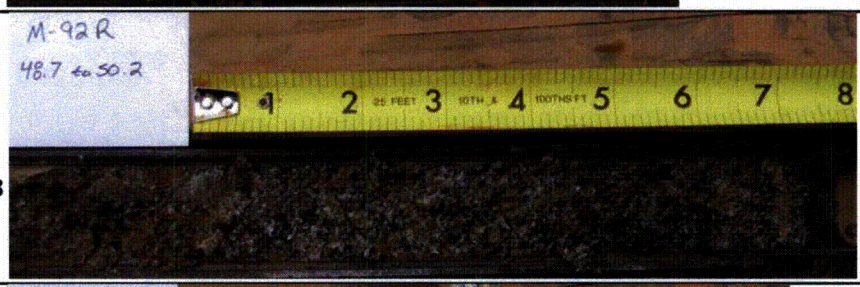
Sample No: 7
Depth (ft-bls): 33.2 - 34.7
Blow Count: 3 * 5 * 7

Sample No: 8
Depth (ft-bls): 38.2 - 39.7
Blow Count: 6 * 7 * 12

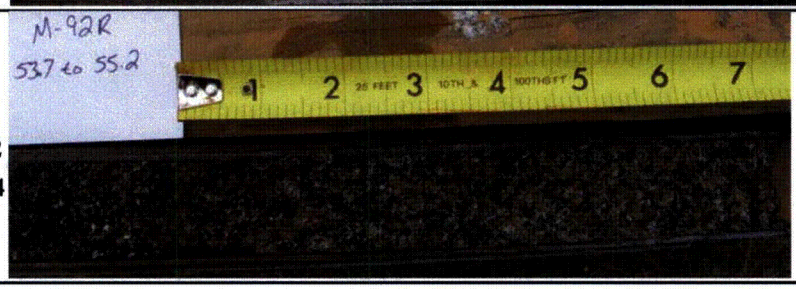
No Recovery

Sample No: 9
Depth (ft-bls): 43.2 - 44.7
Blow Count: 15 * 15 * 11

Sample No: 10
Depth (ft-bls): 48.7 - 50.2
Blow Count: 18 * 28 * 28



Sample No: 11
Depth (ft-bls): 53.7 to 55.2
Blow Count: 34 * 30 * 34



Sample No: 12
Depth (ft-bls): 58.4
Blow Count: 50/0

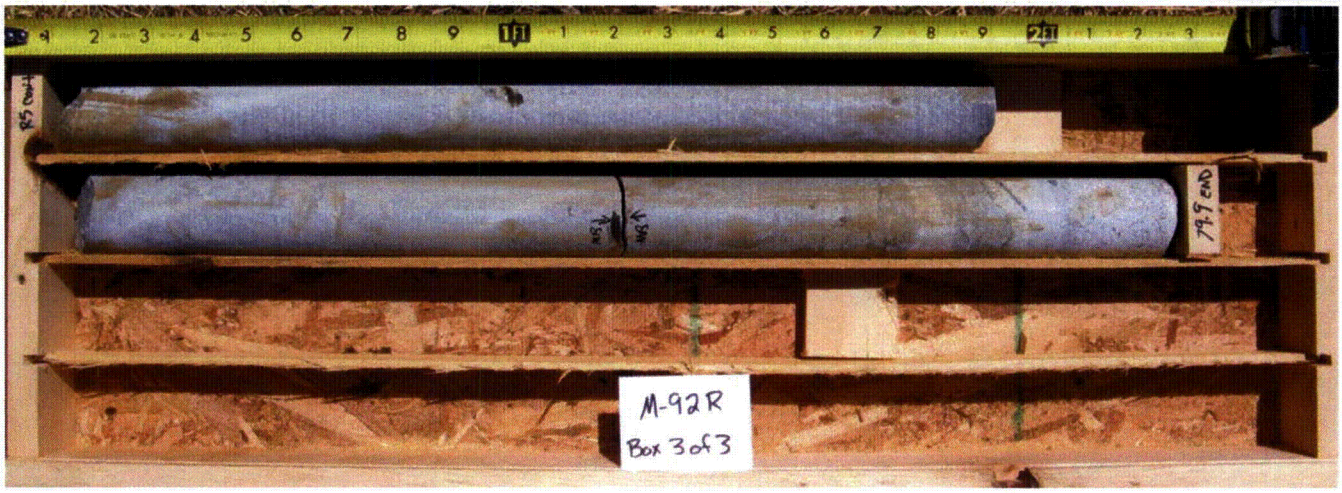
No Recovery

ROCK CORE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-92R



CLASSIFICATION:

58.4' to 76' Medium Grained Quartz Diorite

76' to 79.7' Fine Grained Diorite

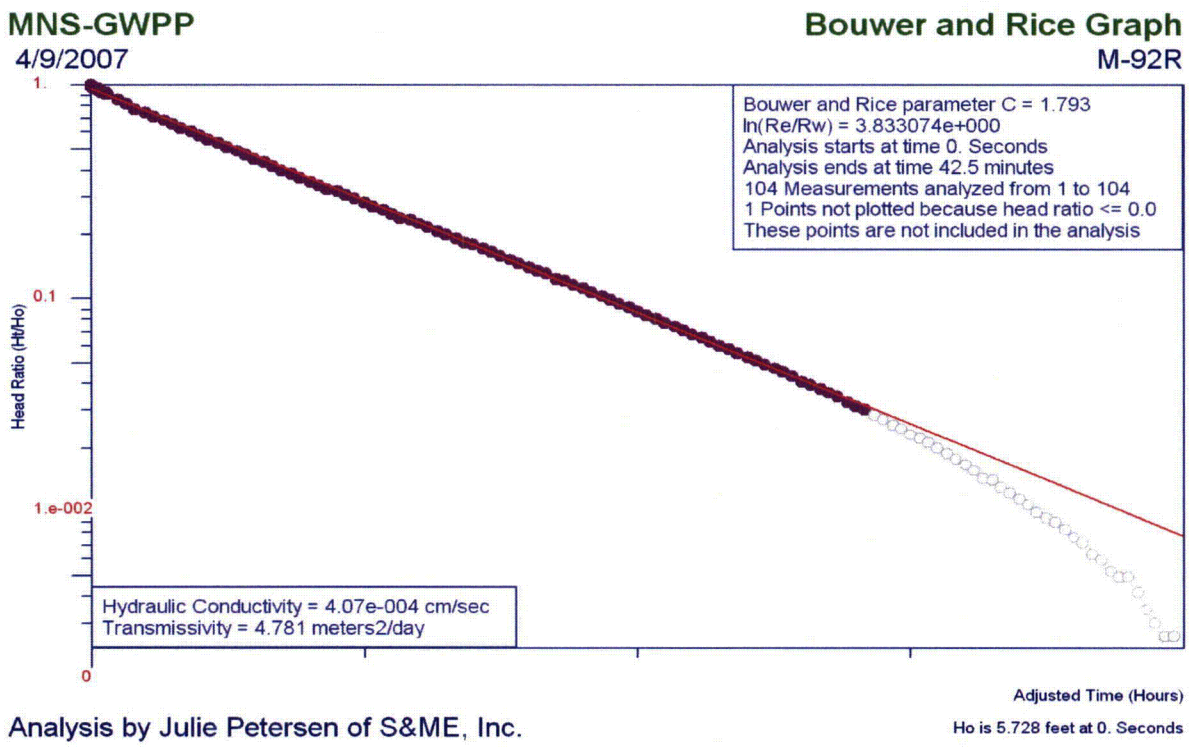
79.7' to 79.9' Fine Grained Granite

Calculation of Permeability By The Falling Head Method (Open Hole in Uniform Material)

Site Name:	MNS-GWPP	
Test Date:	4/9/2007	
Well Label:	M-92R	
Test Interval:	45.66 to 48.7 ft bls	(Soil/Saprolite)
Length of Open Hole:	3.04 feet	
Borehole Radius:	1.5 Inches	
Effective Radius:	1.5 Inches	
Anisotropy Ratio:	1	

Time Adjustment: 0. Seconds
There are 139 time and drawdown measurements
Maximum head is 5.728 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

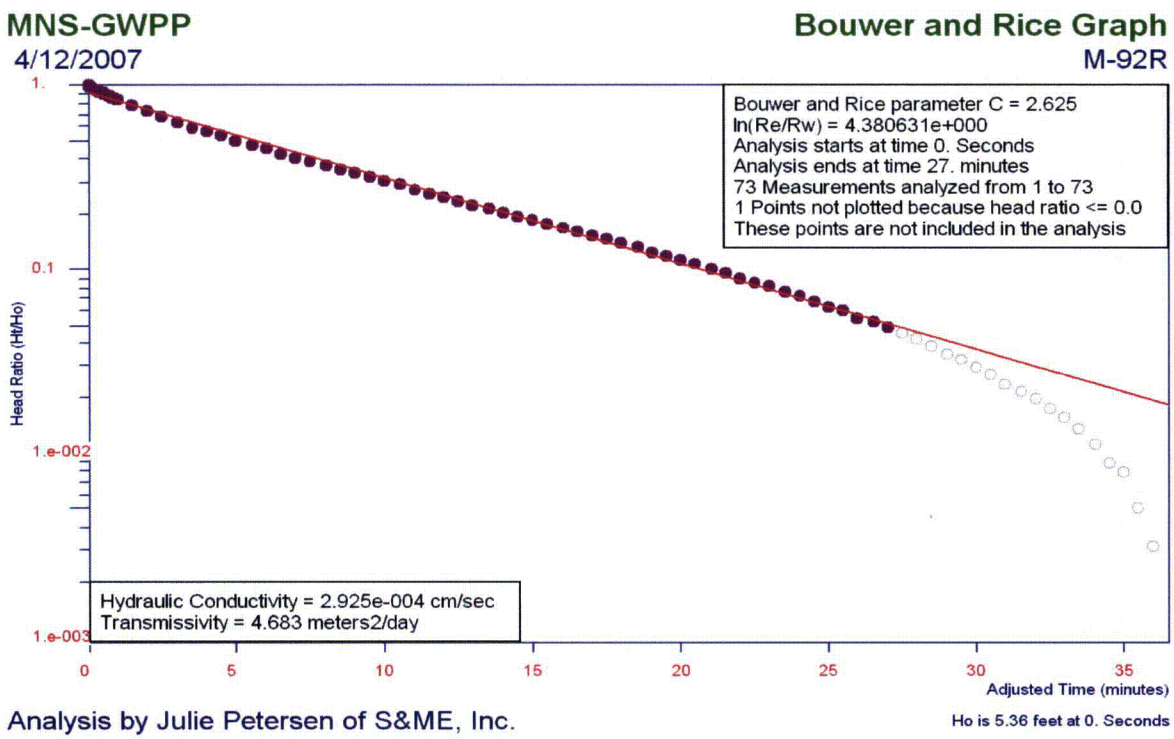
4.07E-04 cm/sec

Calculation of Permeability By The Falling Head Method (Open Hole in Uniform Material)

Site Name:	MNS-GWPP	
Test Date:	4/12/2007	
Well Label:	M-92R	
Test Interval:	58.4 to 64.9	(Sound Rock)
Length of Open Hole:	6.5 feet	
Borehole Radius:	1.5 Inches	
Effective Radius:	1.5 Inches	
Anisotropy Ratio:	1	

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 92 time and drawdown measurements
Maximum head is 5.36 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

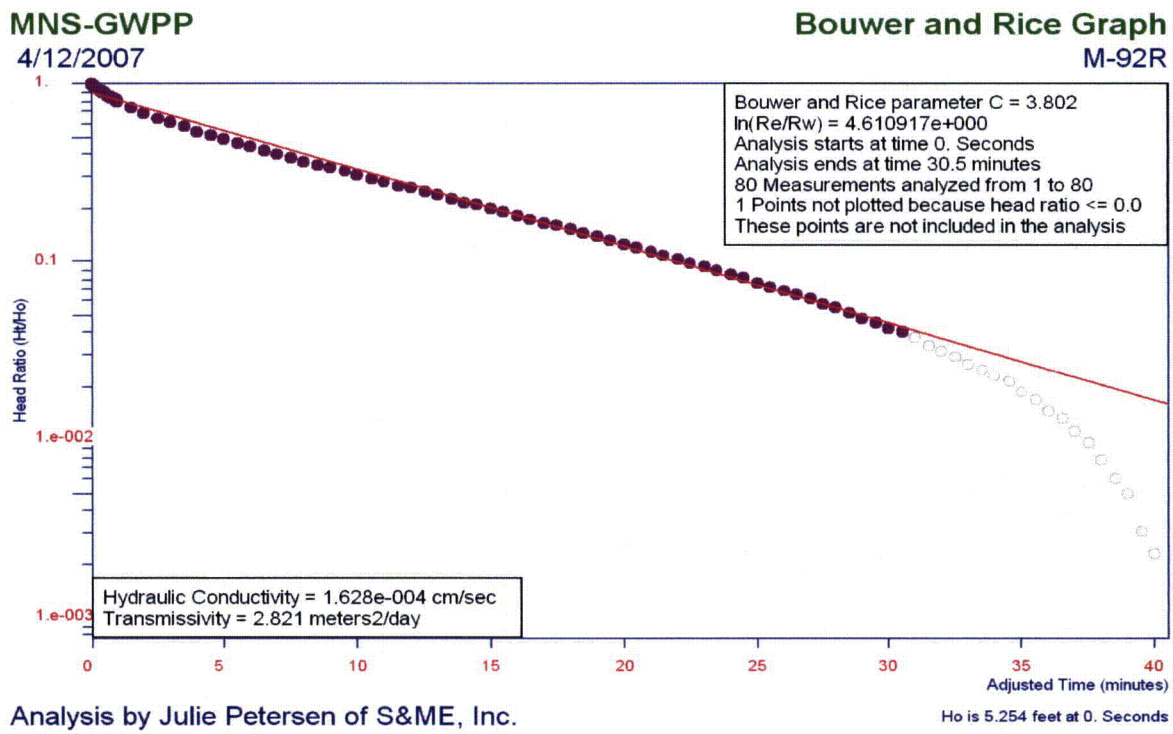
2.93E-04 cm/sec

Calculation of Permeability By The Falling Head Method (Open Hole in Uniform Material)

Site Name:	MNS-GWPP	
Test Date:	4/12/2007	
Well Label:	M-92R	
Test Interval:	58.4 to 69.9 ft bls	(Sound Rock)
Length of Open Hole:	11.5 feet	
Borehole Radius:	1.5 Inches	
Effective Radius:	1.5 Inches	
Anisotropy Ratio:	1	

Time Adjustment: 0. Seconds
There are 100 time and drawdown measurements
Maximum head is 5.254 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

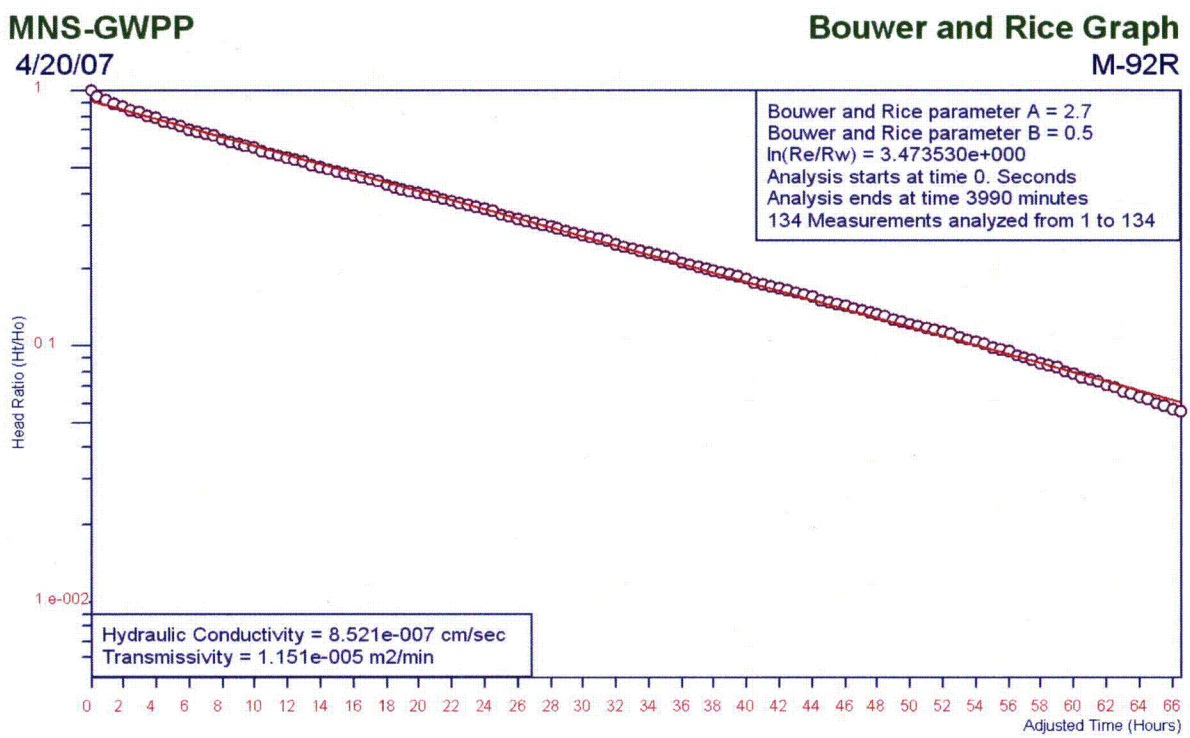
1.63E-04 cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	4/20/2007
Well Label:	M-92R
Aquifer Thickness:	73.87 feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	6.13 feet
Water Table to Screen Bottom:	68.87 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 134 time and drawdown measurements
Maximum head is 15.75 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

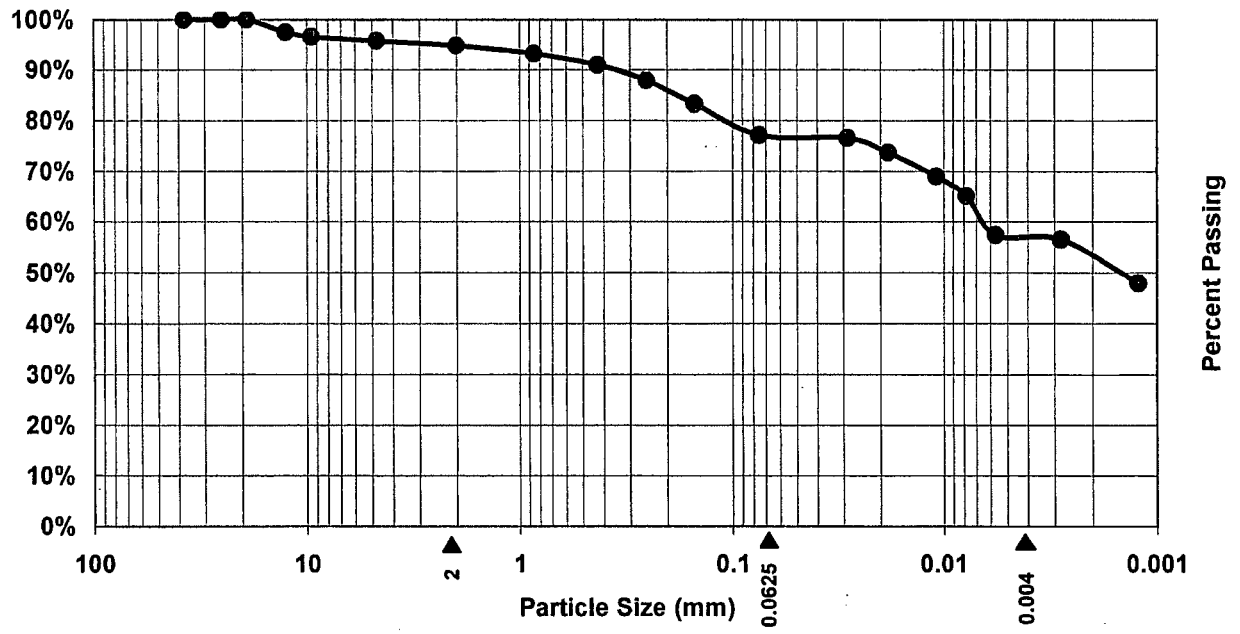
PERMEABILITY

8.52E-07 cm/sec

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-92R	SS-6	28.2 to 29.7 ft bls

Sample Description:
Reddish-Brown, Silty, Clay With Fine to Medium Sand and Mica



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 5.2%	% Sand 17.7%	% Silt 14.0%	% Clay 63.0%
Adjusted for Calculations	**0%**	**19%**	**15%**	**66%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-92R

Boring Depth: 28.2 to 29.7 ft bls

% Sand: 19%

% Silt: 15%

% Clay: 66%

Estimated Specific Yield: 0.3%*

* Estimated Value

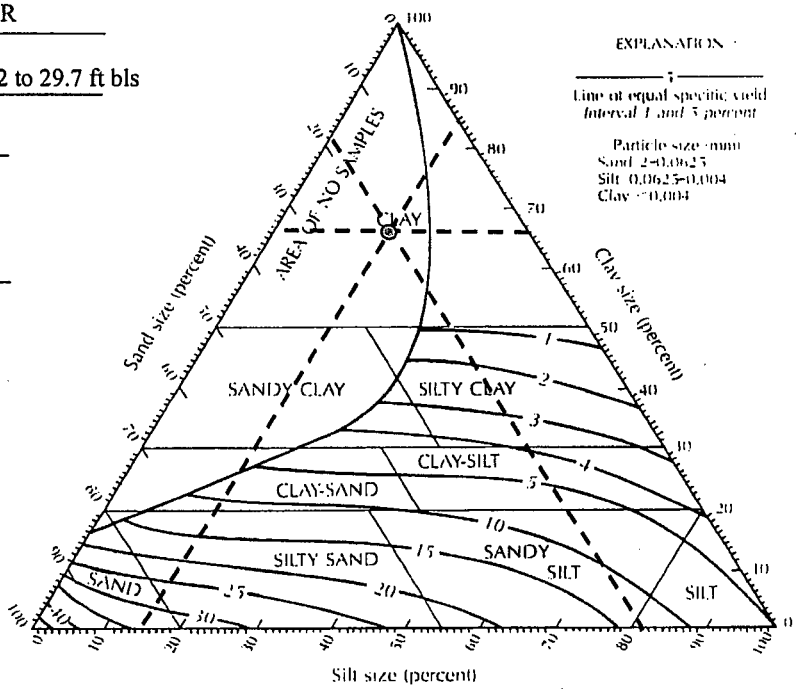
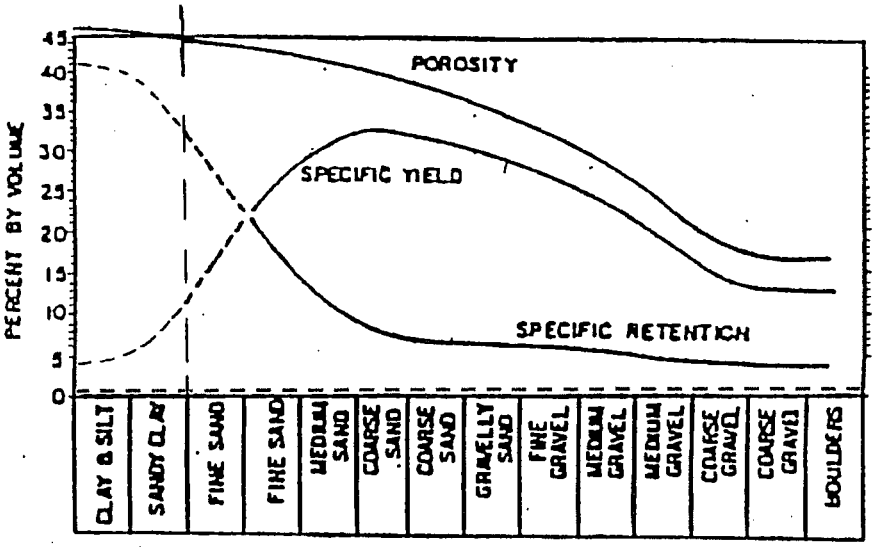


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 50%**

**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-93**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 1
Boring Depth (ft): **43.0**	Elevation (ft): **756.6**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/19/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 32.83 ft bls**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
755			FILL (F): Brownish-Red, Micaceous, Medium to Fine Sandy, Silty, **CLAY** With Manganese Staining and Rock Fragments		
	5				
750					
	10				
745					
	15				
740					
			CONCRETE		
	20		FILL (F): Reddish-Brown, Micaceous, Slightly Clayey, Medium to Fine Sandy, **SILT** With Manganese Staining and Rock Fragments		
735					
			FILL (F): Red, Silty, **CLAY** With Fine Sand		
	25				
730					
			SOIL/SAPROLITE (M1): Yellowish-Red, Slightly Clayey, Fine Sandy, **SILT** With Manganese Nodules		
	30				
725				▼	
	35				
720					
			SOIL/SAPROLITE (M1): Black and White, Silty, Medium to Fine **SAND** With Manganese Staining and Quartz Veins (Dioritic)		
	40				
715			**Boring Terminated at 43.00 ft bls** **Lithologic Descriptions Obtained From M-93R**		

COMPLETION REPORT OF WELL No. M-93

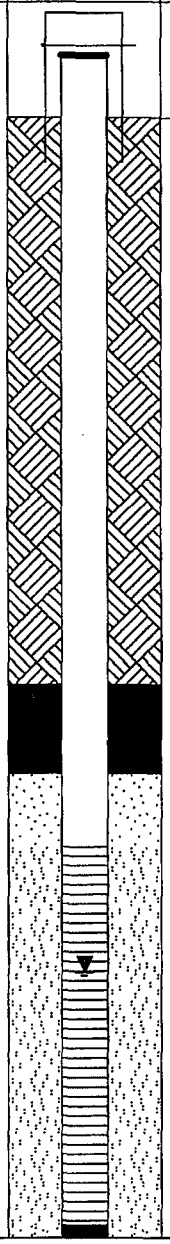
PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 32.83 ft bls**

LATITUDE: **35 25 56.70**
LONGITUDE: **80 57 07.11**
TOP OF CASING ELEVATION: **759.52**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **4/19/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
FILL (F): Brownish-Red, Micaceous, Medium to Fine Sandy, Silty, **CLAY** With Manganese Staining and Rock Fragments		0, 5, 10, 15		0.00		756.60
CONCRETE						
FILL (F): Reddish-Brown, Micaceous, Slightly Clayey, Medium to Fine Sandy, **SILT** With Manganese Staining and Rock Fragments		20, 25		21.75		734.85
FILL (F): Red, Silty, **CLAY** With Fine Sand				25.20		731.40
SOIL/SAPROLITE (M1): Yellowish-Red, Slightly Clayey, Fine Sandy, **SILT** With Manganese Nodules		30, 35				
SOIL/SAPROLITE (M1): Black and White, Silty, Medium to Fine **SAND** With Manganese Staining and Quartz Veins		40		42.50		714.10



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 28 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 21.75 ft bls**

SEAL
Type: **Bentonite**
Interval: **21.75 to 25.2 ft bls**

FILTERPACK
Type: **#1 Filter Sand**
Interval: **25.2 to 43 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **28 to 43 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-93

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION:
LOGGED BY: **756.6**
CHECKED BY: **Courtney Wither**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
(Dioritic) **Boring Terminated at 43.00 ft bls Lithologic Descriptions Obtained From M-93R**				43.00		713.60	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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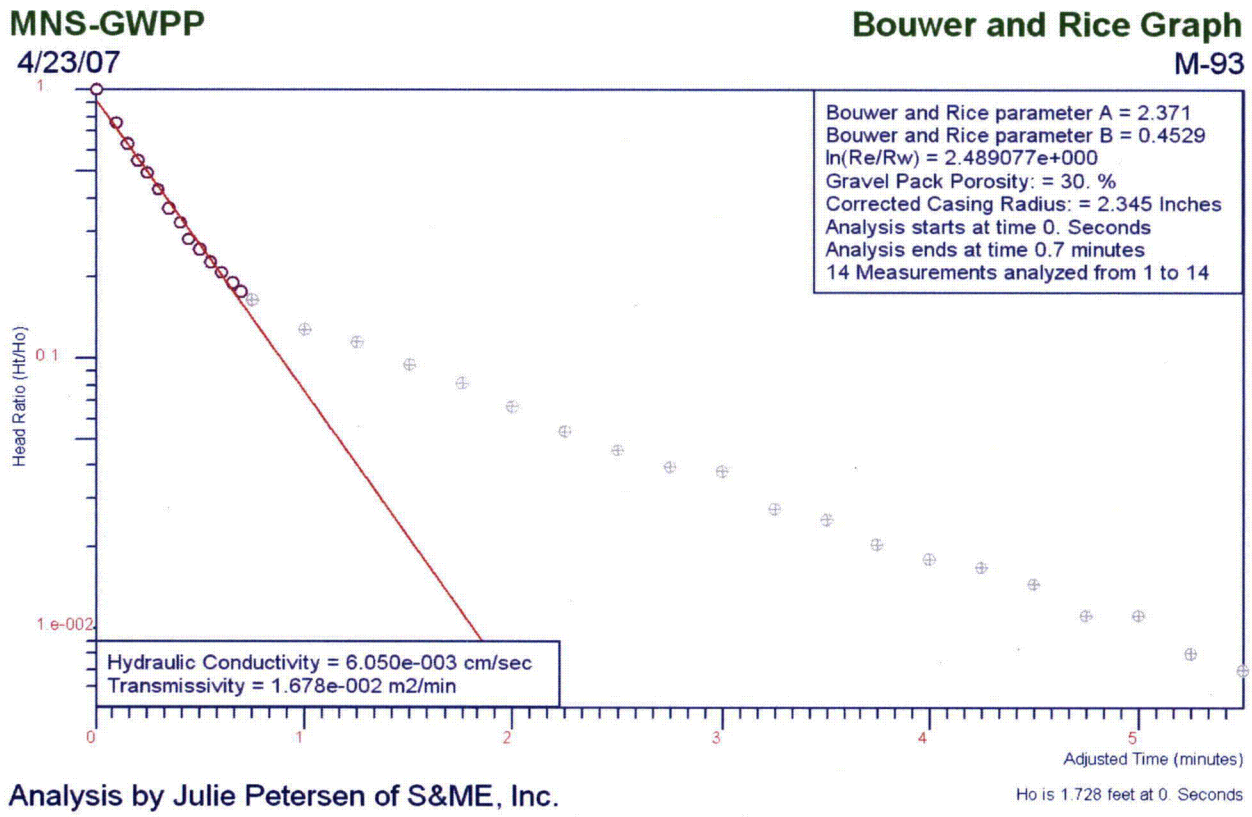
COMPLETION REPORT OF WELL No. M-93

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	4/23/2007
Well Label:	M-93
Aquifer Thickness:	15.17 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	4. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.345 Inches
Static Water Level:	32.83 feet
Water Table to Screen Bottom:	10.17 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 34 time and drawdown measurements
Maximum head is 1.728 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

6.05E-03 cm/sec

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Project: **MNS - Groundwater Protection Project**			**Boring No. M-93R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 3
Boring Depth (ft): **104.8**	Elevation (ft): **756.6**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/10/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 30.20 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
755			FILL (F): Brownish-Red, Micaceous, Medium to Fine Sandy, Silty, **CLAY** With Manganese Staining and Rock Fragments		12
	5				
750					12
	10				
745					7
	15				
740			CONCRETE		
			FILL (F): Reddish-Brown, Micaceous, Slightly Clayey, Medium to Fine Sandy, **SILT** With Manganese Staining and Rock Fragments		6
	20				
735			FILL (F): Red, Silty, **CLAY** With Fine Sand		23
	25				
730			SOIL/SAPROLITE (M1): Yellowish-Red, Slightly Clayey, Fine Sandy, **SILT** With Manganese Nodules		7
	30				
725					3

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Project: **MNS - Groundwater Protection Project**			**Boring No. M-93R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 2 of 3
Boring Depth (ft): **104.8**	Elevation (ft): **756.6**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/10/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 30.20 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
720					
	40		SOIL/SAPROLITE (M1): Black and White, Silty, Medium to Fine **SAND** With Manganese Staining and Quartz Veins (Dioritic)		2
715					
	45		SOIL/SAPROLITE (M1): Brown and White, Fine Sandy, **SILT** With Manganese Staining		5
710					
	50		SOIL/SAPROLITE (M1): Black and White, Silty, Medium to Fine **SAND** With Manganese Staining and Quartz Veins; Brown, Micaceous, Silty, Medium to Fine Sand Lense From 63.20 to 63.27 ft bls		27
705					
	55				
700					19
	60				
695					28
	65				
690					10

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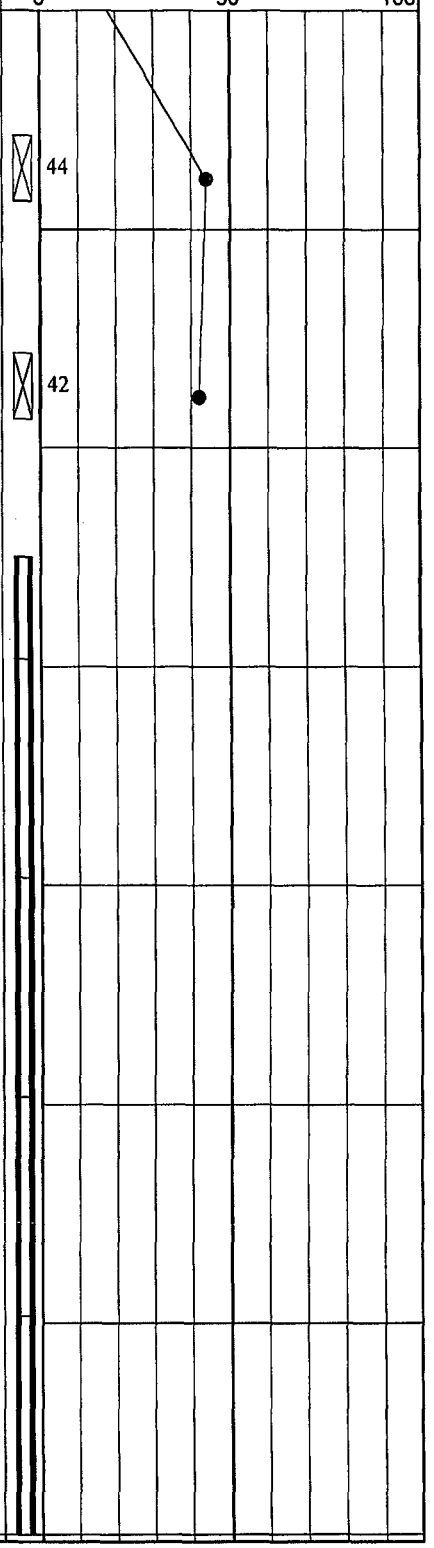
Project: **MNS - Groundwater Protection Project**			**Boring No. M-93R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 3 of 3
Boring Depth (ft): **104.8**	Elevation (ft): **756.6**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/10/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 30.20 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
685			
	75		
680			
	80		
675			**Roller Cone Refusal at 82.48 ft bls**
	85		SOUND ROCK (D): Fine-Grained **GRANITE** With Orbicuals, Moderate to Slight Fracturing
670			
	90		SOUND ROCK (D): Medium-Grained **GRANITE**, Moderately Fractured
665			SOUND ROCK (D): Fine-Grained **DIORITE**, Unfractured With Exception of Intensely Fractured Zone From 90.65 to 91.15 ft bls
	95		
660			
	100		
655			**Boring Terminated at 104.83 ft bls**

Well Construction

Penetration Resistance (Blows/Foot)

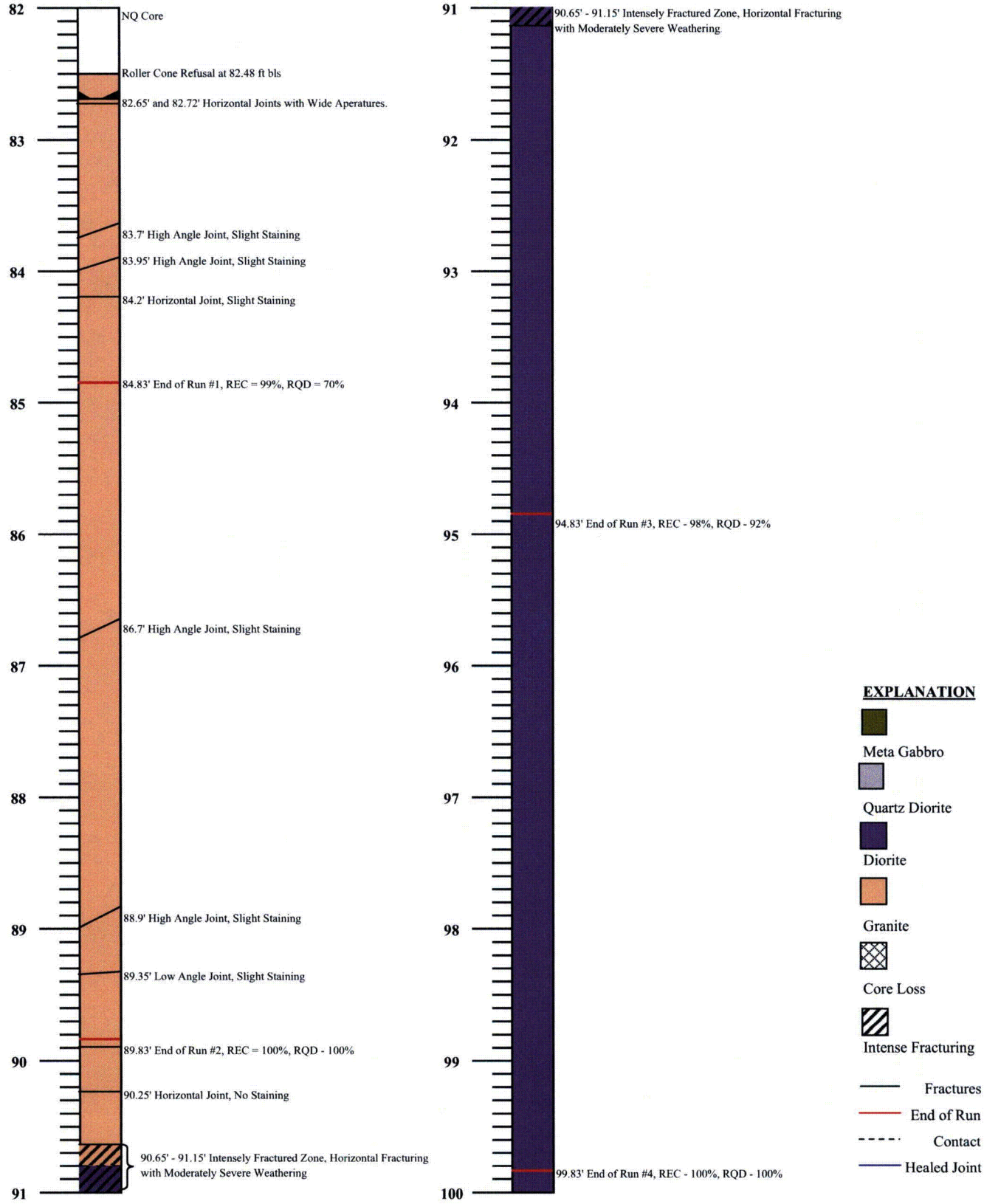


FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-93R

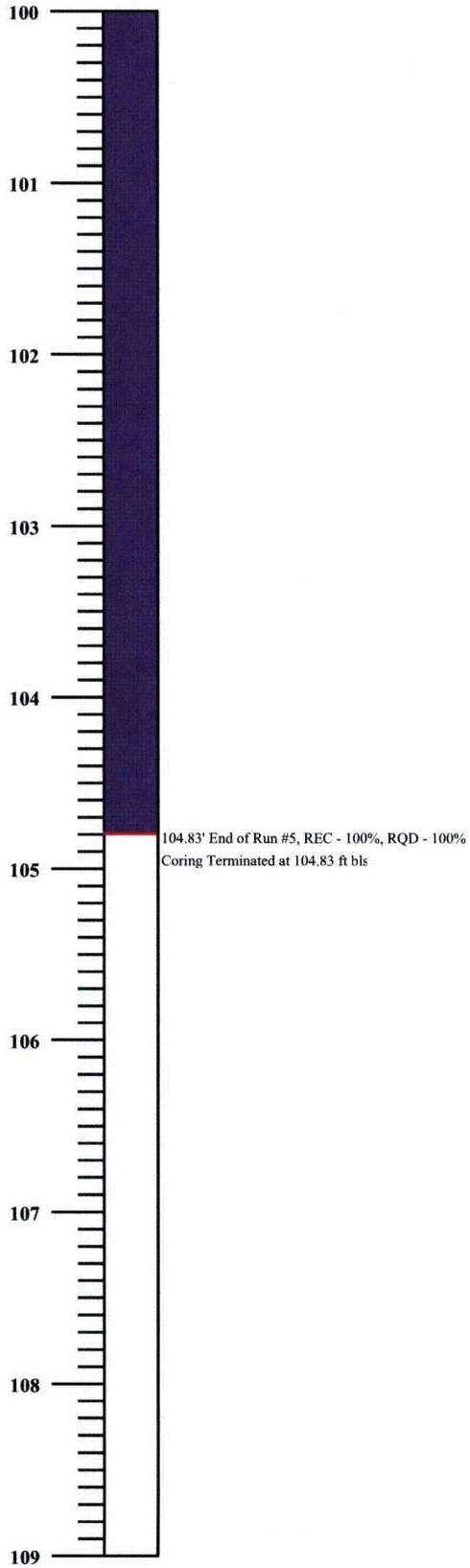


FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-93R



EXPLANATION

- Meta Gabbro
- Quartz Diorite
- Diorite
- Granite
- Core Loss
- Intense Fracturing
- Fractures
- End of Run
- Contact
- Healed Joint

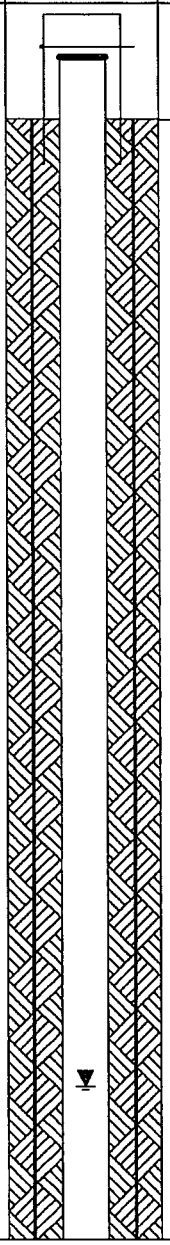
COMPLETION REPORT OF WELL No. M-93R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 30.20 ft bls**
LATITUDE: **35 25 56.72**
LONGITUDE: **80 57 07.16**
TOP OF CASING ELEVATION: **759.56**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **4/10/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		756.55
FILL (F): Brownish-Red, Micaceous, Medium to Fine Sandy, Silty, **CLAY** With Manganese Staining and Rock Fragments		0, 5, 10, 15				
CONCRETE						
FILL (F): Reddish-Brown, Micaceous, Slightly Clayey, Medium to Fine Sandy, **SILT** With Manganese Staining and Rock Fragments		20				
FILL (F): Red, Silty, **CLAY** With Fine Sand		25				
SOIL/SAPROLITE (M1): Yellowish-Red, Slightly Clayey, Fine Sandy, **SILT** With Manganese Nodules		30				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **6" X 6"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **4" and 2"**
Type: **Sch. 40 PVC**
Interval: **4": 0 to 50.45 ft bls 2": 0 to 88 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 86 ft bls**

SEAL
Type: **K-Packer + Bentonite**
Interval: **86 to 87.3 ft bls**

FILTERPACK
Type: **N/A**
Interval: **N/A**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **88 to 93 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-93R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION: **756.6**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
		35					
SOIL/SAPROLITE (M1): Black and White, Silty, Medium to Fine **SAND** With Manganese Staining and Quartz Veins (Dioritic)		40					
SOIL/SAPROLITE (M1): Brown and White, Fine Sandy, **SILT** With Manganese Staining		45					
SOIL/SAPROLITE (M1): Black and White, Silty, Medium to Fine **SAND** With Manganese Staining and Quartz Veins; Brown, Micaceous, Silty, Medium to Fine Sand Lense From 63.20 to 63.27 ft bls		50		50.45		706.10	
		55					
		60					
		65					
		70					
		75					

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-93R

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PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION: **756.6**
LOGGED BY: **Courtney Withe**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
		80					
SOUND ROCK (D): Fine-Grained **GRANITE** With Orbicuals, Moderate to Slight Fracturing		85		86.00		670.55	
				87.10		669.45	
				87.30		669.25	
				88.00		668.55	
SOUND ROCK (D): Medium-Grained **GRANITE**, Moderately Fractured		90					
				92.50		664.05	
SOUND ROCK (D): Fine-Grained **DIORITE**, Unfractured With Exception of Intensely Fractured Zone From 90.65 to 91.15 ft bls				93.00		663.55	
		95					
		100					
				104.83		651.72	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-93R

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: M-93R

Sample No: 1
Depth (ft-bls): 3.16 - 4.66
Blow Count: 2 * 3 * 9

Sample No: 2
Depth (ft-bls): 8.16 - 9.66
Blow Count: 3 * 4 * 8

Sample No: 3
Depth (ft-bls): 13.16 - 14.66
Blow Count: 3 * 3 * 4

Sample No: 4
Depth (ft-bls): 18.16 - 19.66
Blow Count: 2 * 3 * 3

Sample No: 5
Depth (ft-bls): 23.16 - 24.66
Blow Count: 6 * 9 * 14

Sample No: 6
Depth (ft-bls): 28.16 - 29.66
Blow Count: 2 * 3 * 4

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: M-93R

Sample No: 7
Depth (ft-bls): 33.16 - 34.66
Blow Count: 1 * 1 * 2

Sample No: 8
Depth (ft-bls): 38.16 - 39.66
Blow Count: 2 * 1 * 1

Sample No: 9
Depth (ft-bls): 43.16 - 44.66
Blow Count: 2 * 2 * 3

Sample No: 10
Depth (ft-bls): 48.16 - 49.66
Blow Count: 2 * 5 * 22

Sample No: 11
Depth (ft-bls): 57.85 - 59.35
Blow Count: 4 * 7 * 12

Sample No: 12
Depth (ft-bls): 62.85 - 64.35
Blow Count: 6 * 10 * 18

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

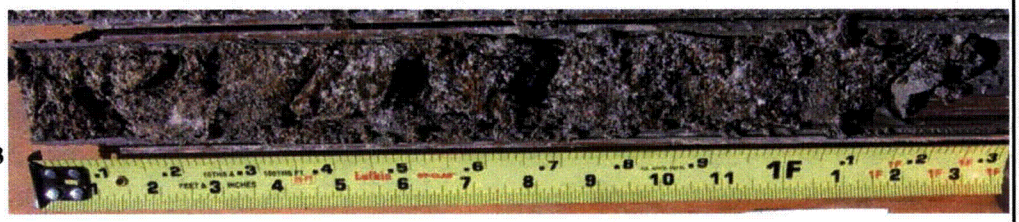
S&ME Project No: 1264-06-724

Boring Number: M-93R

Sample No: 13
Depth (ft-bls): 67.85 - 69.35
Blow Count: 3 * 4 * 6

Sample No: 14
Depth (ft-bls): 72.85 - 74.35
Blow Count: 6 * 18 * 26

Sample No: 15
Depth (ft-bls): 77.85 - 79.35
Blow Count: 14 * 19 * 23

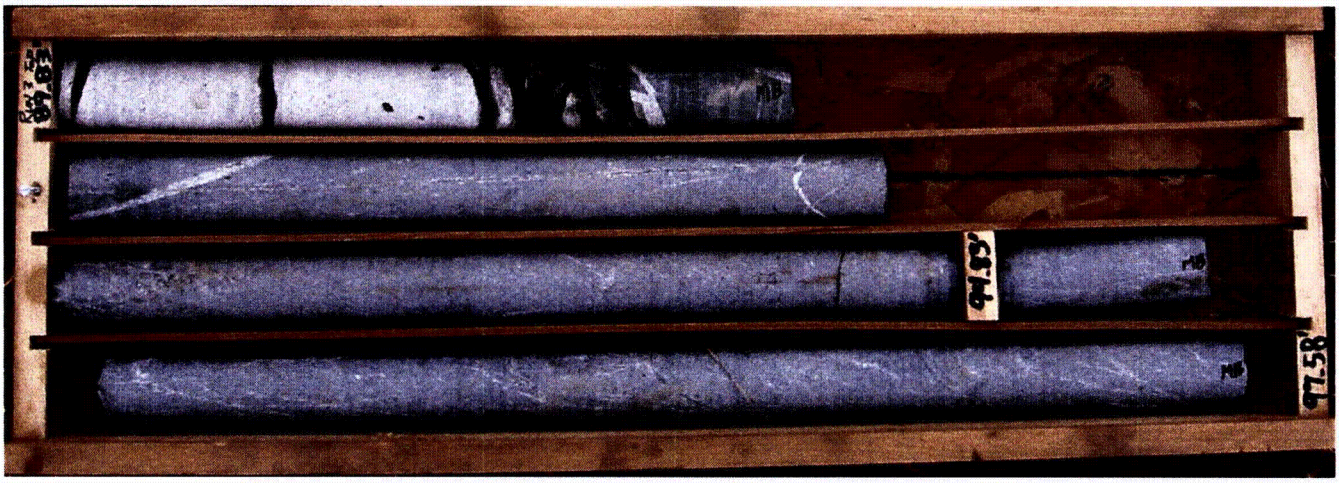


ROCK CORE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-93R



CLASSIFICATION:

82.48' to 89.25' Fine Grained Granite with Orbicuals

89.25' to 90.8' Medium Grained Granite

90.8' to 104.83' Fine Grained Diorite

CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

S&ME

Site Name:	MNS - GWPP		
Date:	4/16/2007		
Boring I.D.	M-93R		
Test Interval:	82.48 to 89.83	(Sound Rock)	
Total Depth of Hole:	89.83 ft		2738.72 cm
Length of Open Hole:	7.35 ft		224.09 cm
Transformation Ratio m=	1		
Performed by:	Scott Dacus		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	2272.10	
60	2264.60	7.27E-06
120	2256.46	7.92E-06
180	2248.08	8.19E-06
240	2239.88	8.04E-06
300	2231.74	8.01E-06
360	2223.99	7.65E-06
420	2216.37	7.55E-06
480	2208.84	7.49E-06
540	2201.55	7.27E-06
600	2194.09	7.48E-06
900	2158.75	7.14E-06
1200	2125.55	6.82E-06
1500	2093.66	6.65E-06
1800	2062.77	6.54E-06
2400	2004.82	6.27E-06
3000	1951.71	5.91E-06
3600	1903.05	5.55E-06

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} > 4$

Where:

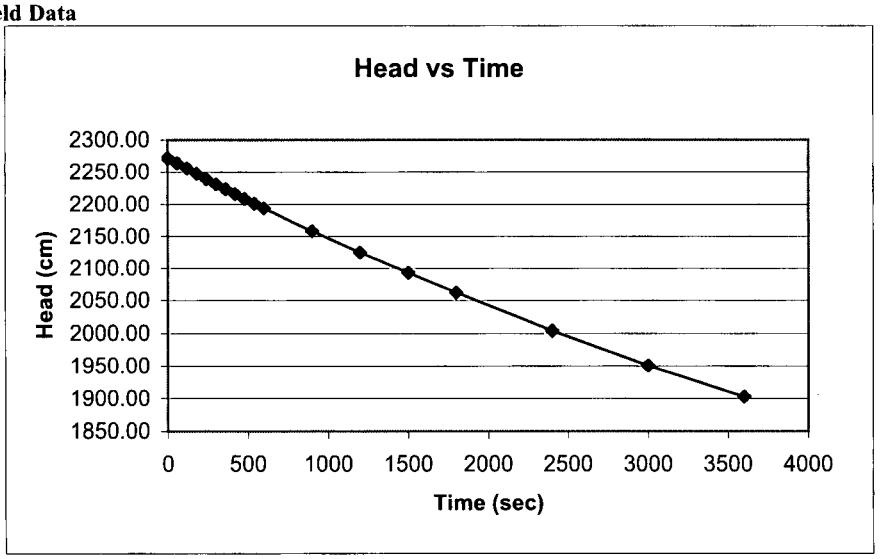
K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where
	$m = \sqrt{K_h / K_v}$ — K_h is the Horizontal Permeability; K_v is the Vertical Permeability
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec)

7.16E-06

Graph of Field Data



BOREHOLE PERMEABILITY TEST USING PACKERS
FIELD DATA SHEET

S&ME

PROJECT NAME AND NO.:	MNS - GWPP	**BOREHOLE NO.:**	M-93R				
LOCATION:	Huntersville, NC	**TEST INTERVAL:**	88.3	to	93.3	bgs	
TEST DATE:	4/18/2006	**TEST INTERVAL:**	668.1	to	663.1	EL	
TESTED BY:	Justin Milwood and Courtney Withers						
GROUND ELEV (ft MSL):	756.4						

TEST METHOD: Double Packer Method using Multiple Pressure Tests
METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

TEST DATA (Enter data in underlined cells):
Rock Description of test interval:

	Granite - Sound Rock.			
Source of test water and clarity:	Catawba River - Slightly Turbid			
Method of cleaning hole prior to testing:	Flushed			
Drilling Fluid (water or type of drilling mud)	Water			
Packer Brand and Model:				
Packer Inflation Pressure	160	psi		
Packer Length:	2.00	feet		
Method: Single (1) or double (2) packer (Enter 1 or 2):	2			
Interval below base of packer for Method 1 (single packer test), A_1:	-	feet		
Interval between packers for Method 2 (double packer test), A_2:	5.0	feet		
Depth of hole at time of test:	101.4	feet below ground surface (bgs)		
Diameter of borehole, d:	3.0	inches	0.3	feet
Radius of the borehole, r	0.13	feet		
Depth to water table (thickness of unsaturated material above water table, U):	33.0	feet		
Height above ground surface of pressure gauge:	4.6	feet ags		
Top of test section (bottom of upper packer), h_t:	88.3	feet bgs		
Bottom of test section (top of lower packer if double packer used, bottom of hole for a single packer, D):	93.3	feet bgs		
Is test section above or below water table?	below			
For tests below the water table determine h_1, the distance between the gauge and the water table:	37.6	feet		
Length of pipe over which head loss occurs (distance from gauge to outlet of pipe in test section):	95.4	feet		
Diameter and type of pipe used:	1.25-inch I.D.			

BOREHOLE PERMEABILITY TEST USING PACKERS
FIELD DATA SHEET

S&ME

PROJECT NAME AND NO.:	MNS - GWPP	**BOREHOLE NO.:**	M-93R				
LOCATION:	Huntersville, NC	**TEST INTERVAL:**	88.3	to	93.3	bgs	
TEST DATE:	4/18/06	**TEST INTERVAL:**	668.11	to	663.11	EL	

Gauge Pressure (h_2) in psi	Elapsed Time (minutes)	Water Level (feet bgs)	Flow Rate (total flow in gal)	Flow Rate (gpm)
Step 1				
25	0		1804.00	
25	1		1804.70	0.70
25	2		1805.00	0.30
25	5		1805.70	0.23
25	10		1806.70	0.20
25	15		1807.50	0.16
25	20		1808.40	0.18
		Average	0.22	0.30
		Selected stabilized flow rate to be used in calculations		0.30
Step 2				
37.5	0		1808.70	
37.5	1		1808.80	0.10
37.5	2		1809.20	0.40
37.5	5		1809.90	0.23
37.5	10		1811.10	0.24
37.5	15		1812.20	0.22
37.5	20		1813.30	0.22
		Average	0.23	0.24
		Selected stabilized flow rate to be used in calculations		0.24
Step 3				
50	0		1813.50	
50	1		1813.80	0.30
50	2		1814.50	0.70
50	5		1815.50	0.33
50	10		1817.00	0.30
50	15		1818.20	0.24
50	20		1819.60	0.28
		Average	0.30	0.36
		Selected stabilized flow rate to be used in calculations		0.36
Step 4				
37.5	0		1819.90	
37.5	1		1820.00	0.10
37.5	3		1820.50	0.25
37.5	5		1820.80	0.15
		Average	0.18	0.17
		Selected stabilized flow rate to be used in calculations		0.17
Step 5				
25	0		1821.00	
25	1		1821.10	0.10
25	3		1821.30	0.10
25	5		1821.50	0.10
		Average	0.10	0.10
		Selected stabilized flow rate to be used in calculations		0.10

NOTES:

BOREHOLE PERMEABILITY TEST USING PACKERS CALCULATIONS

S&ME

PROJECT NAME AND NO.:	MNS - GWPP	**BOREHOLE NO.:**	M-93R				
LOCATION:	Huntersville, NC	**TEST INTERVAL:**	88.3	to	93.3	bgs	
TEST DATE:	4/18/2006	**TEST INTERVAL:**	668.1	to	663.1	EL	
TESTED BY:	Justin Milwood and Courtney Withers						
GROUND ELEV (ft MSL):	756.4						

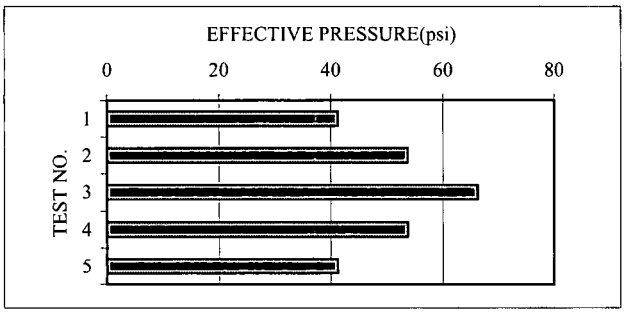
TEST METHOD: Double Packer Method using Multiple Pressure Tests
METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

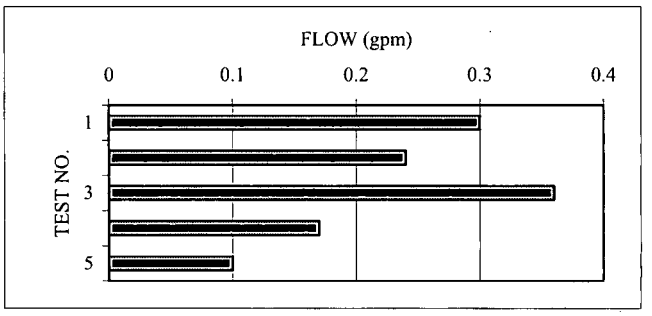
RESULTS OF PERMEABILITY CALCULATIONS
MULTIPLE STEP TEST

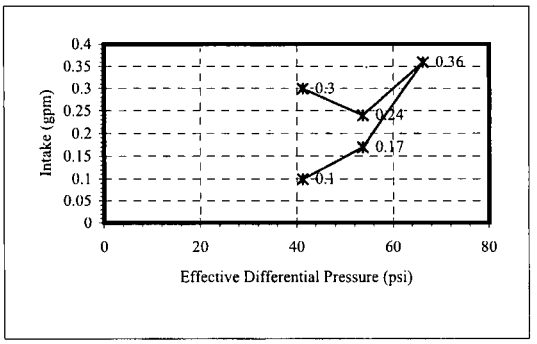
Step	Flow (Q) (gpm)	Pressure (psi) Gauge	Pressure (psi) Effective	Lugeons	Permeability (ft/sec)	Permeability (cm/sec)
1	0.3	25	41	3	8.77E-07	2.7E-05
2	0.24	37.5	54	2	5.4E-07	1.6E-05
3	0.36	50	66	2	6.6E-07	2.0E-05
4	0.17	37.5	54	1	3.8E-07	1.2E-05
5	0.1	25	41	1	2.9E-07	8.9E-06
			AVERAGE	2	5.5E-07	1.7E-05
			SELECTED VALUES			

Rock Description of Tested Interval:
Granite - Sound Rock.

TEST INTERPRETATION
Text here
Text here







PERMEABILITY CALCULATIONS FOR EACH STEP OF TEST

S&ME

CALCULATED PERMEABILITY FOR STEP 1

Gauge Pressure, **h2**:	25	psi	57.7	feet of water
Flow Rate, **Q**:	0.3	gpm	0.001	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	37.6	feet		
Value of $\mathbf{h_1}$:	37.6	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	95.3	feet	41.3	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	35.0	feet		
X = (H/Tu)*100	272.6	%		
Tu/A	7.0			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	8.77E-07	ft/sec	2.67E-05	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 2

Gauge Pressure, **h2**:	37.5	psi	86.6	feet of water
Flow Rate, **Q**:	0.24	gpm	0.001	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	37.6	feet		
Value of h_1:	37.6	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	124.2	feet	53.8	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	63.8	feet		
X = (H/Tu)*100	194.5	%		
Tu/A	12.8			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	5.38E-07	ft/sec	1.64E-05	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 3

Gauge Pressure, **h2**:	50	psi	115.5	feet of water
Flow Rate, **Q**:	0.36	gpm	0.001	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	37.6	feet		
Value of h_1:	37.6	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	153.1	feet	66.3	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	92.7	feet		
X = (H/Tu)*100	165.1	%		
Tu/A	18.5			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	6.55E-07	ft/sec	2.00E-05	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 4

Gauge Pressure, **h2**:	37.5	psi	86.6	feet of water
Flow Rate, **Q**:	0.17	gpm	0.000	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	37.6	feet		
Value of h_1:	37.6	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	124.2	feet	53.8	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	63.8	feet		
X = (H/Tu)*100	194.5	%		
Tu/A	12.8			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	3.81E-07	ft/sec	1.16E-05	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 5				
Gauge Pressure, **h2**:	25	psi	57.7	feet of water
Flow Rate, **Q**:	0.10	gpm	0.000	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	37.6	feet		
Value of h_1:	37.6	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	95.3	feet	41.3	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	35.0	feet		
X = (H/Tu)*100	272.6	%		
Tu/A	7.0			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	2.92E-07	ft/sec	8.91E-06	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

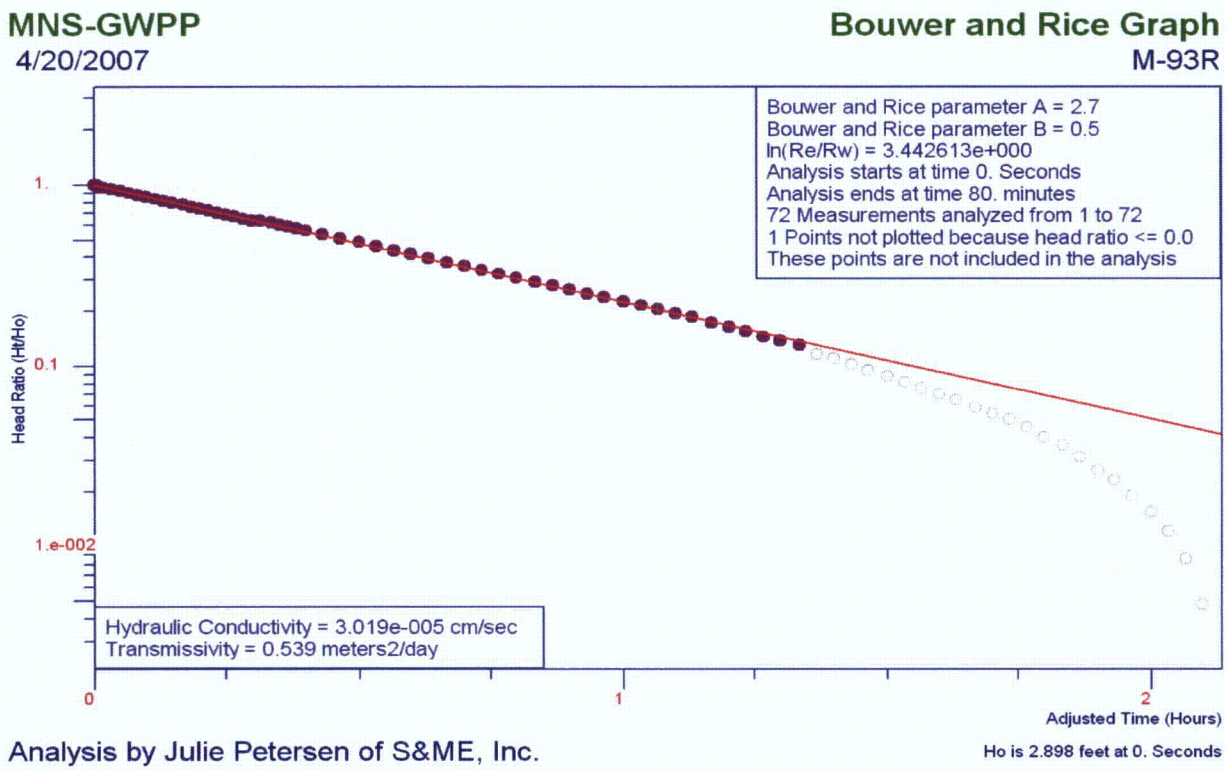
Is Q/a * (estimated porosity) > 10?? True, Test Valid

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	4/20/2007
Well Label:	M-93R
Aquifer Thickness:	67.8 feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	30.2 feet
Water Table to Screen Bottom:	62.8 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 96 time and drawdown measurements
Maximum head is 2.898 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

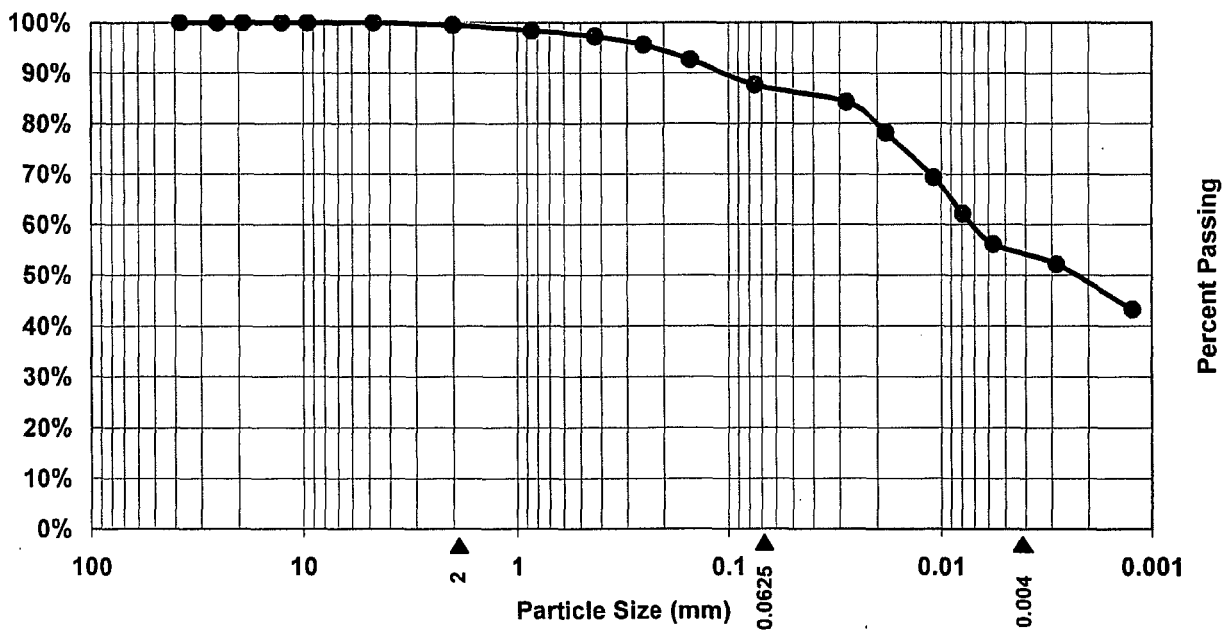
PERMEABILITY

3.02E-05 cm/sec

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-93R	SS-5	23.16 to 24.66 ft bls

Sample Description:
Red, Silty, Clay With Fine Sand



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.5%	% Sand 12.6%	% Silt 28.3%	% Clay 58.6%
Adjusted for Calculations	**0%**	**13%**	**28%**	**59%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-93R

Boring Depth: 23.16 to 24.66 ft bls

% Sand: 13%

% Silt: 28%

% Clay: 59%

Estimated Specific Yield: 0.4%*

* Estimated Value

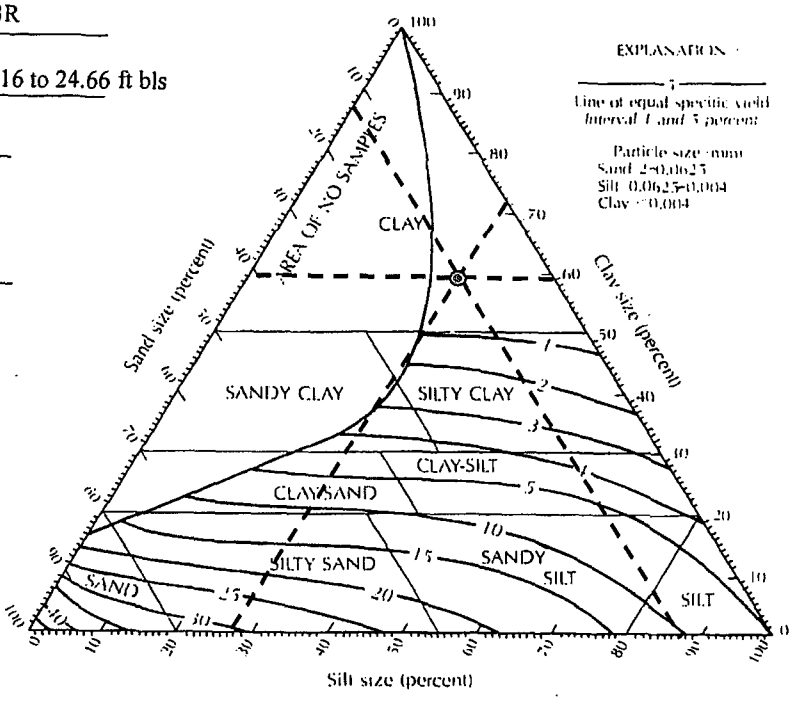
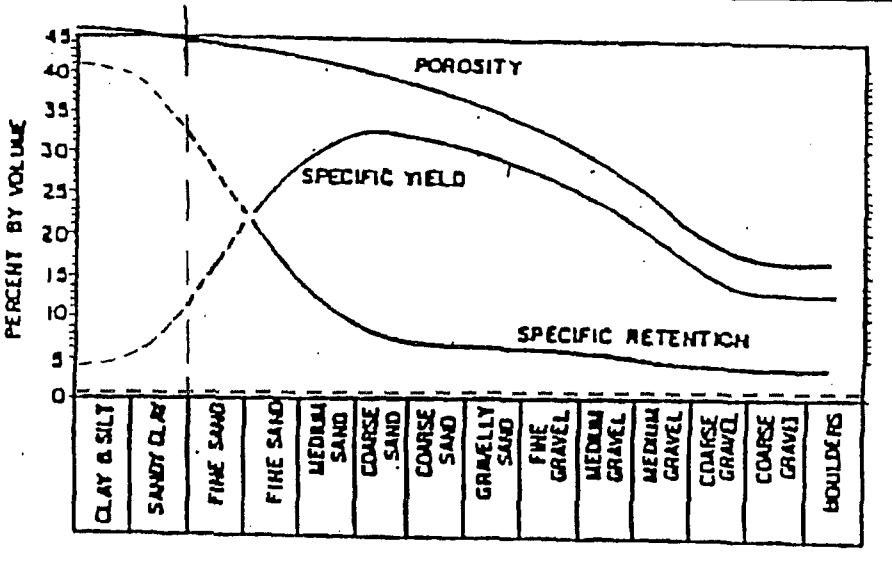


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 50%**

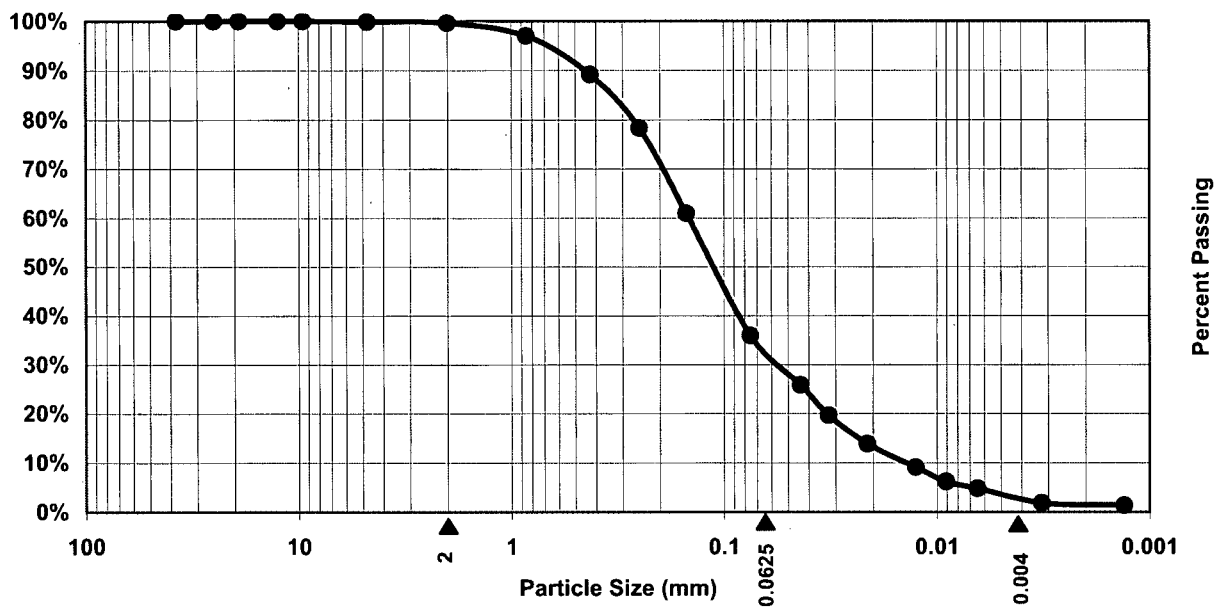
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	**Sample No.:**	**Depth:**
M-93R	SS-12	62.85 to 64.35 ft bls

Sample Description:
Black and White, Silty, Fine to Medium Sand With Mica



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.4%	% Sand 66.8%	% Silt 30.2%	% Clay 2.6%
Adjusted for Calculations	**0%**	**67%**	**30%**	**3%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-93R

Boring Depth: 62.85 to 64.35 ft bls

% Sand: 67%

% Silt: 30%

% Clay: 3%

Estimated Specific Yield: 26%

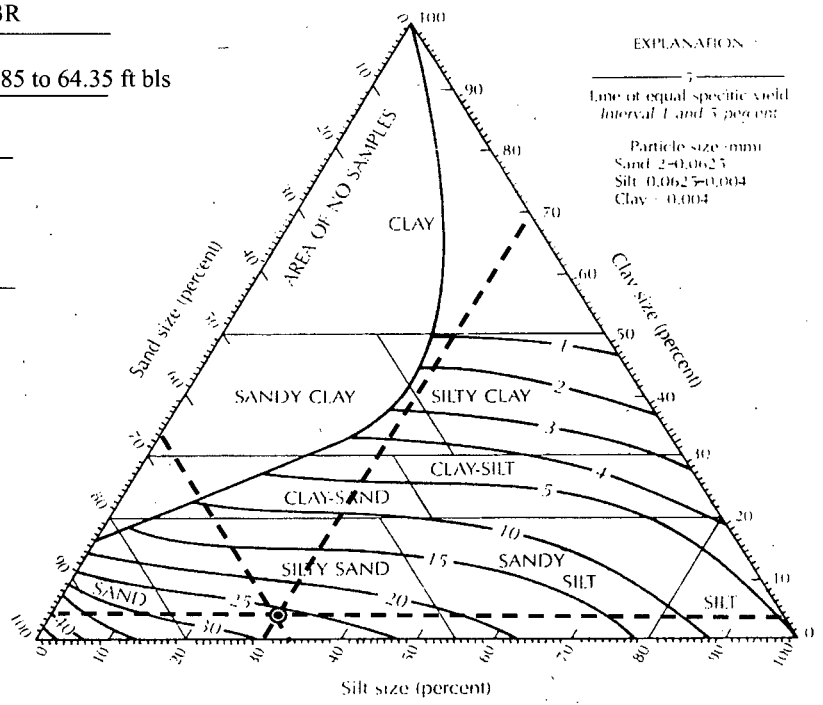
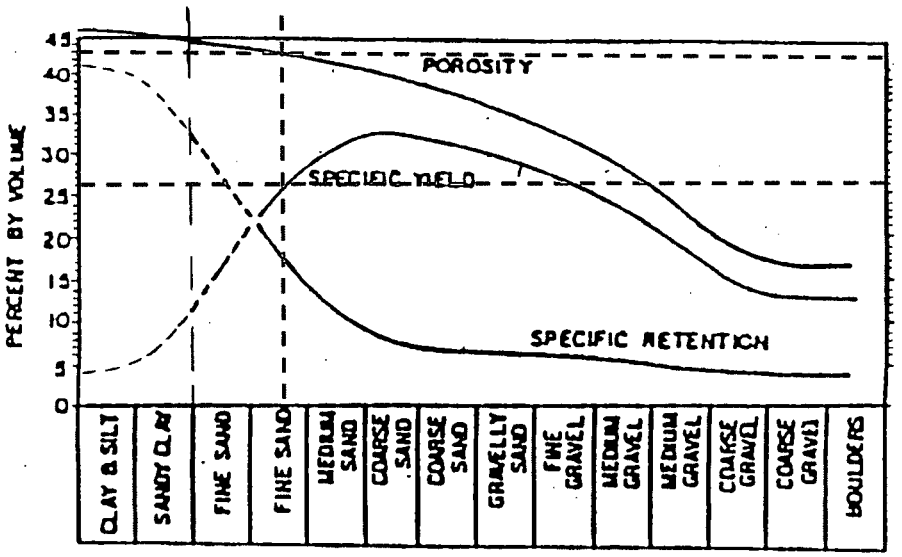


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 43%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

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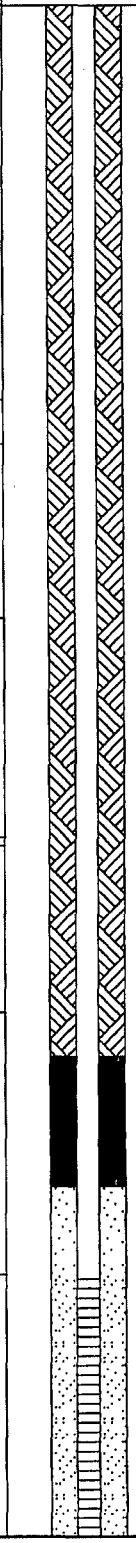
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

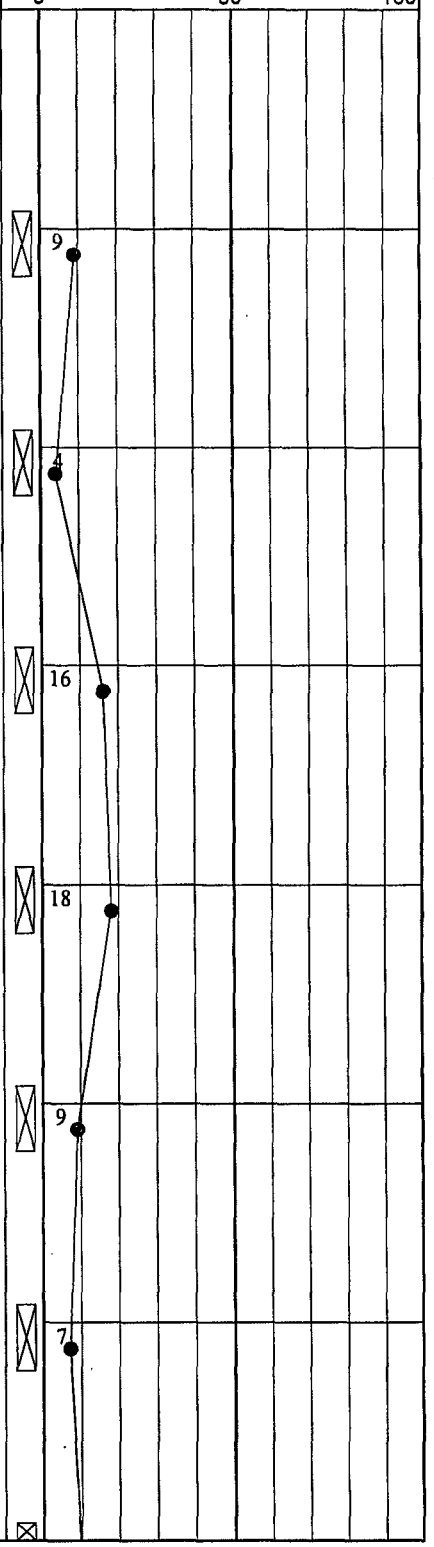
Project: **MNS - Groundwater Protection Project**			**Boring No. M-94**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 2
Boring Depth (ft): **44.1**	Elevation (ft): **751.4**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **6/26/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 32.47 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Material Description
750		ALLUVIUM (S): Light Brown, Micaceous, Fine Sandy, **SILT** Interlayered With Dark Brown, Medium to Fine Sandy, **CLAY**
745	5	
740	10	ALLUVIUM (S): Yellow-Brown and White, Micaceous, Clayey, **SILT** With Manganese and Organics ALLUVIUM (S): Red and Reddish-Brown, Micaceous, Medium to Fine Sandy, Clayey, **SILT** With Manganese Staining and Rock Fragments
735	15	ALLUVIUM (S): Red, Silty, **CLAY** With Fine Sand and Rock Fragments
730	20	ALLUVIUM (S): Light Brown, Micaceous, Fine Sandy, **SILT** With Rock Fragments and Organics ALLUVIUM (S): Yellow-Red, Micaceous, Medium to Fine Sandy, **CLAY**
725	25	SOIL/SAPROLITE (M1): Red, Reddish-Brown, and Yellow, Micaceous, Slightly Clayey, Fine Sandy, **SILT**
720	30	SOIL/SAPROLITE (M1): Brown, Tan, White, and Orange, Coarse to Fine Sandy, **SILT** With Manganese and Rock Fragments

Well Construction



Penetration Resistance (Blows/Foot)



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2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-94**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 2 of 2
Boring Depth (ft): **44.1**	Elevation (ft): **751.4**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **6/26/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 32.47 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
715			SOIL/SAPROLITE (M1): Orange and White, Medium to Fine Sandy, **SILT** With Manganese Staining		10
	40				6
710			**Roller Cone Refusal at 44.10 ft bls**		

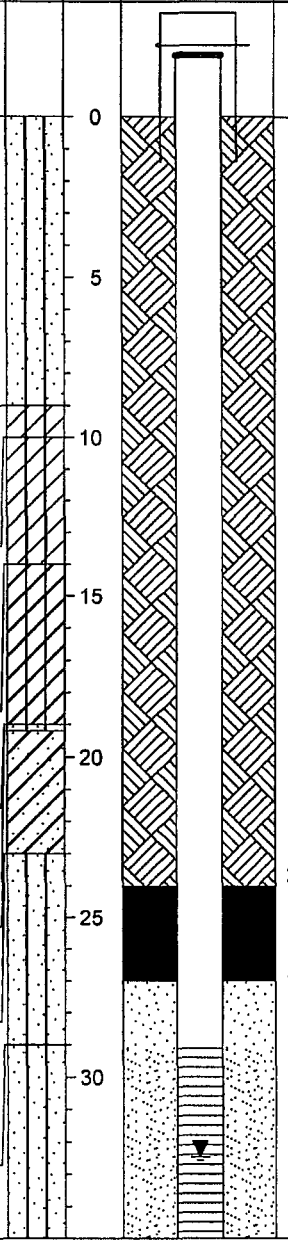
COMPLETION REPORT OF WELL No. M-94

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 32.47 ft bls**
LATITUDE: **35 25 54.06**
LONGITUDE: **80 57 05.36**
TOP OF CASING ELEVATION: **754.36**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **6/26/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
ALLUVIUM (S): Light Brown, Micaceous, Fine Sandy, **SILT** Interlayered With Dark Brown, Medium to Fine Sandy, **CLAY**		0		0.00		751.40
ALLUVIUM (S): Yellow-Brown and White, Micaceous, Clayey, **SILT** With Manganese and Organics		10				
ALLUVIUM (S): Red and Reddish-Brown, Micaceous, Medium to Fine Sandy, Clayey, **SILT** With Manganese Staining and Rock Fragments		15				
ALLUVIUM (S): Red, Silty, **CLAY** With Fine Sand and Rock Fragments		20				
ALLUVIUM (S): Light Brown, Micaceous, Fine Sandy, **SILT** With Rock Fragments and Organics				24.00		727.40
ALLUVIUM (S): Yellow-Red, Micaceous, Medium to Fine Sandy, **CLAY**		25		27.00		724.40
SOIL/SAPROLITE (M1): Red, Reddish-Brown, and Yellow, Micaceous, Slightly Clayey, Fine Sandy, **SILT**		30				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 29.1 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 24 ft bls**

SEAL
Type: **Bentonite**
Interval: **24 to 27 ft bls**

FILTERPACK
Type: **# 1 Filter Sand**
Interval: **27 to 44.1 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **29.1 to 44.1 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-94

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION:
LOGGED BY: **751.4**
CHECKED BY: **Courtney Wither**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOIL/SAPROLITE (M1): Brown, Tan, White, and Orange, Coarse to Fine Sandy, **SILT** With Manganese and Rock Fragments *(continued)*		35					
		40					
SOIL/SAPROLITE (M1): Orange and White, Medium to Fine Sandy, **SILT** With Manganese Staining				43.60		707.80	
				44.10		707.30	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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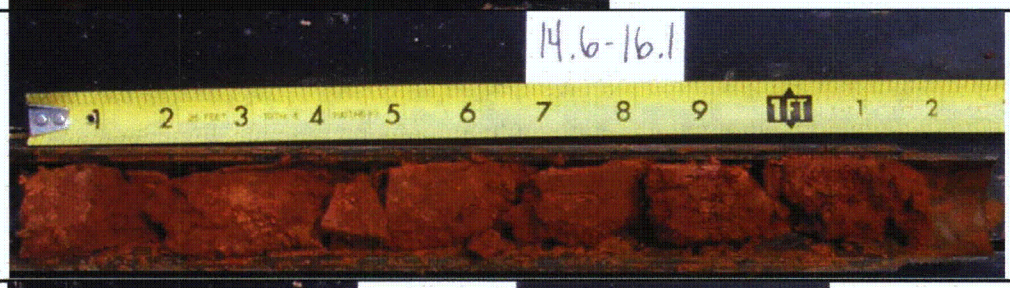
COMPLETION REPORT OF WELL No. M-94

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: M-94

Sample No: 1 **Depth (ft-bls):** 4.6-6.1 **Blow Count:** 4 * 4 * 5	
Sample No: 2 **Depth (ft-bls):** 9.6-11.1 **Blow Count:** 2 * 2 * 2	
Sample No: 3 **Depth (ft-bls):** 14.6-16.1 **Blow Count:** 4 * 6 * 10	
Sample No: 4 **Depth (ft-bls):** 19.6-21.1 **Blow Count:** 8 * 7 * 11	
Sample No: 5 **Depth (ft-bls):** 24.6-26.1 **Blow Count:** 3 * 4 * 5	
Sample No: 6 **Depth (ft-bls):** 29.6-31.1 **Blow Count:** 3 * 4 * 3	

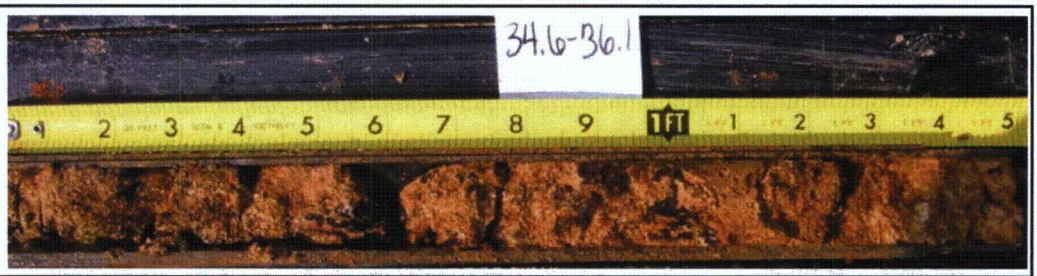
SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: **M-94**

Sample No: 7
Depth (ft-bls): 34.6-36.1
Blow Count: 3 * 4 * 6



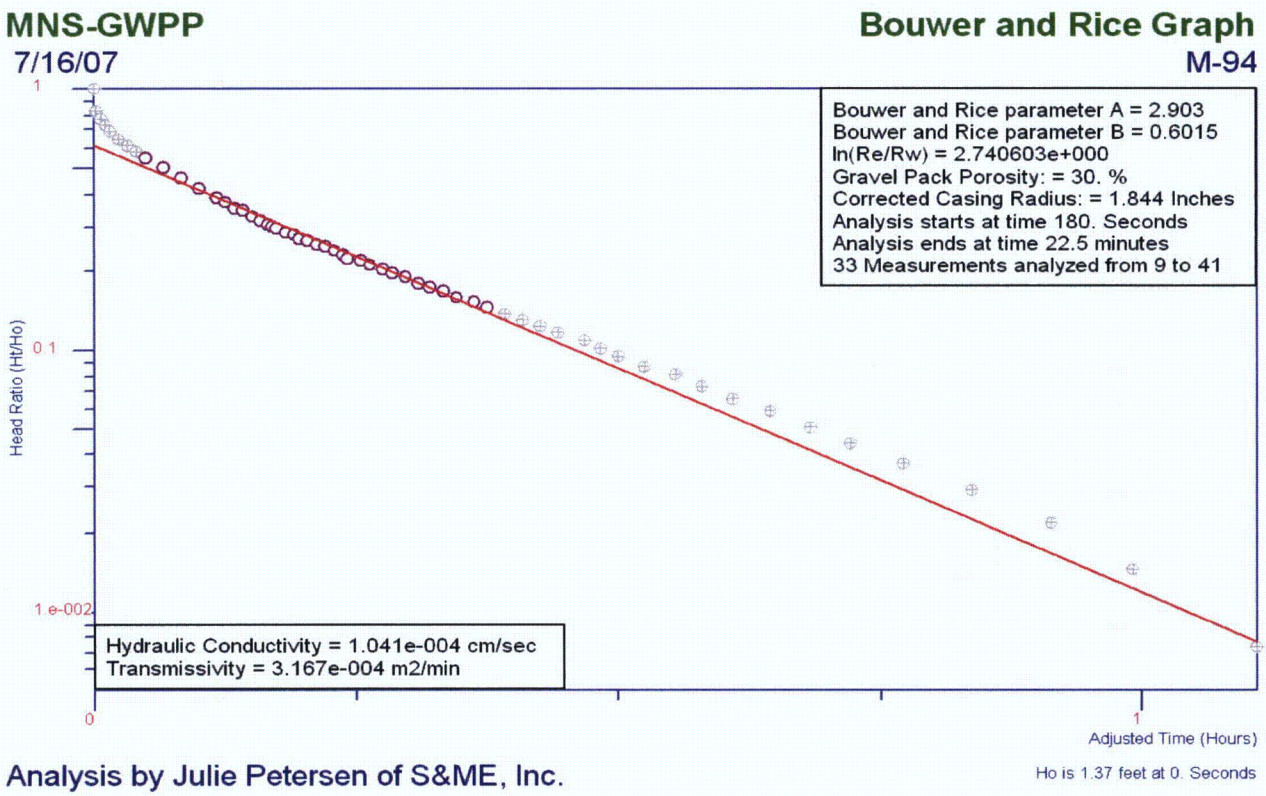
Sample No: 8
Depth (ft-bls): 39.6-41.1
Blow Count: 2 * 2 * 4

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	7/16/2007
Well Label:	M-94
Aquifer Thickness:	16.63 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	32.47 feet
Water Table to Screen Bottom:	11.63 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 60 time and drawdown measurements
Maximum head is 1.37 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

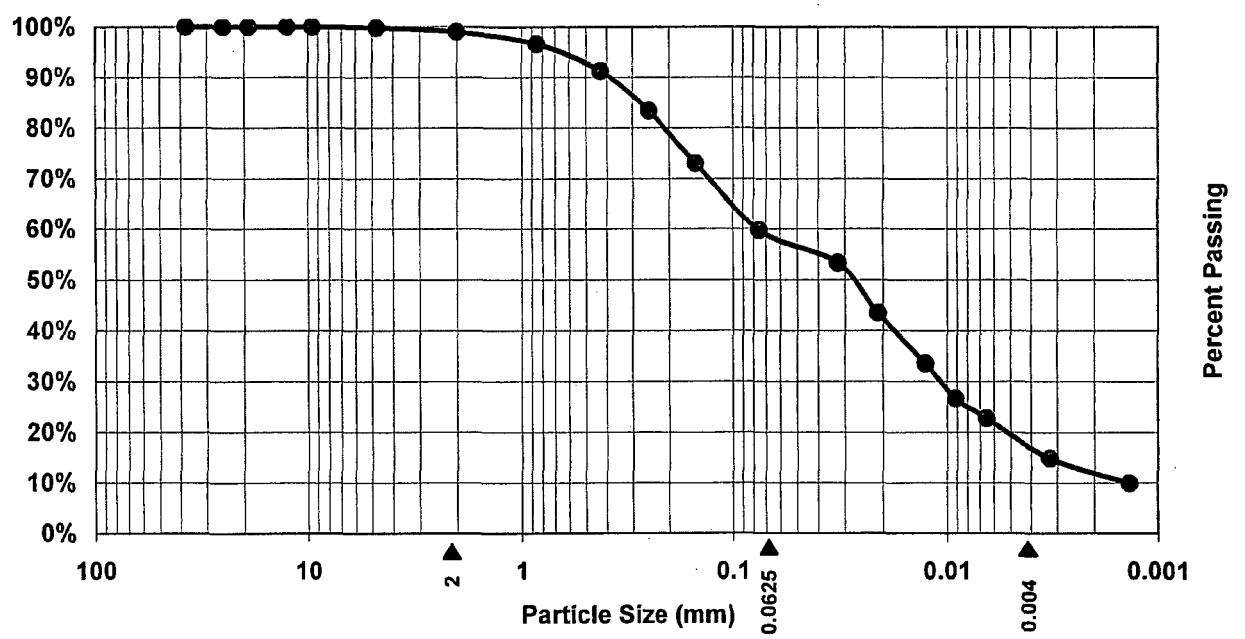
PERMEABILITY

1.04E-04 cm/sec

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-94	SS-2	9.6 to 11.1 ft bls

Sample Description:
Red and Brown, Fine to Medium Sandy, Clayey, Silt With Mica



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.0%	% Sand 40.8%	% Silt 41.5%	% Clay 16.7%
Adjusted for Calculations	**0%**	**41%**	**42%**	**17%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-94

Boring Depth: 9.6 to 11.1 ft bls

% Sand: 41%

% Silt: 42%

% Clay: 17%

Estimated Specific Yield: 12%

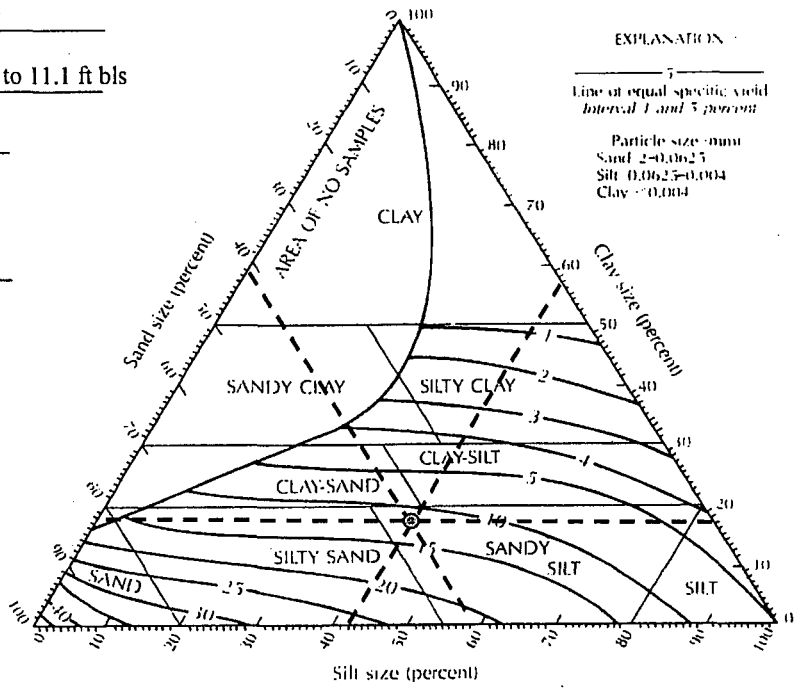
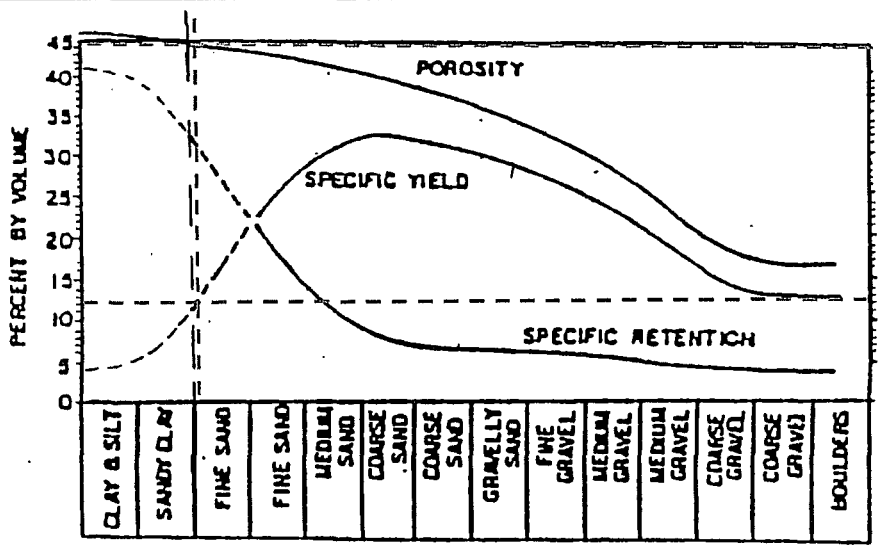


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



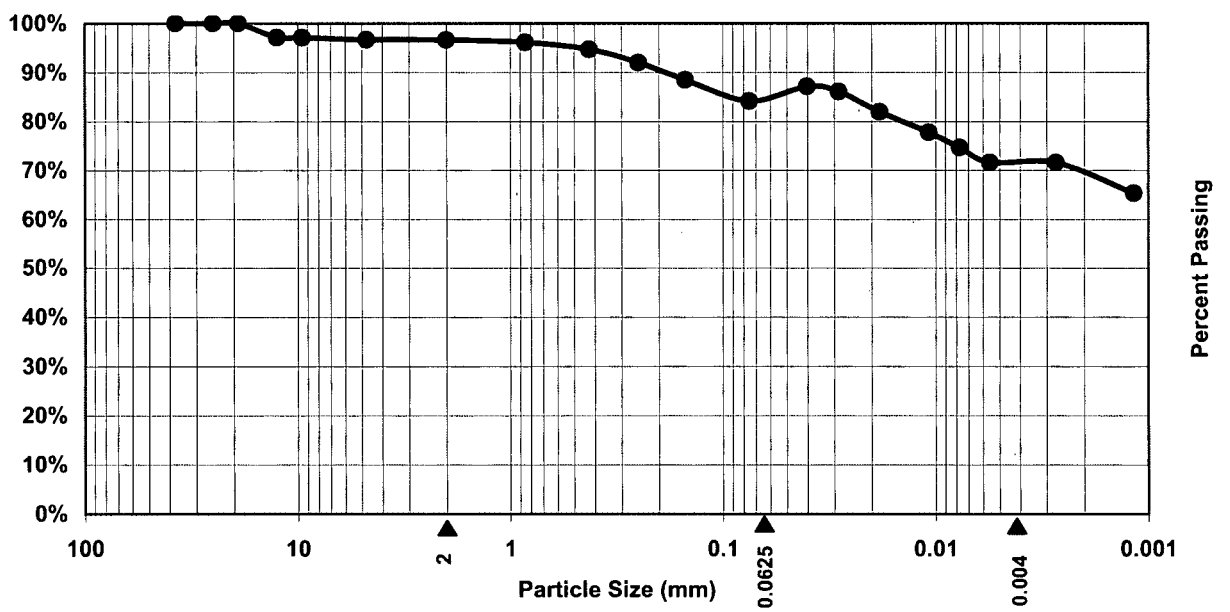
Estimated Porosity: 44.5%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	**Sample No.:**	**Depth:**
M-94	SS-3	14.6 to 16.1 ft bls

Sample Description:
Red, Silty, Clay With Fine Sand



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 3.4%	% Sand 11.5%	% Silt 13.5%	% Clay 71.6%
Adjusted for Calculations	**0%**	**12%**	**14%**	**74%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-94

Boring Depth: 14.6 to 16.1 ft bls

% Sand: 12%

% Silt: 14%

% Clay: 74%

Estimated Specific Yield: 0.2%*

* Estimated Value

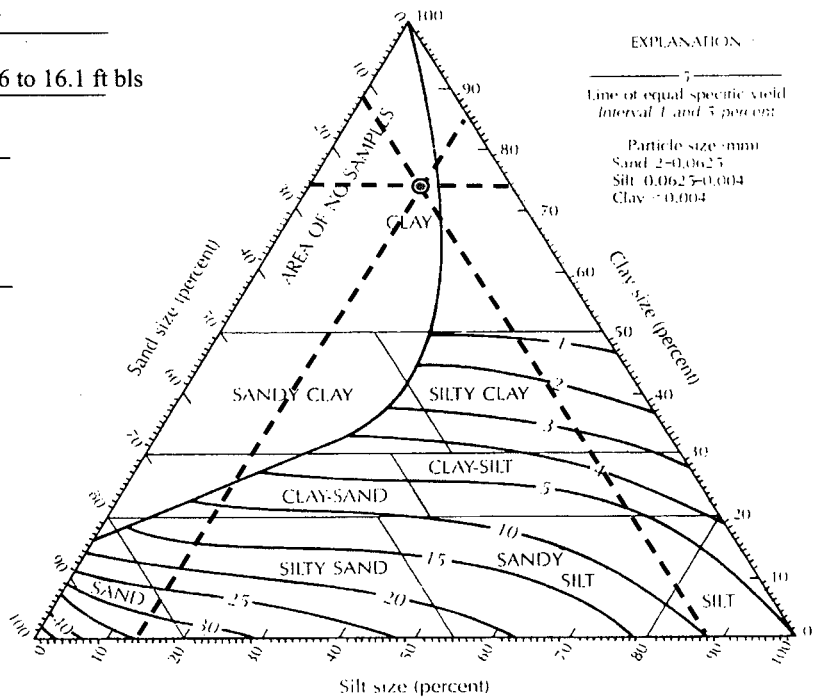
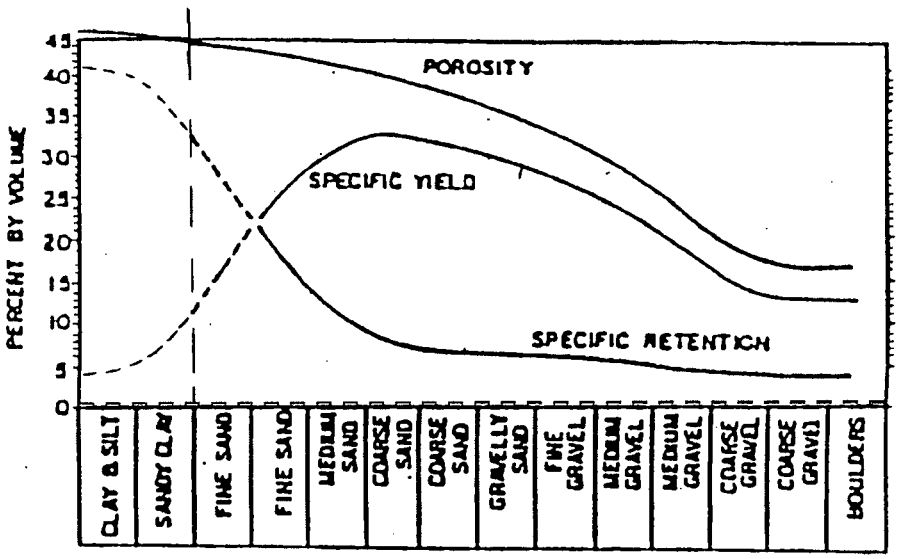


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 50%**

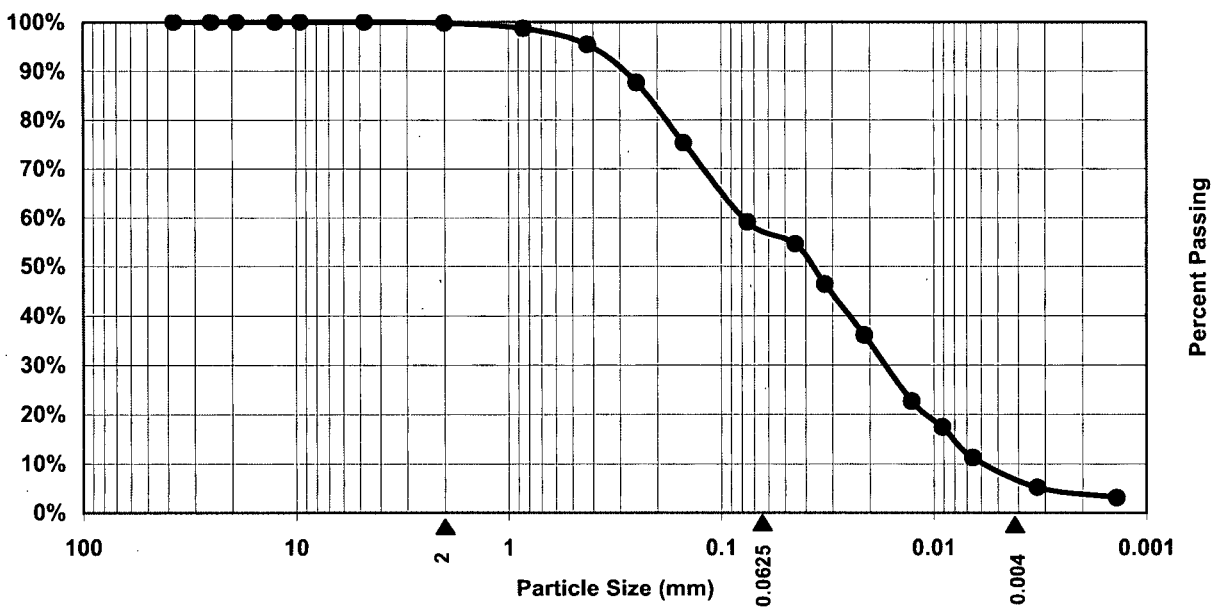
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	**Sample No.:**	**Depth:**
M-94	SS-8	39.6 to 41.1 ft bls

Sample Description:
Orange and White, Fine to Medium Sandy, Silt



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.2%	% Sand 42.2%	% Silt 51.0%	% Clay 6.6%
Adjusted for Calculations	**0%**	**42%**	**51%**	**7%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-94

Boring Depth: 39.6 to 41.1 ft bls

% Sand: 42%

% Silt: 51%

% Clay: 7%

Estimated Specific Yield: 18%

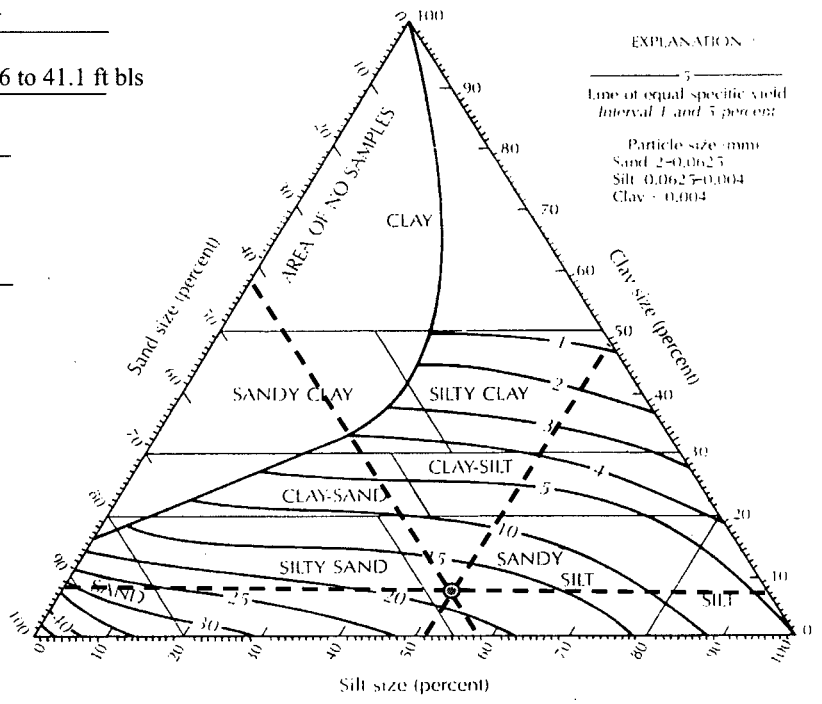
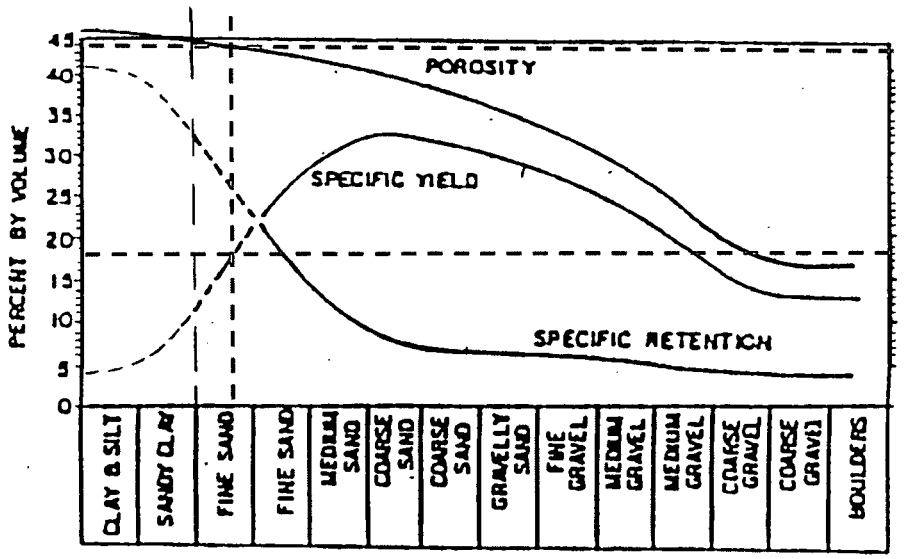


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-95**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 1
Boring Depth (ft): **24.0**	Elevation (ft): **731.7**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/24/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 15.13 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
			ASPHALT		
730			ALLUVIUM (S): Red, Micaceous, Fine Sandy, Silty, **CLAY** With Manganese Staining and Rock Fragments		
	5				
725					
			ALLUVIUM (S): Red and Gray Striated, Micaceous, Medium to Fine Sandy, Silty, **CLAY** With Manganese Staining, Rock Fragments, and Organics		
	10				
			WOOD		
720			ALLUVIUM (S): Brown and Gray, Micaceous, Silty, **CLAY** With Fine Sand, Manganese Staining, and Organics		
			ALLUVIUM (S): Reddish-Brown, Micaceous, Silty, **CLAY** With Manganese Staining		
	15				
715			ALLUVIUM (S): Red, Yellow, Brown, and Gray Mottled, Micaceous, Silty, **CLAY** With Manganese Staining		
	20				
710					
			SOIL/SAPROLITE (M1): Orange, Brown, and White, Micaceous, Silty, Coarse to Fine **SAND** (Granitic)		
			Boring Terminated at 24.00 ft bls **Lithologic Descriptions Obtained From M-95R**		

COMPLETION REPORT OF WELL No. M-95

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 15.13 ft bls**

LATITUDE: **35 25 51.50**
LONGITUDE: **80 57 04.14**
TOP OF CASING ELEVATION: **731.35**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **4/24/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		731.65
ASPHALT		0				
ALLUVIUM (S): Red, Micaceous, Fine Sandy, Silty, **CLAY** With Manganese Staining and Rock Fragments		5		5.00		726.65
				7.00		724.65
ALLUVIUM (S): Red and Gray Striated, Micaceous, Medium to Fine Sandy, Silty, **CLAY** With Manganese Staining, Rock Fragments, and Organics		10				
WOOD						
ALLUVIUM (S): Brown and Gray, Micaceous, Silty, **CLAY** With Fine Sand, Manganese Staining, and Organics		15				
ALLUVIUM (S): Reddish-Brown, Micaceous, Silty, **CLAY** With Manganese Staining		20				
ALLUVIUM (S): Red, Yellow, Brown, and Gray Mottled, Micaceous, Silty, **CLAY** With Manganese Staining				23.50		708.15
				24.00		707.65
SOIL/SAPROLITE (M1): Orange, Brown, and White, Micaceous, Silty, Coarse to Fine **SAND** (Granitic)						

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **8"**
Type: **Steel Flush Mount**
Interval: **At Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 9 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 5 ft bls**

SEAL
Type: **Bentonite**
Interval: **5 to 7 ft bls**

FILTERPACK
Type: **#1 Filter Sand**
Interval: **7 to 24 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **9 to 24 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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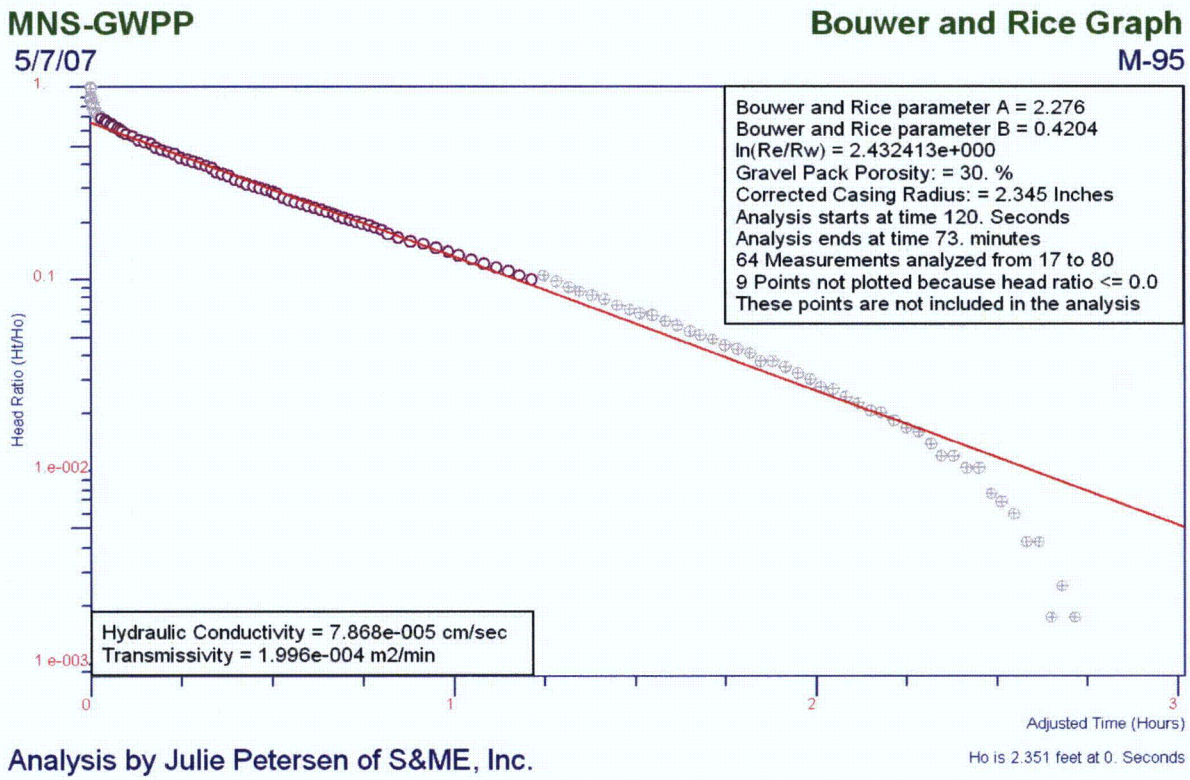
COMPLETION REPORT OF WELL No. M-95

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	5/7/2007
Well Label:	M-95
Aquifer Thickness:	13.87 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	4. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.345 Inches
Static Water Level:	15.13 feet
Water Table to Screen Bottom:	8.87 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 134 time and drawdown measurements
Maximum head is 2.351 feet
Minimum head is -1.5e-002 feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

7.87E-05 cm/sec

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Charlotte, North Carolina
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Fax: 704-525-3953

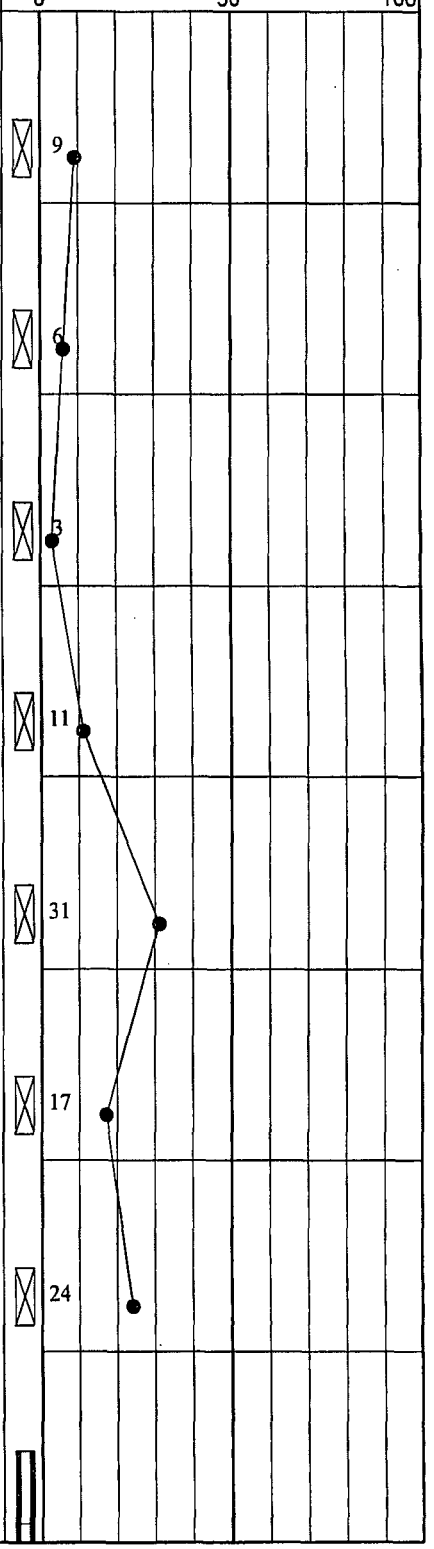
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-95R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 2
Boring Depth (ft): **64.5**	Elevation (ft): **731.7**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/23/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 14.25 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description
			ASPHALT
730			ALLUVIUM (S): Red, Micaceous, Fine Sandy, Silty, **CLAY** With Manganese Staining and Rock Fragments
	5		
725			
			ALLUVIUM (S): Red and Gray Striated, Micaceous, Medium to Fine Sandy, Silty, **CLAY** With Manganese Staining, Rock Fragments, and Organics
	10		
720			**WOOD**
			ALLUVIUM (S): Brown and Gray, Micaceous, Silty, **CLAY** With Fine Sand, Manganese Staining, and Organics
	15		ALLUVIUM (S): Reddish-Brown, Micaceous, Silty, **CLAY** With Manganese Staining
715			
			ALLUVIUM (S): Red, Yellow, Brown, and Gray Mottled, Micaceous, Silty, **CLAY** With Manganese Staining
	20		
710			
			SOIL/SAPROLITE (M1): Orange, Brown, and White, Micaceous, Silty, Coarse to Fine **SAND** (Granitic)
	25		
705			
			SOIL/SAPROLITE (M1): Reddish-Brown, Silty, Medium to Fine **SAND** With Large Flakes of Mica and Manganese Staining (Schistose)
	30		
700			
			SOIL/SAPROLITE (M1): Black and White, Micaceous, Silty, Fine **SAND** With Brown, Oxidized Veins (Granitic)
	35		
695			WEATHERED ROCK (M2): When Sampled Becomes Black and White, Micaceous, Silty, Fine **SAND** With Brown, Oxidized Veins (Granitic)
			Roller Cone Refusal at 37.60 ft bls

Well Construction

Penetration Resistance (Blows/Foot)



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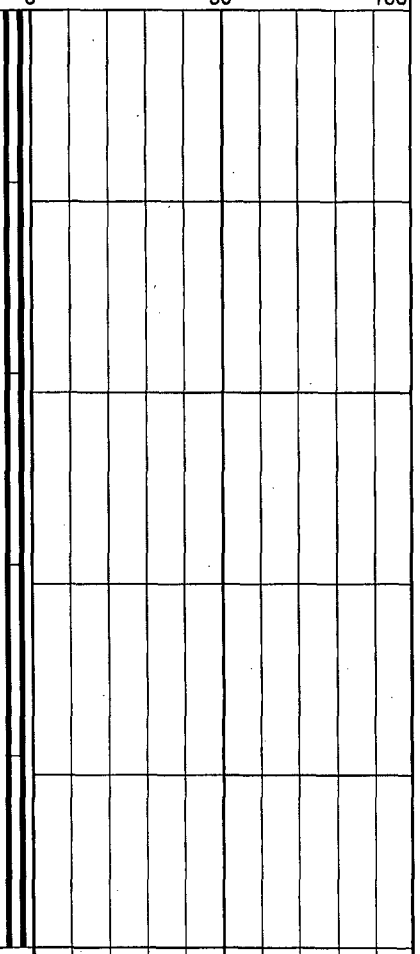
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-95R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 2 of 2
Boring Depth (ft): **64.5**	Elevation (ft): **731.7**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/23/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 14.25 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description
690			SOUND ROCK (D): Medium-Grained **GRANITE**, Slightly to Moderately Fractured With Intermittent Intensely Fractured Zones With Soil Seams
	45		
685			
	50		
680			
	55		
675			PARTIALLY WEATHERED ROCK (WF): Medium-Grained **GRANITE**, Intensely Fractured
	60		SOUND ROCK (D): Medium-Grained **GRANITE**, Unfractured
670			SOUND ROCK (D): Coarse-Grained **QUARTZ DIORITE**, Slightly Fractured
			Boring Terminated at 64.50 ft bls

Well Construction

Penetration Resistance (Blows/Foot)



FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

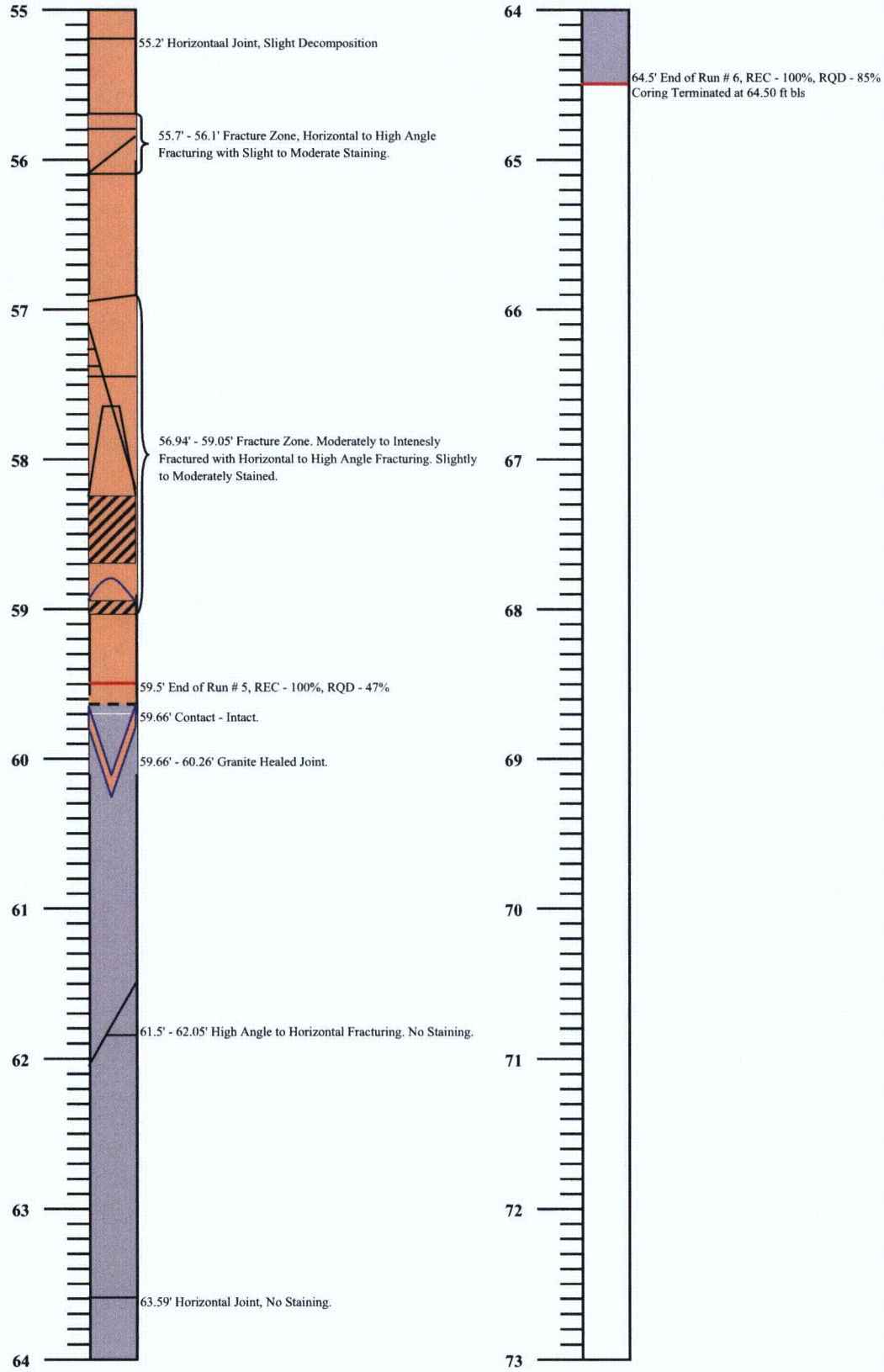
Core Location: M-95R

FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-95R



EXPLANATION

- Meta Gabbro
- Quartz Diorite
- Diorite
- Granite
- Core Loss
- Intense Fracturing
- Fractures
- End of Run
- Contact
- Healed Joint

COMPLETION REPORT OF WELL No. M-95R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 14.25 ft bls**

LATITUDE: **35 25 51.49**
LONGITUDE: **80 57 04.08**
TOP OF CASING ELEVATION: **731.49**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **4/23/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		731.65
ASPHALT		0				
ALLUVIUM (S): Red, Micaceous, Fine Sandy, Silty, **CLAY** With Manganese Staining and Rock Fragments		5				
ALLUVIUM (S): Red and Gray Striated, Micaceous, Medium to Fine Sandy, Silty, **CLAY** With Manganese Staining, Rock Fragments, and Organics		10				
WOOD		15				
ALLUVIUM (S): Brown and Gray, Micaceous, Silty, **CLAY** With Fine Sand, Manganese Staining, and Organics		20		20.00		711.65
ALLUVIUM (S): Reddish-Brown, Micaceous, Silty, **CLAY** With Manganese Staining		25				
ALLUVIUM (S): Red, Yellow, Brown, and Gray Mottled, Micaceous, Silty, **CLAY** With Manganese Staining		30				
SOIL/SAPROLITE (M1): Orange, Brown, and White, Micaceous, Silty, Coarse to Fine **SAND** (Granitic)		35				
SOIL/SAPROLITE (M1): Reddish-Brown, Silty, Medium to Fine **SAND** With Large				38.10		693.55
				38.30		693.35
				39.00		692.65

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **8"**
Type: **Steel Flush Mount**
Interval: **At Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 39 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 20 ft bls**

SEAL
Type: **K-Packer + Bentonite**
Interval: **20 to 38.3 ft bls**

FILTERPACK
Type: **N/A**
Interval: **N/A**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **39 to 44 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-95R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION: **731.7**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
Flakes of Mica and Manganese Staining (Schistose)		40				
SOIL/SAPROLITE (M1): Black and White, Micaceous, Silty, Fine **SAND** With Brown, Oxidized Veins (Granitic)		45		43.50 44.00 45.00		688.15 687.65 686.65
WEATHERED ROCK (M2): When Sampled Becomes Black and White, Micaceous, Silty, Fine **SAND** With Brown, Oxidized Veins (Granitic)		50				
SOUND ROCK (D): Medium-Grained **GRANITE**, Slightly to Moderately Fractured With Intermittent Intensely Fractured Zones With Soil Seams *(continued)*		55				
PARTIALLY WEATHERED ROCK (WF): Medium-Grained **GRANITE**, Intensely Fractured		60		64.50		667.15
SOUND ROCK (D): Medium-Grained **GRANITE**, Unfractured						
SOUND ROCK (D): Coarse-Grained **QUARTZ DIORITE**, Slightly Fractured						

WELL CONSTRUCTION DETAILS

(See Page 1)

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-95R

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

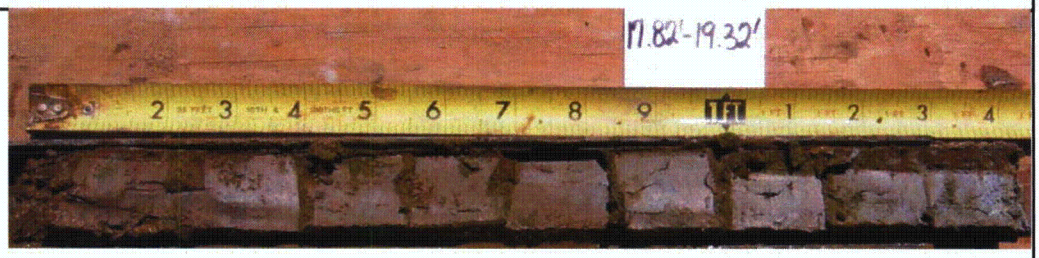
Boring Number: M-95R

Sample No: 1
Depth (ft-bls): 2.82 - 4.32
Blow Count: 2 * 4 * 5

Sample No: 2
Depth (ft-bls): 7.82 - 9.32
Blow Count: 3 * 3 * 3

Sample No: 3
Depth (ft-bls): 12.82 - 14.32
Blow Count: 1 * 1 * 2

Sample No: 4
Depth (ft-bls): 17.82 - 19.32
Blow Count: 3 * 5 * 6



Sample No: 5
Depth (ft-bls): 22.82 - 24.32
Blow Count: 8 * 13 * 18

Sample No: 6
Depth (ft-bls): 27.82 - 29.32
Blow Count: 5 * 7 * 10

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: **M-95R**

Sample No: 7

Depth (ft-bls): 32.82 - 34.32

Blow Count: 4 * 9 * 15

ROCK CORE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-95R

CLASSIFICATION:

37.6' to 59.66' Medium Grained Granite with Orbicuals

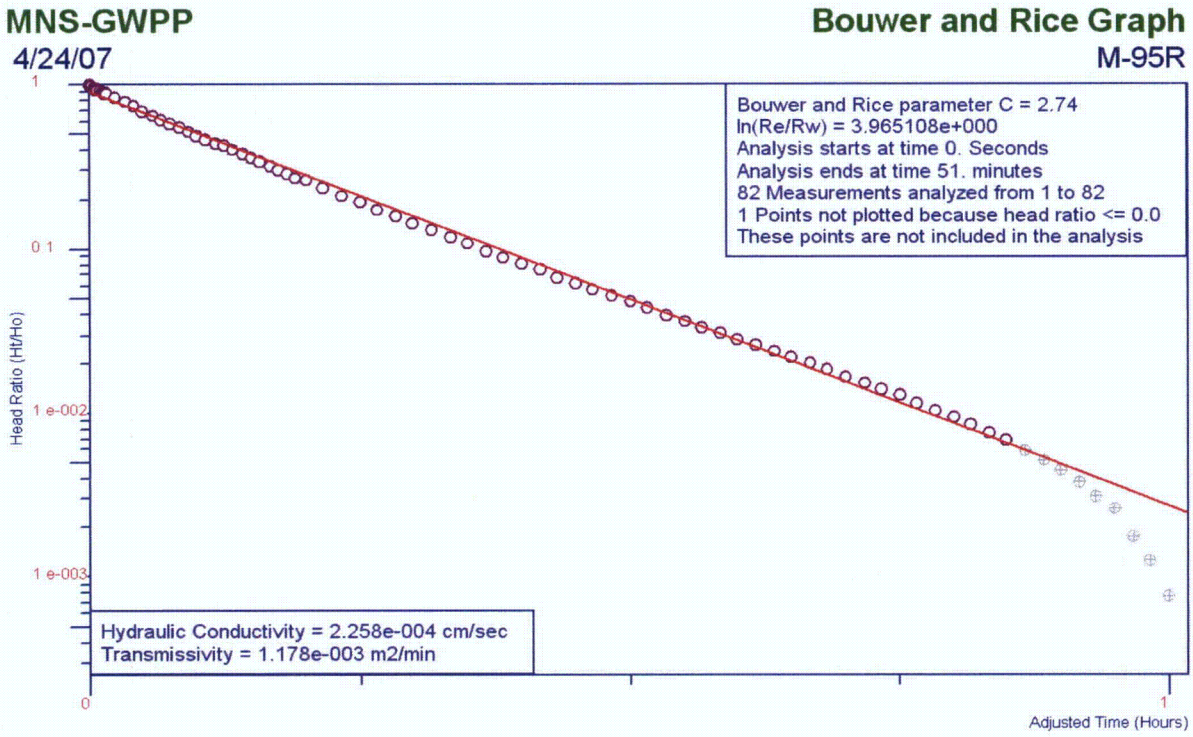
59.66' to 64.5' Coarse Grained Quartz Diorite

Calculation of Permeability By The Falling Head Method (Open Hole in Uniform Material)

Site Name:	MNS-GWPP	
Test Date:	4/24/2007	
Well Label:	M-95R	
Test Interval:	37.6 to 44.5 ft bls	(Sound Rock)
Length of Open Hole:	6.9 feet	
Casing Radius:	1.5 Inches	
Effective Radius:	1.5 Inches	
Anisotropy Ratio:	1	

Test starts with trial 0
There are 92 time and drawdown measurements
Maximum head is 15.93 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

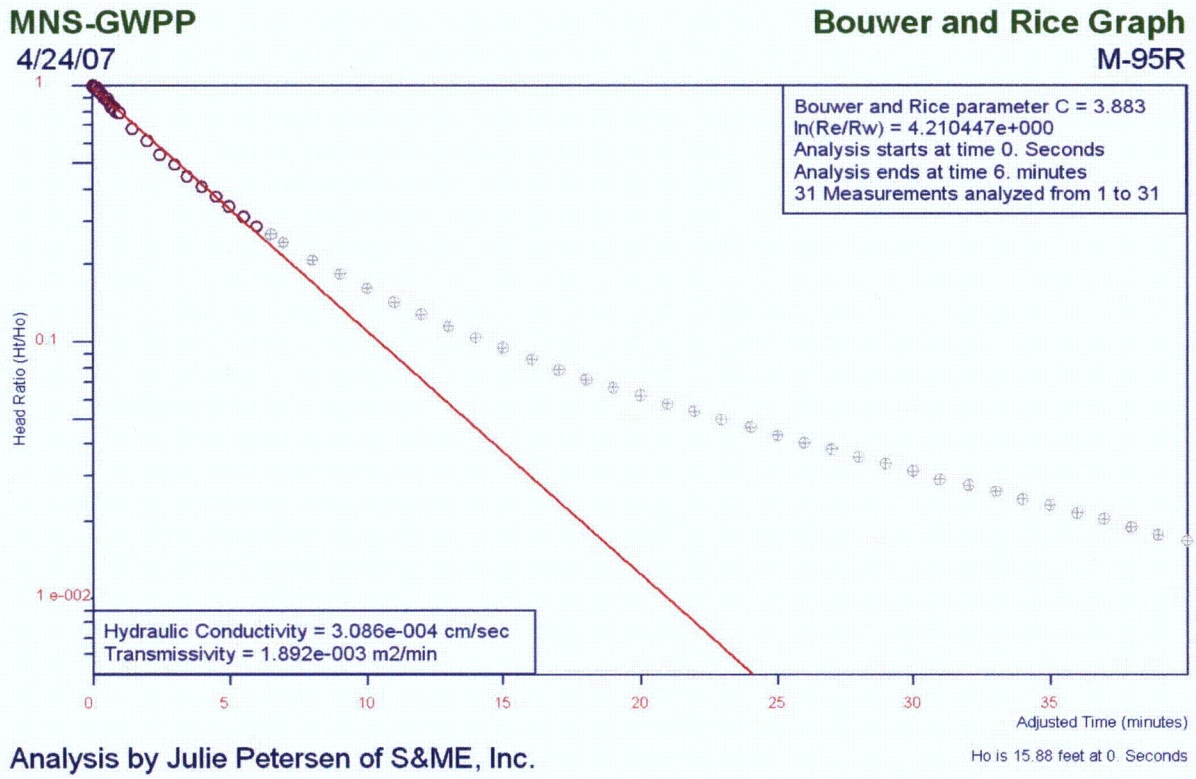
2.26E-04 cm/sec

Calculation of Permeability By The Falling Head Method (Open Hole in Uniform Material)

Site Name:	MNS-GWPP	
Test Date:	4/24/2007	
Well Label:	M-95R	
Test Interval:	37.6 to 49.5 ft bls	(Sound Rock)
Length of Open Hole:	11.9 feet	
Casing Radius:	1.5 Inches	
Effective Radius:	1.5 Inches	
Anisotropy Ratio:	1	

Test starts with trial 0
There are 66 time and drawdown measurements
Maximum head is 15.88 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

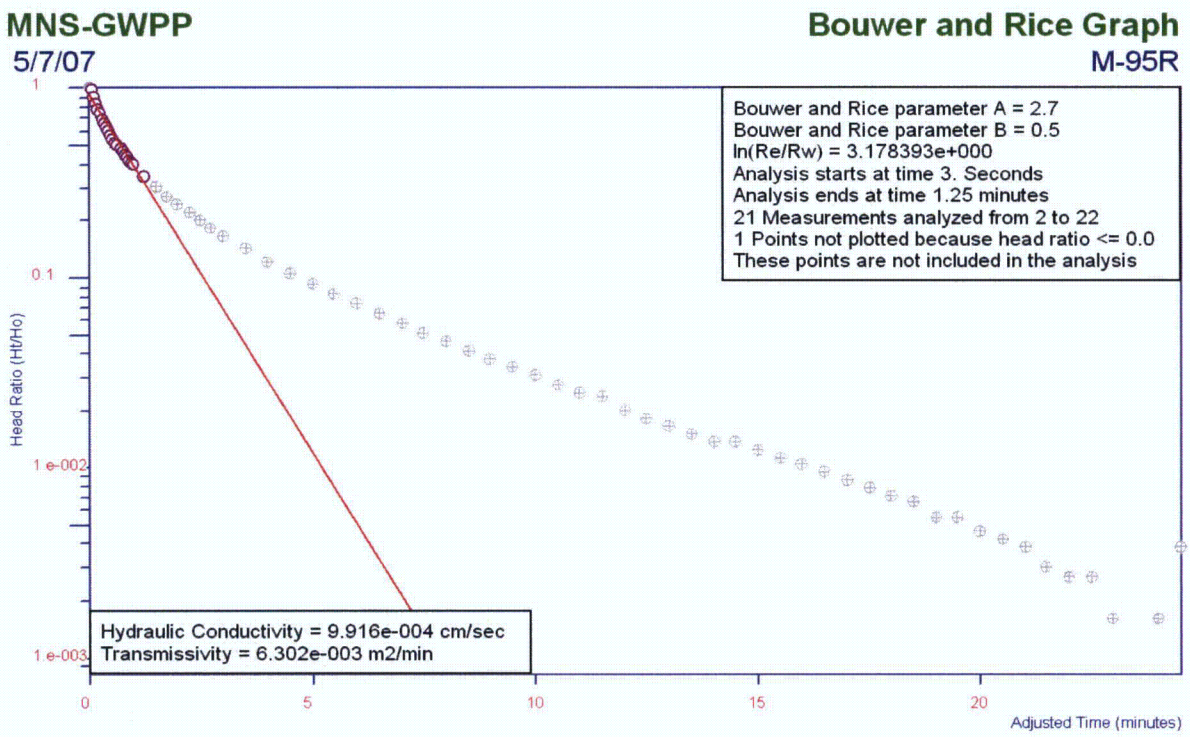
3.09E-04 cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	5/7/2007
Well Label:	M-95R
Aquifer Thickness:	34.75 feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	14.25 feet
Water Table to Screen Bottom:	29.75 feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds

Test starts with trial 0
There are 72 time and drawdown measurements
Maximum head is 4.938 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

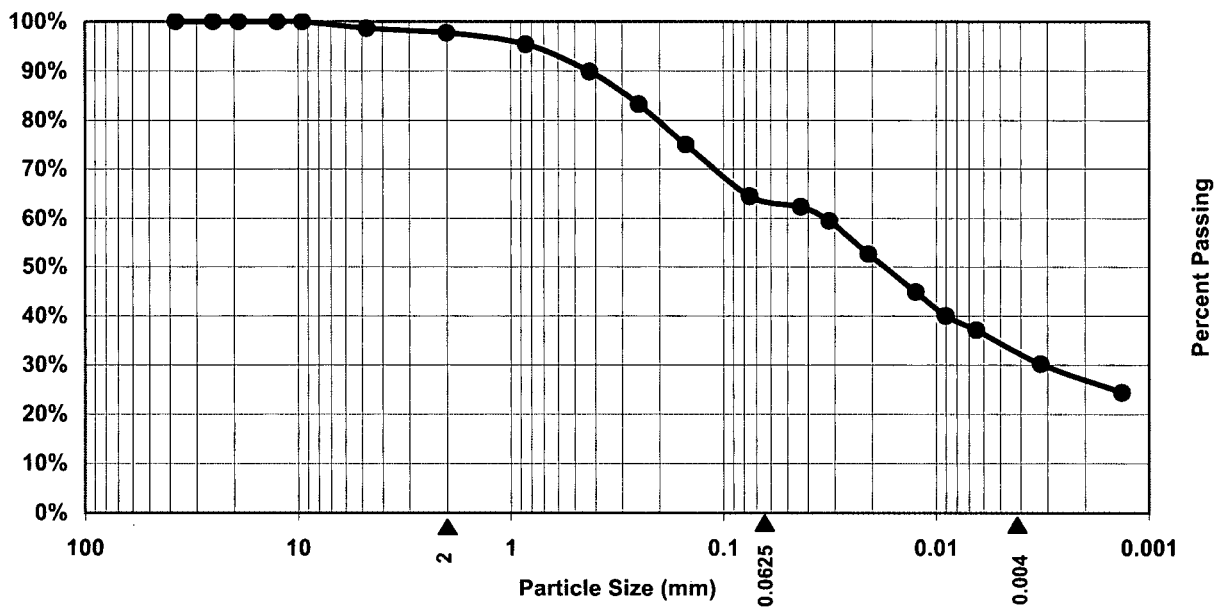
PERMEABILITY

9.92E-04 cm/sec

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	**Sample No.:**	**Depth:**
M-95R	SS-2	7.82 to 9.32 ft bls

Sample Description:
Red and Gray, Fine to Medium Sandy, Silty, Clay With Mica



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 2.3%	% Sand 33.9%	% Silt 32.0%	% Clay 31.8%
Adjusted for Calculations	**0%**	**35%**	**33%**	**33%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-95R

Boring Depth: 7.82 to 9.32 ft bls

% Sand: 35%

% Silt: 33%

% Clay: 33%

Estimated Specific Yield: 3.8%

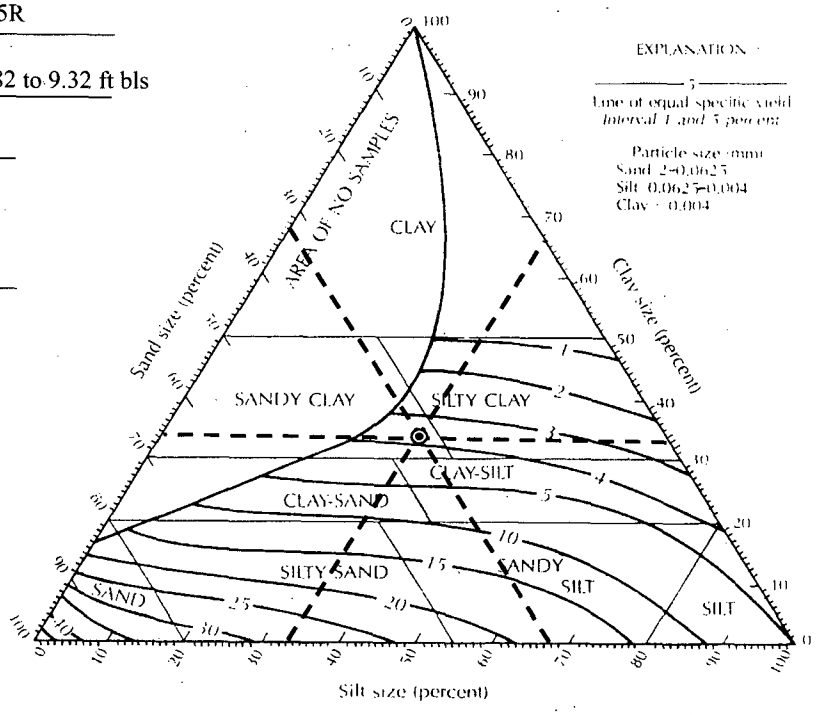
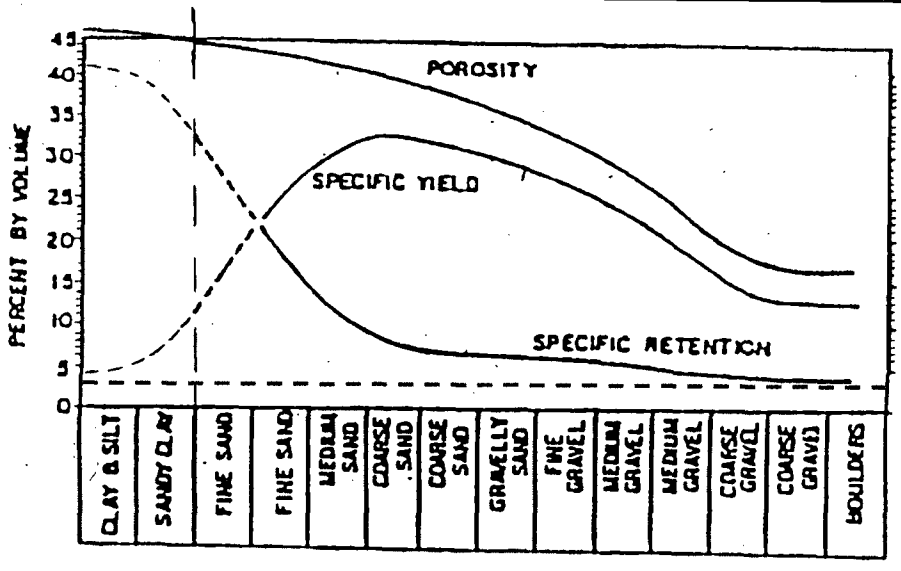


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 48%**

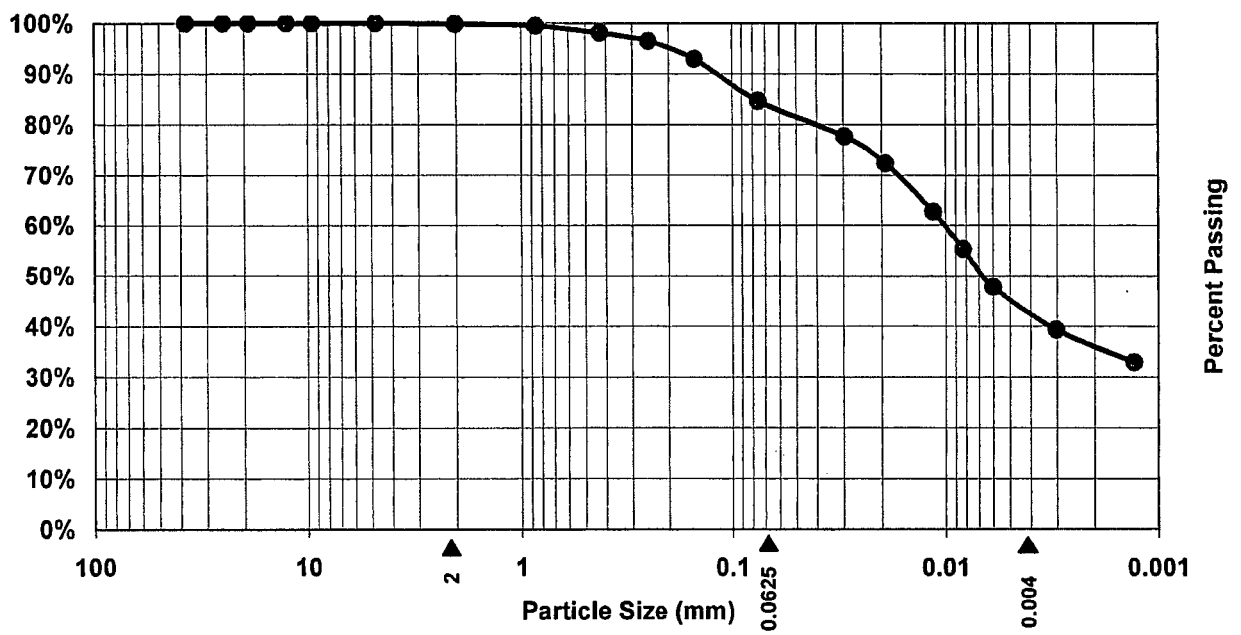
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-95R	SS-3	12.82 to 14.32 ft bls

Sample Description:
Brown and Gray, Silty, Clay With Fine Sand and Mica



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.1%	% Sand 16.8%	% Silt 40.1%	% Clay 42.9%
Adjusted for Calculations	**0%**	**17%**	**40%**	**43%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-95R

Boring Depth: 12.82 to 14.32 ft bls

% Sand: 17%

% Silt: 40%

% Clay: 43%

Estimated Specific Yield: 2%

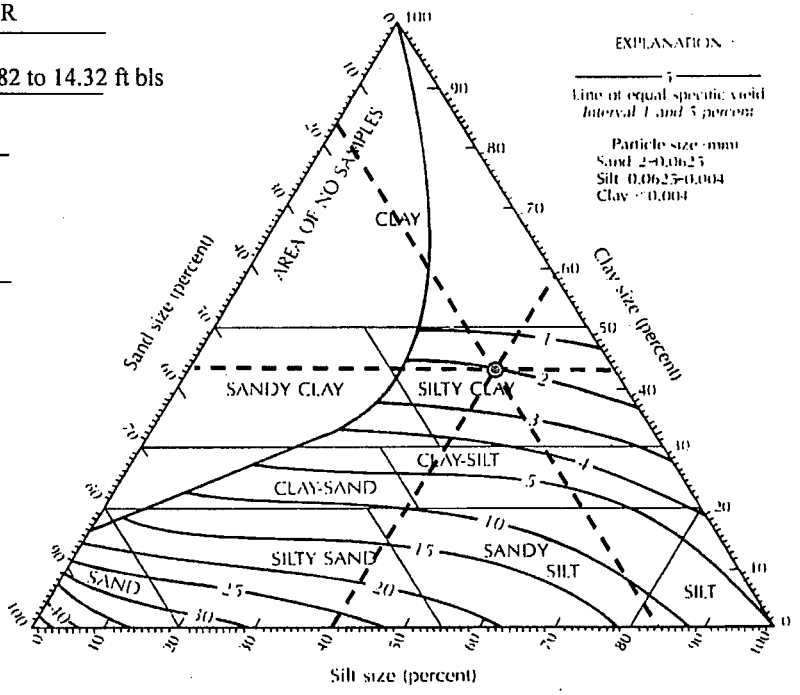
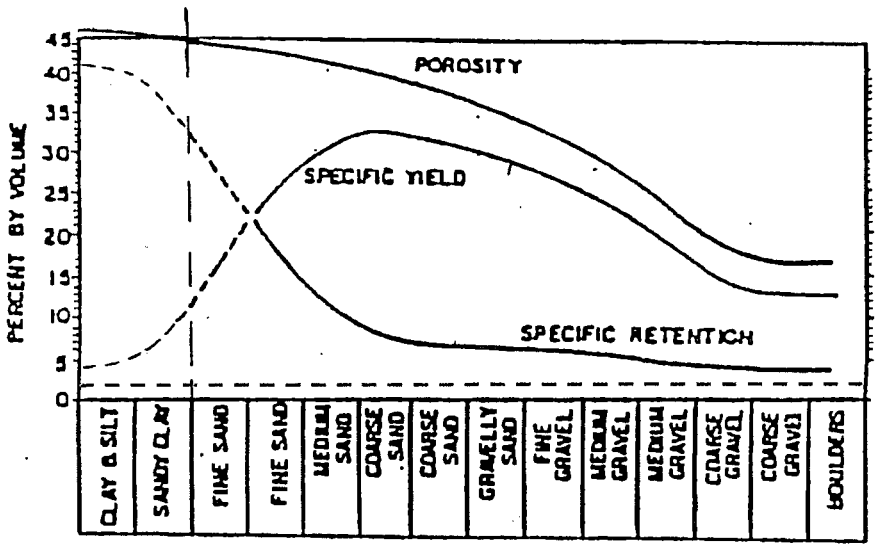


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 48%**

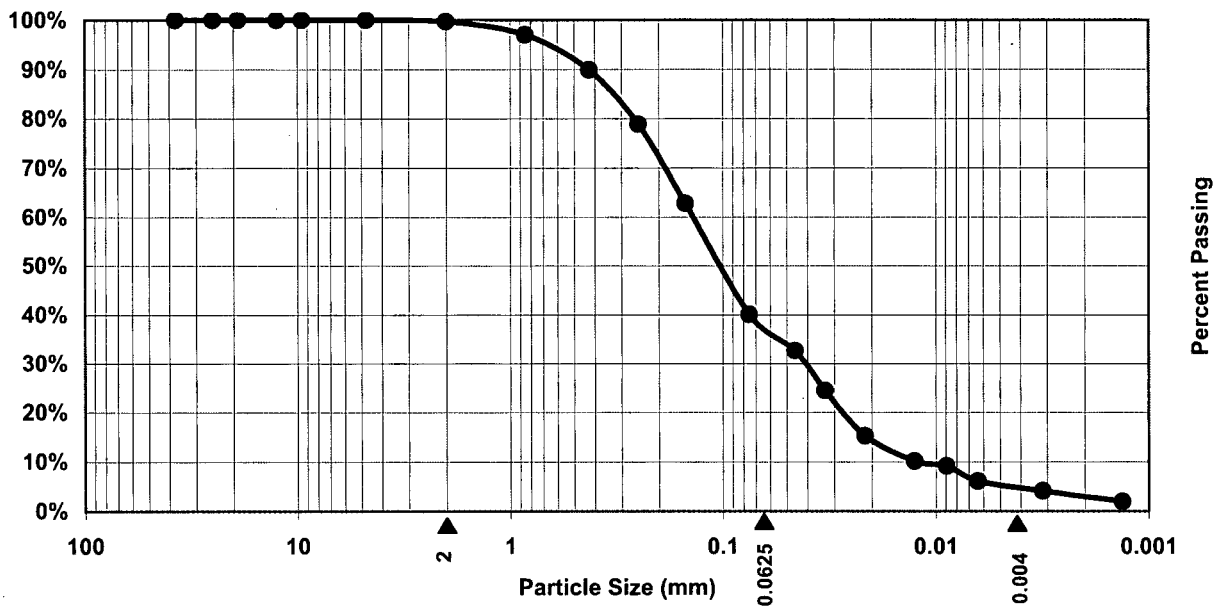
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	**Sample No.:**	**Depth:**
M-95R	SS-6	27.82 to 29.32 ft bls

Sample Description:
Reddish-Brown, Silty, Fine to Medium Sand With Mica



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.3%	% Sand 62.1%	% Silt 32.9%	% Clay 4.6%
Adjusted for Calculations	**0%**	**62%**	**33%**	**5%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-95R

Boring Depth: 27.82 to 29.32 ft bls

% Sand: 62%

% Silt: 33%

% Clay: 5%

Estimated Specific Yield: 24%

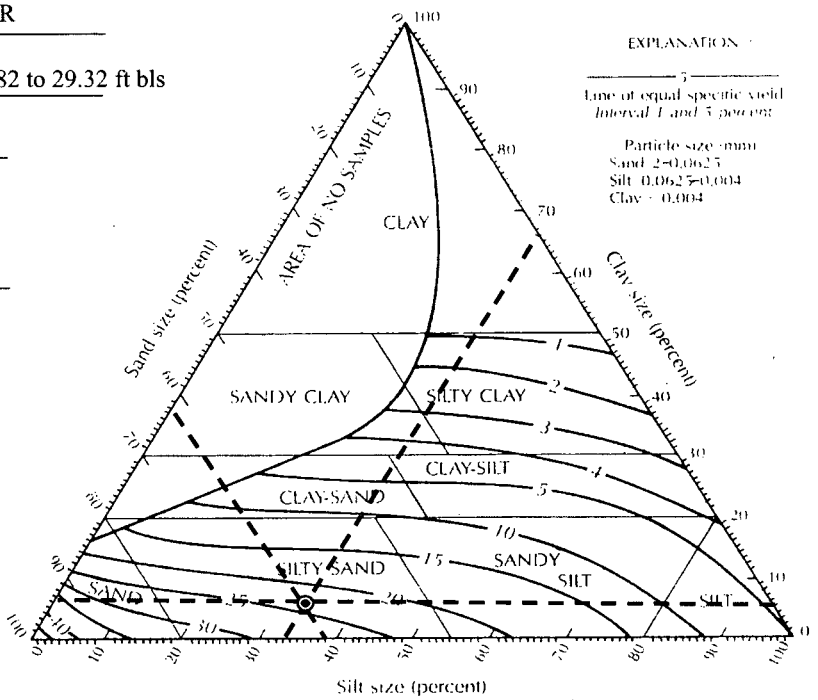
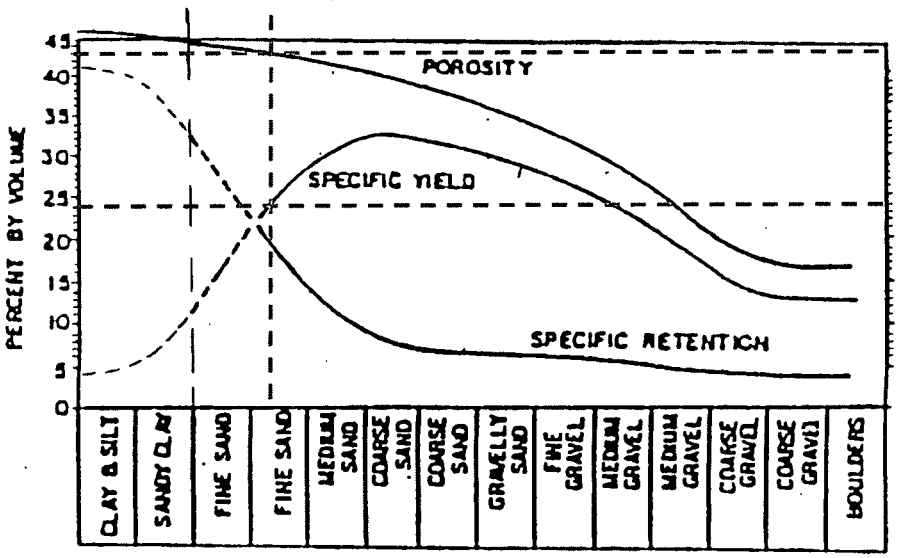


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 43%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

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Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **MNS - Groundwater Protection Project**			**Boring No. M-96**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 1
Boring Depth (ft): **34.0**	Elevation (ft): **747.3**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **5/4/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 24.36 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
745			FILL (F): Red, Yellow, and Gray, Micaceous, Medium to Fine Sandy, Clayey, **SILT**		
	5				
740			SOIL/SAPROLITE (M1): Red, Micaceous, Fine Sandy, Clayey, **SILT** With Tan, Micaceous, Medium to Fine Sand Lenses		
	10				
735			SOIL/SAPROLITE (M1): Yellow, Red, and Brown, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining		
	15				
730					
	20				
725			SOIL/SAPROLITE (M1): Yellow, Brown, and White, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Nodules (Granitic)		
	25				
720			SOIL/ SAPROLITE (M1): Brown and White, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining		
	30				
715			SOIL/SAPROLITE (M1): Greenish-Black, Tan, and White, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining (Dioritic); Black Rock Lense From 43.02 to 43.15 ft bls		
			Boring Terminated at 34.00 ft bls		
			Lithologic Descriptions Obtained From M-96R		

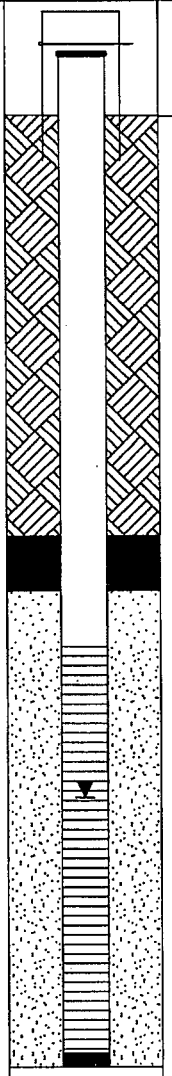
COMPLETION REPORT OF WELL No. M-96

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 24.36 ft bls**
LATITUDE: **35 25 53.45**
LONGITUDE: **80 56 58.54**
TOP OF CASING ELEVATION: **750.27**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **5/4/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		747.29
FILL (F): Red, Yellow, and Gray, Micaceous, Medium to Fine Sandy, Clayey, **SILT**		0, 5				
SOIL/SAPROLITE (M1): Red, Micaceous, Fine Sandy, Clayey, **SILT** With Tan, Micaceous, Medium to Fine Sand Lenses		10				
SOIL/SAPROLITE (M1): Yellow, Red, and Brown, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining		15, 20		15.00 17.00		732.29 730.29
SOIL/SAPROLITE (M1): Yellow, Brown, and White, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Nodules (Granitic)		25				
SOIL/ SAPROLITE (M1): Brown and White, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining		30		33.50		713.79
SOIL/SAPROLITE (M1): Greenish-Black, Tan, and White, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With				34.00		713.29



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 19 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 15 ft bls**

SEAL
Type: **Bentonite**
Interval: **15 to 17 ft bls**

FILTERPACK
Type: **#1 Filter Sand**
Interval: **17 to 34 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **19 to 34 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-96

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION:
LOGGED BY: **747.3**
CHECKED BY: **Courtney Wither**

STRATA			WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
DESCRIPTION	SYMBOL	DEPTH (ft.)					
							(See Page 1)
Manganese Staining (Dioritic); Black Rock Lense From 43.02 to 43.15 ft bls							

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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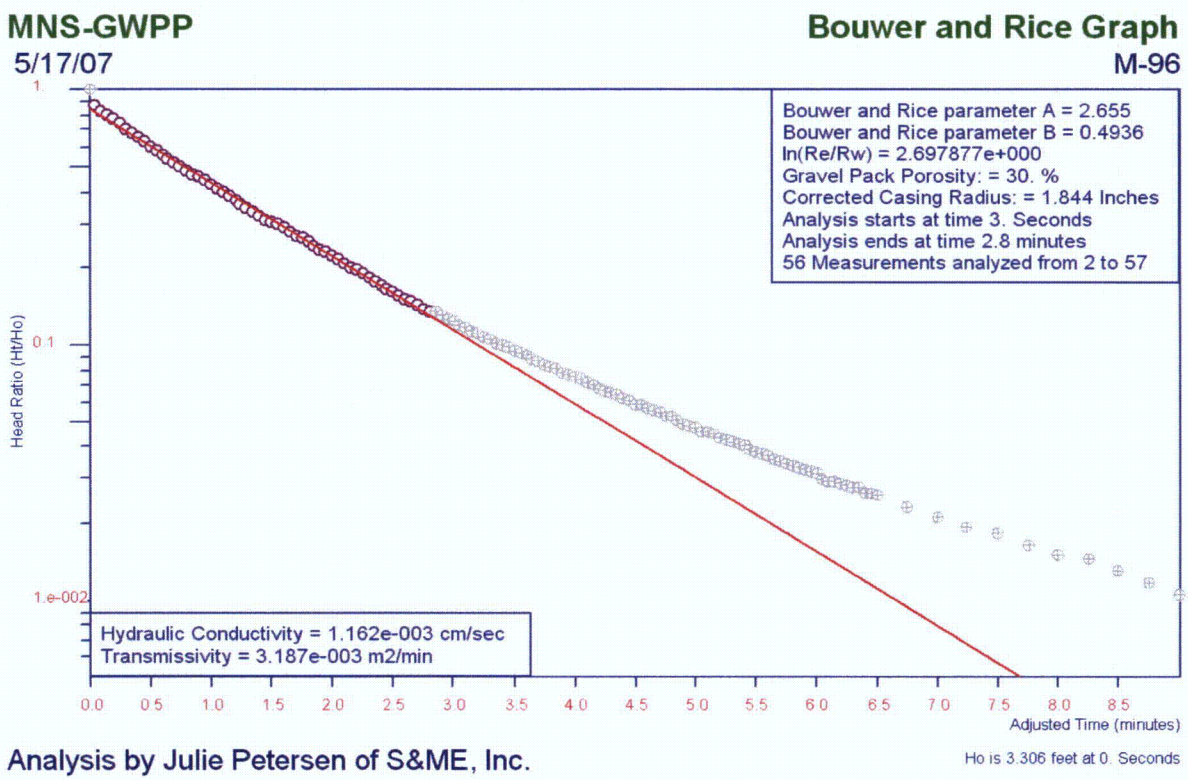
COMPLETION REPORT OF WELL No. M-96

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	5/17/2007
Well Label:	M-96
Aquifer Thickness:	15. feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	24.36 feet
Water Table to Screen Bottom:	9.64 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 141 time and drawdown measurements
Maximum head is 3.306 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

1.16E-03 cm/sec

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Project: **MNS - Groundwater Protection Project**			**Boring No. M-96R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 3
Boring Depth (ft): **99.6**	Elevation (ft): **747.4**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/26/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 23.14 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
745			FILL (F): Red, Yellow, and Gray, Micaceous, Medium to Fine Sandy, Clayey, **SILT**		19
	5				
740			SOIL/SAPROLITE (M1): Red, Micaceous, Fine Sandy, Clayey, **SILT** With Tan, Micaceous, Medium to Fine Sand Lenses		15
	10				
735			SOIL/SAPROLITE (M1): Yellow, Red, and Brown, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining		13
	15				
730					10
	20				
725			SOIL/SAPROLITE (M1): Yellow, Brown, and White, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Nodules (GRANITIC)	▼	5
	25				
720			SOIL/ SAPROLITE (M1): Brown and White, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining		6
	30				
715			SOIL/SAPROLITE (M1): Greenish-Black, Tan, and White, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining (Dioritic); Black Rock Lense From 43.02 to 43.15 ft bls		9

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Project: **MNS - Groundwater Protection Project**			**Boring No. M-96R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 2 of 3
Boring Depth (ft): **99.6**	Elevation (ft): **747.4**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/26/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 23.14 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
710					
	40				11
705					
	45				20
700			SOIL/SAPROLITE (M1): Black, White, and Orange, Micaceous, Silty, Medium to Fine **SAND** With Manganese Staining (Granitic)		
	50				38
695			**Roller Cone Refusal at 52.54 ft bls**		
			WEATHERED ROCK (M2): When Sampled Becomes Black, Tan, and Gray, Micaceous, Silty, Coarse to Fine **SAND** with Fine-Grained **GRANITE** Fragments		
	55				
690					
	60				
685					
	65				
680					

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Project: **MNS - Groundwater Protection Project**			**Boring No. M-96R**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 3 of 3
Boring Depth (ft): **99.6**	Elevation (ft): **747.4**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **4/26/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 23.14 ft bls**		Drilling Method: **Mud Rotary**

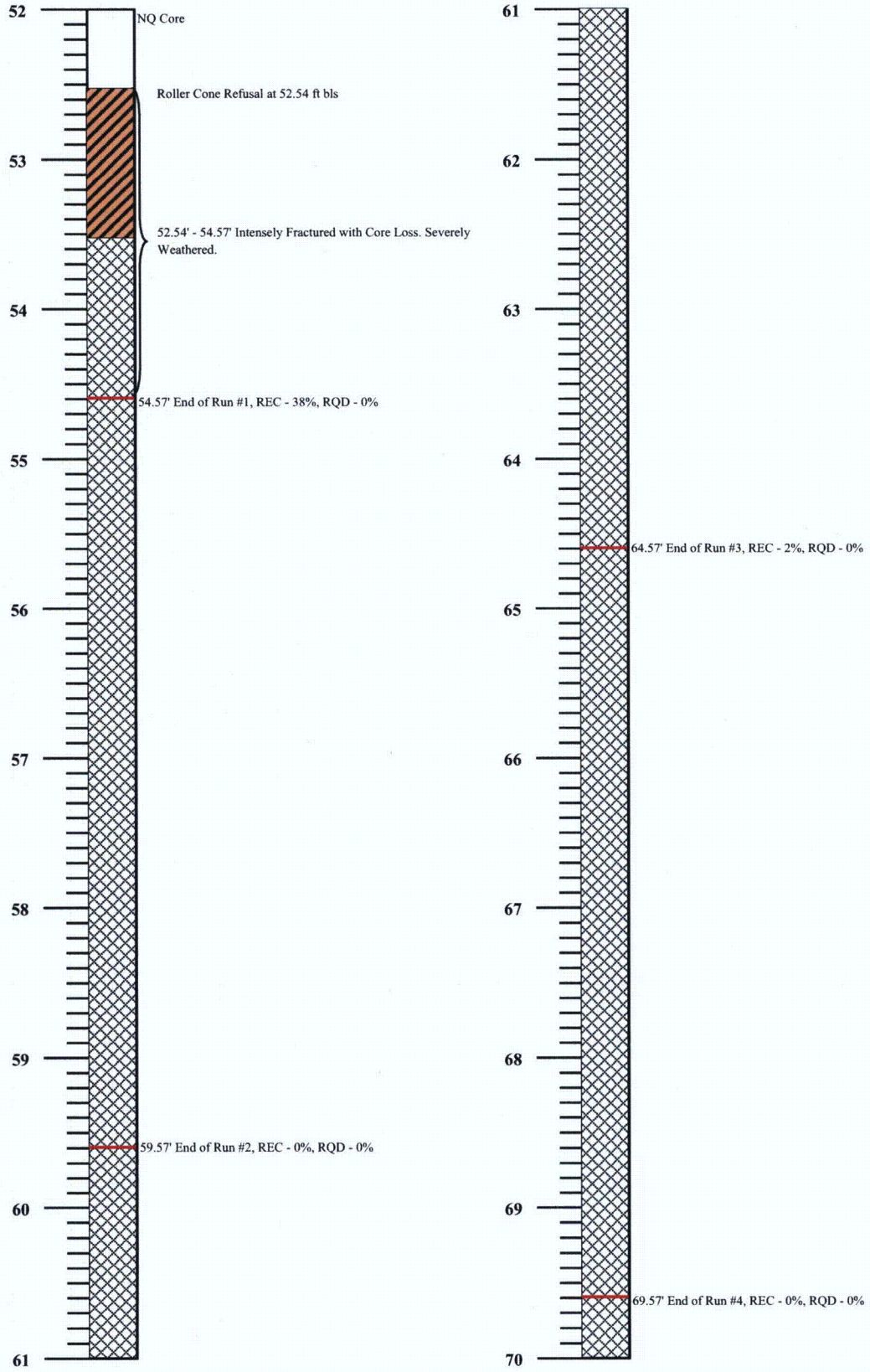
Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
675					
	75		**Set Back up to Mud Rotary at 74.57 ft bls**		
670					50/3 >>
	80		**Roller Cone Refusal at 80.38 ft bls**		
			SOUND ROCK (D): Coarse-Grained, **QUARTZ DIORITE**, Moderately Fractured With Soil Seam From 82.84 to 83.84 ft bls		
665					
	85				
660					
	90				
655					
	95				
			SOUND ROCK (D): Fine-Grained **QUARTZ DIORITE**, Slightly Fractured		
650					
			SOUND ROCK (D): Coarse-Grained, **QUARTZ DIORITE**, Slightly Fractured		
			Boring Terminated at 99.57 ft bls		

FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-96R



EXPLANATION

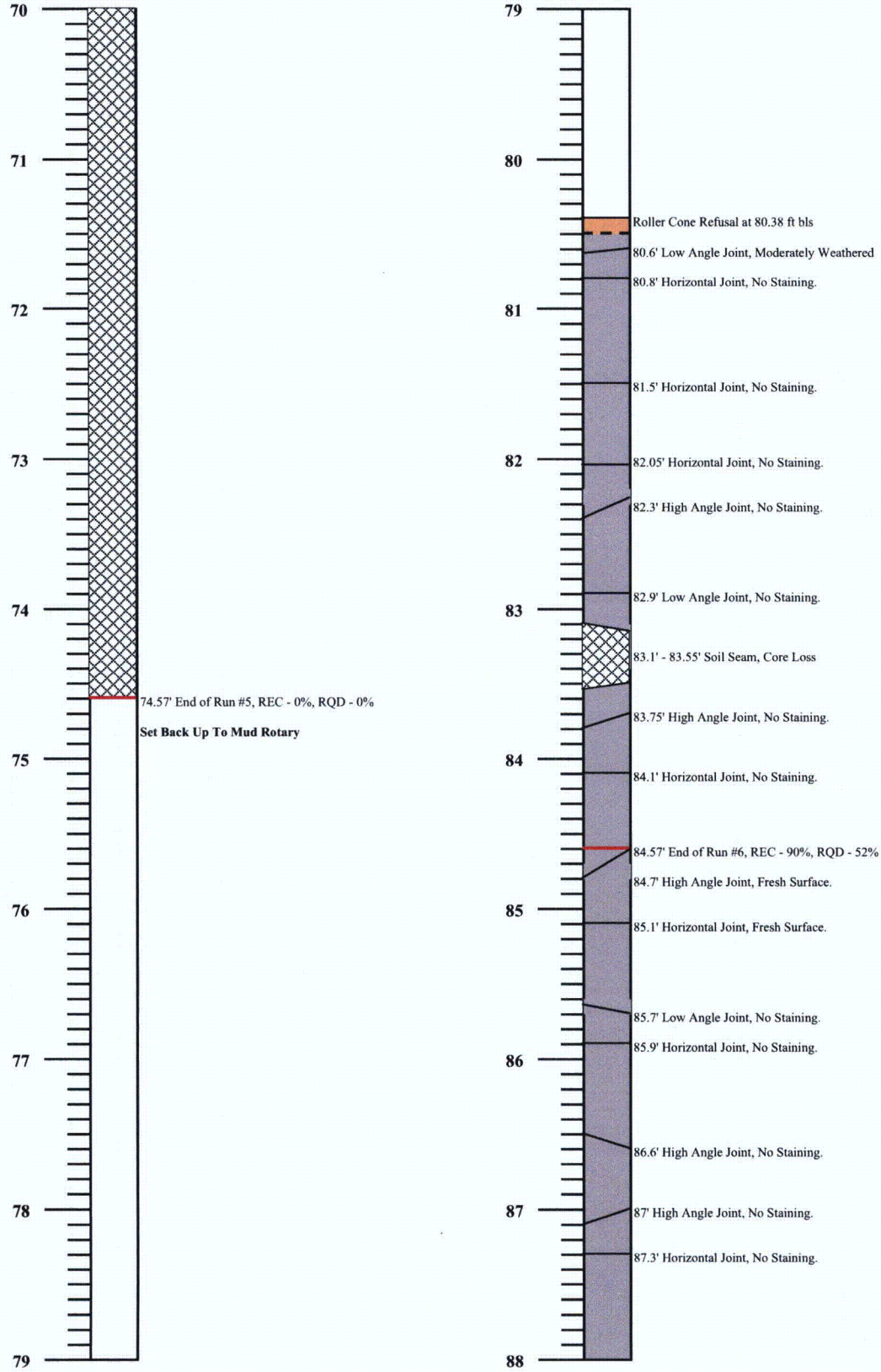
- Meta Gabbro
- Quartz Diorite
- Diorite
- Granite
- Core Loss
- Intense Fracturing
- Fractures
- End of Run
- Contact
- Healed Joint

FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-96R

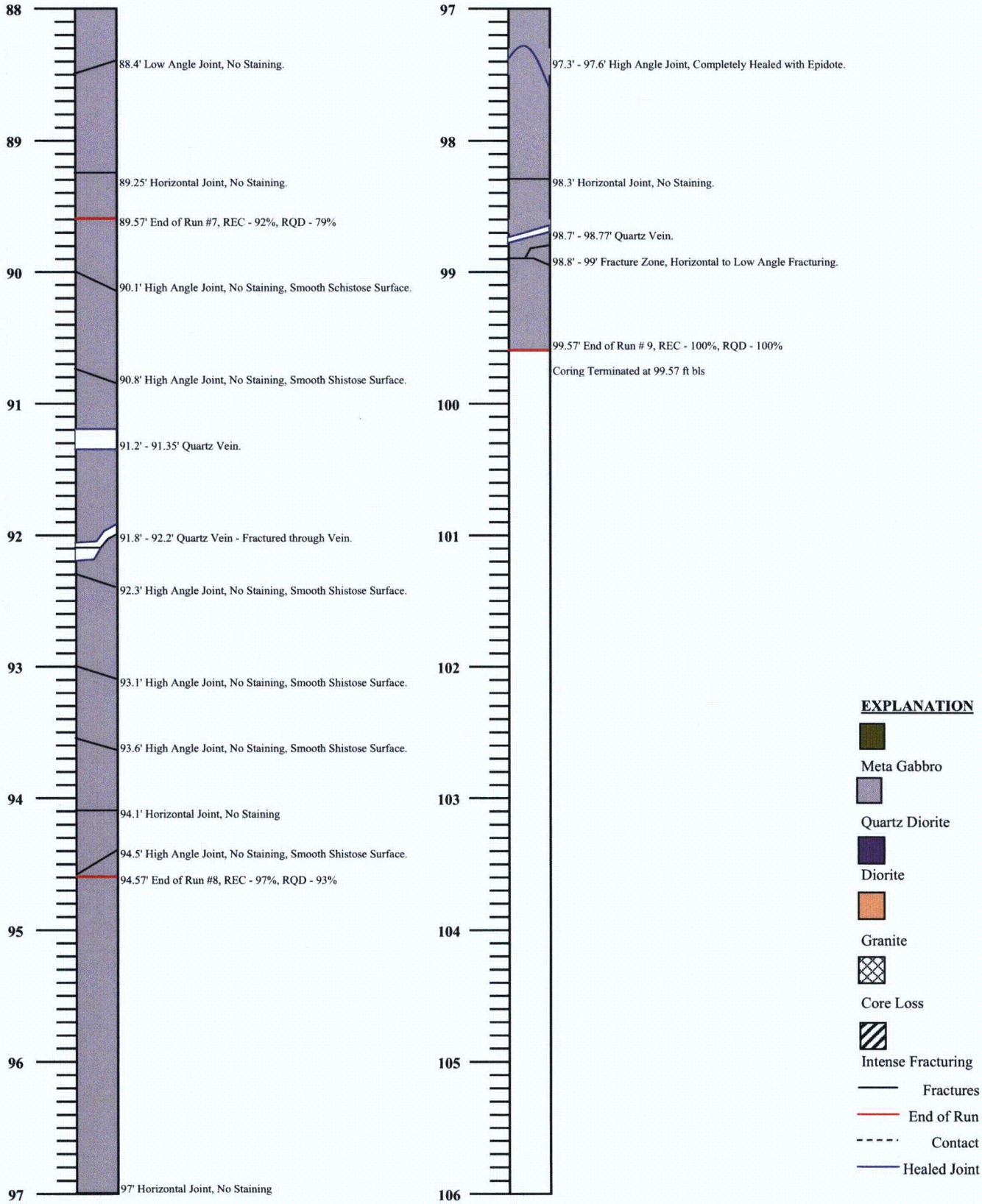


FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-96R



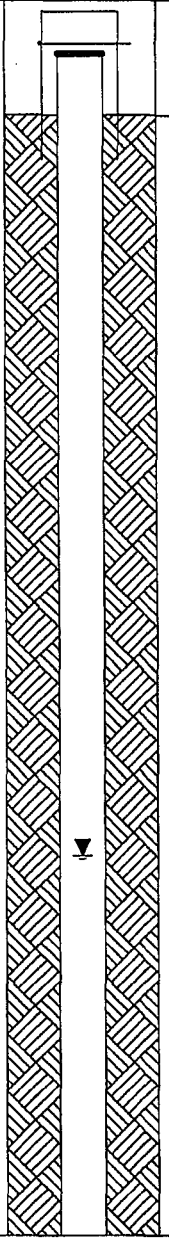
COMPLETION REPORT OF WELL No. M-96R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 23.14 ft bls**
LATITUDE: **35 25 53.46**
LONGITUDE: **80 56 58.60**
TOP OF CASING ELEVATION: **750.25**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **4/26/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		747.40
FILL (F): Red, Yellow, and Gray, Micaceous, Medium to Fine Sandy, Clayey, **SILT**		0, 5				
SOIL/SAPROLITE (M1): Red, Micaceous, Fine Sandy, Clayey, **SILT** With Tan, Micaceous, Medium to Fine Sand Lenses		10				
SOIL/SAPROLITE (M1): Yellow, Red, and Brown, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining		15, 20				
SOIL/SAPROLITE (M1): Yellow, Brown, and White, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Nodules (GRANITIC)		25				
SOIL/ SAPROLITE (M1): Brown and White, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining		30				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Lockable Steel**
Interval: **Above Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 81.2 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 78 ft bls**

SEAL
Type: **K-Packer + Bentonite**
Interval: **78 to 81.4 ft bls**

FILTERPACK
Type: **N/A**
Interval: **N/A**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **82 to 87 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. M-96R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION: **747.4**
LOGGED BY: **Courtney Withe**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOIL/SAPROLITE (M1): Greenish-Black, Tan, and White, Micaceous, Slightly Clayey, Fine Sandy, **SILT** With Manganese Staining (Dioritic); Black Rock Lense From 43.02 to 43.15 ft bls *(continued)*		35, 40, 45					
SOIL/SAPROLITE (M1): Black, White, and Orange, Micaceous, Silty, Medium to Fine **SAND** With Manganese Staining (Granitic)		50					
WEATHERED ROCK (M2): When Sampled Becomes Black, Tan, and Gray, Micaceous, Silty, Coarse to Fine **SAND** with Fine-Grained **GRANITE** Fragments		55, 60, 65, 70, 75		78.00		669.40	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-96R

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION: **747.4**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
		80					
SOUND ROCK (D): Coarse-Grained, **QUARTZ DIORITE**, Moderately Fractured With Soil Seam From 82.84 to 83.84 ft bls				81.20		666.20	
				81.40		666.00	
				82.00		665.40	
		85					
				87.00		660.40	
				88.00		659.40	
		90					
		95					
SOUND ROCK (D): Fine-Grained **QUARTZ DIORITE**, Slightly Fractured							
SOUND ROCK (D): Coarse-Grained, **QUARTZ DIORITE**, Slightly Fractured				99.57		647.83	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
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MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-96R

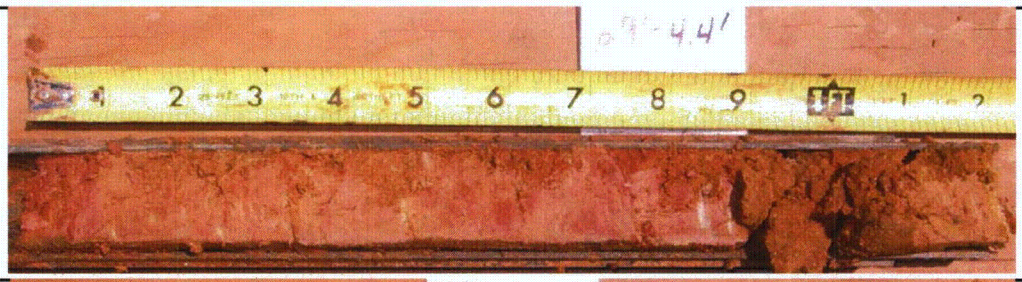
SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

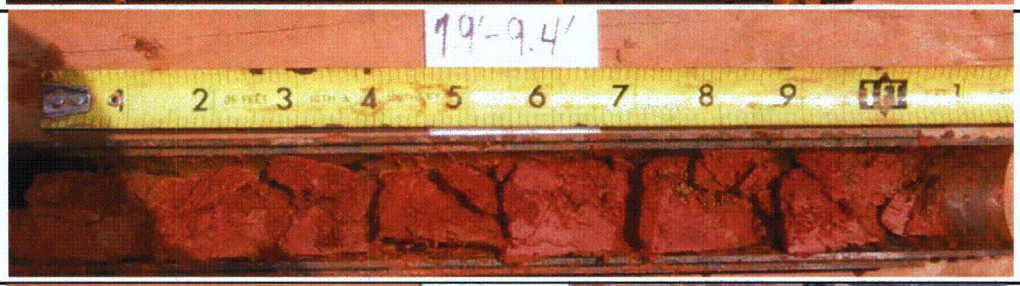
S&ME Project No: 1264-06-724

Boring Number: M-96R

Sample No: 1
Depth (ft-bls): 2.9 - 4.4
Blow Count: 4 * 8 * 11

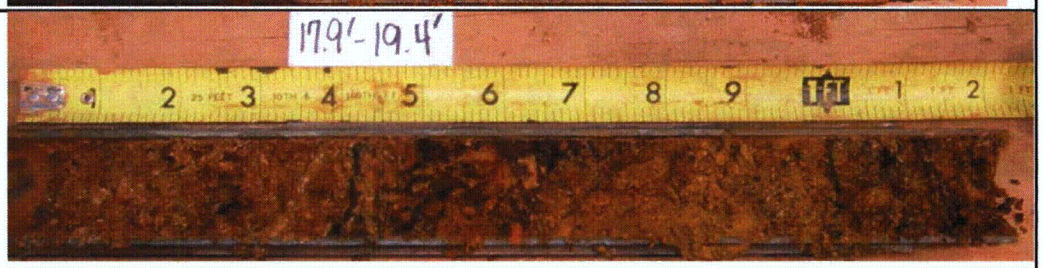


Sample No: 2
Depth (ft-bls): 7.9 - 9.4
Blow Count: 4 * 5 * 10



Sample No: 3
Depth (ft-bls): 12.9 - 14.4
Blow Count: 3 * 5 * 8

Sample No: 4
Depth (ft-bls): 17.9 - 19.4
Blow Count: 2 * 5 * 5



Sample No: 5
Depth (ft-bls): 22.9 - 24.4
Blow Count: 2 * 2 * 3

Sample No: 6
Depth (ft-bls): 27.9 - 29.4
Blow Count: 2 * 2 * 4

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: M-96R

Sample No: 7
Depth (ft-bls): 32.9 - 34.4
Blow Count: 3 * 3 * 6

Sample No: 8
Depth (ft-bls): 37.9 - 39.4
Blow Count: 2 * 4 * 7

Sample No: 9
Depth (ft-bls): 42.9 - 44.4
Blow Count: 7 * 7 * 13

Sample No: 10
Depth (ft-bls): 47.9 - 49.4
Blow Count: 12 * 15 * 23

Sample No: 11
Depth (ft-bls): 77.48 - 78.98
Blow Count: 50/3

ROCK CORE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-96R

CLASSIFICATION:

52.54' to 80.5' Fine Grained Granite with Core Loss (Weathered Rock)

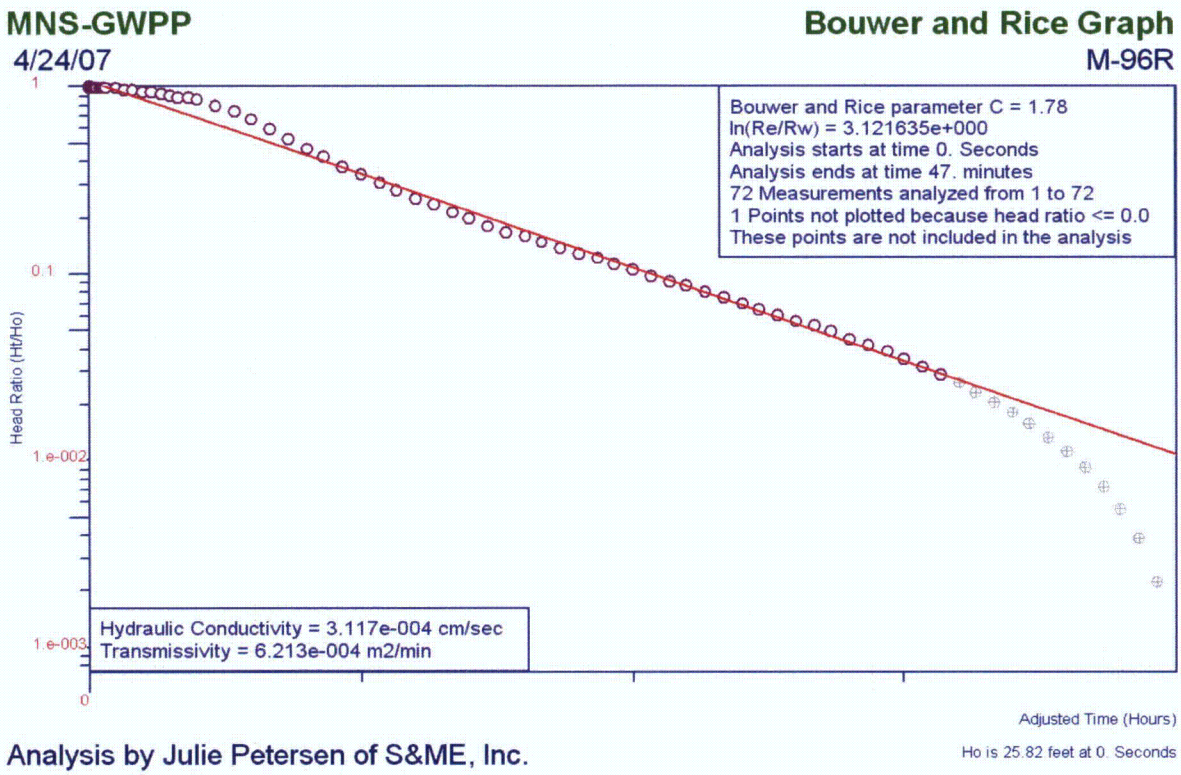
80.5' to 99.57' Coarse to Fine Grained Quartz Diorite

Calculation of Permeability By The Falling Head Method (Open Hole in Uniform Material)

Site Name:	MNS-GWPP	
Test Date:	4/24/2007	
Well Label:	M-96R	
Test Interval:	33.9 to 36.9 ft bls	(Soil/Saprolite)
Length of Open Hole:	3. feet	
Casing Radius:	1.5 Inches	
Effective Radius:	1.5 Inches	
Anisotropy Ratio:	1	

Test starts with trial 0
There are 85 time and drawdown measurements
Maximum head is 25.82 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

3.12E-04 cm/sec

CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

S&ME

Site Name:	MNS - GWPP	
Date:	5/1/2007	
Boring I.D.	M-96R	(Weathered Rock)
Test Interval:	52.17 to 59.57	
Total Depth of Hole:	59.57 ft	1816.16 cm
Length of Open Hole:	7.40 ft	225.61 cm
Transformation Ratio m=	1	
Performed by:	Julie Petersen	

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1838.41	
60	1627.74	2.66E-04
120	1455.76	2.44E-04
180	1337.10	1.86E-04
240	1251.19	1.45E-04
300	1186.83	1.16E-04
360	1138.41	9.11E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} > 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

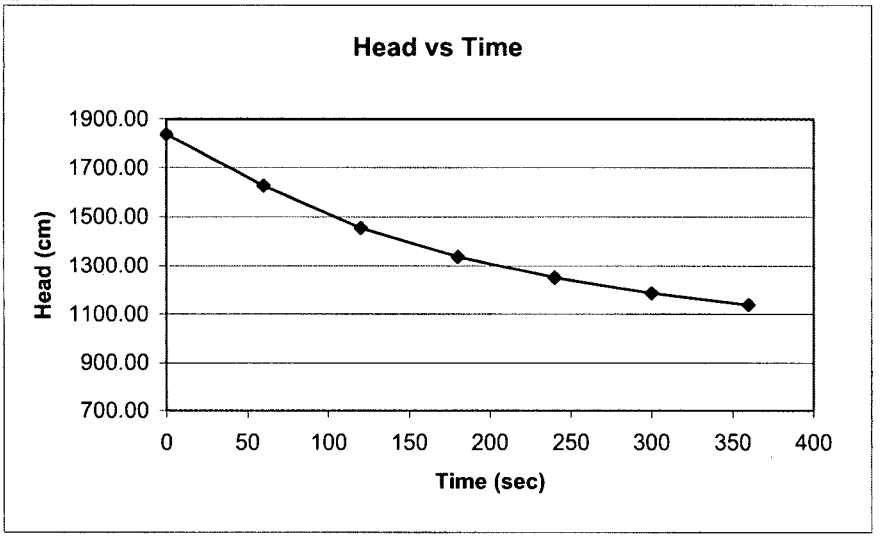
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec)

1.75E-04

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

S&ME

Site Name:	MNS - GWPP		
Date:	5/1/2007		
Boring I.D.	M-96R	(Weathered Rock)	
Test Interval:	52.17 to 64.57		
Total Depth of Hole:	64.57 ft		1968.6 cm
Length of Open Hole:	12.40 ft		378.05 cm
Transformation Ratio m=	1		
Performed by:	Julie Petersen		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1847.71	
60	1637.87	1.77E-04
120	1504.94	1.25E-04
180	1414.79	9.09E-05
240	1350.15	6.88E-05
300	1302.56	5.28E-05
360	1266.71	4.11E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} > 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

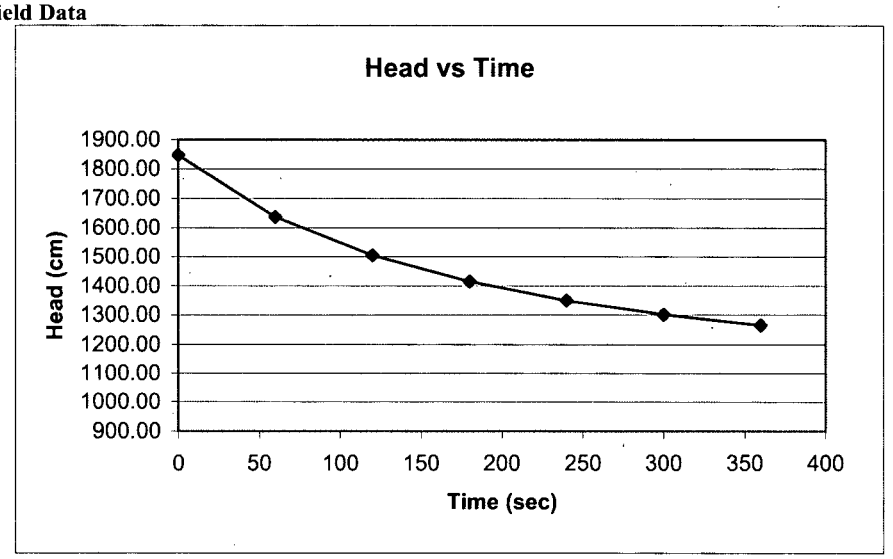
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec)

9.26E-05

Graph of Field Data



BOREHOLE PERMEABILITY TEST USING PACKERS
FIELD DATA SHEET

S&ME

PROJECT NAME AND NO.:	MNS - GWPP	**BOREHOLE NO.:**	M-96R				
LOCATION:	Huntersville, NC	**TEST INTERVAL:**	83.0	to	88.0	bgs	
TEST DATE:	5/3/2007	**TEST INTERVAL:**	664.2	to	659.2	EL	
TESTED BY:	Justin Milwood and Courtney Withers						
GROUND ELEV (ft MSL):	747.2						

TEST METHOD: Double Packer Method using Multiple Pressure Tests
METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

TEST DATA (Enter data in underlined cells):
Rock Description of test interval:

	Sound Rock - Coarse Grained Quartz Diorite, Moderately Fractured			
Source of test water and clarity:	Holding Pond - Slightly Turbid			
Method of cleaning hole prior to testing:	Flushed			
Drilling Fluid (water or type of drilling mud)	Water			
Packer Brand and Model:				
Packer Inflation Pressure	160	psi		
Packer Length:	2.00	feet		
Method: Single (1) or double (2) packer (Enter 1 or 2):	2			
Interval below base of packer for Method 1 (single packer test), A_1:	-	feet		
Interval between packers for Method 2 (double packer test), A_2:	5.0	feet		
Depth of hole at time of test:	99.2	feet below ground surface (bgs)		
Diameter of borehole, d:	3.0	inches	0.3	feet
Radius of the borehole, r	0.13	feet		
Depth to water table (thickness of unsaturated material above water table, U):	23.8	feet		
Height above ground surface of pressure gauge:	4.9	feet ags		
Top of test section (bottom of upper packer), h_t:	83.0	feet bgs		
Bottom of test section (top of lower packer if double packer used, bottom of hole for a single packer, D):	88.0	feet bgs		
Is test section above or below water table?	below			
For tests below the water table determine h_1, the distance between the gauge and the water table:	28.7	feet		
Length of pipe over which head loss occurs (distance from gauge to outlet of pipe in test section):	90.4	feet		
Diameter and type of pipe used:	1.25-inch I.D.			

BOREHOLE PERMEABILITY TEST USING PACKERS
FIELD DATA SHEET

S&ME

PROJECT NAME AND NO.:	MNS - GWPP	**BOREHOLE NO.:**	M-96R				
LOCATION:	Huntersville, NC	**TEST INTERVAL:**	83	to	88	bgs	
TEST DATE:	5/3/07	**TEST INTERVAL:**	664.22	to	659.22	EL	

Gauge Pressure (h_2) in psi	Elapsed Time (minutes)	Water Level (feet bgs)	Flow Rate (total flow in gal)	Flow Rate (gpm)
Step 1				
30	0		2004.50	
30	1		2004.60	0.10
30	2		2004.60	0.00
30	5		2004.60	0.00
30	10		2004.60	0.00
30	15		2004.60	0.00
30	20		2004.60	0.00
		Average	0.00	0.02
		Selected stabilized flow rate to be used in calculations		0.00
Step 2				
40	0		2004.70	
40	1		2004.75	0.05
40	2		2004.80	0.05
40	5		2004.90	0.03
40	10		2005.00	0.02
40	15		2005.15	0.03
40	20		2005.30	0.03
		Average	0.03	0.04
		Selected stabilized flow rate to be used in calculations		0.03
Step 3				
50	0		2005.50	
50	1		2005.60	0.10
50	2		2005.80	0.20
50	5		2006.30	0.17
50	10		2007.10	0.16
50	15		2007.70	0.12
50	20		2008.60	0.18
		Average	0.15	0.15
		Selected stabilized flow rate to be used in calculations		0.15
Step 4				
40	0		2008.60	
40	1		2008.70	0.10
40	3		2008.90	0.10
40	5		2009.10	0.10
		Average	0.10	0.10
		Selected stabilized flow rate to be used in calculations		0.10
Step 5				
30	0		2009.20	
30	1		2009.30	0.10
30	3		2009.50	0.10
30	5		2009.60	0.05
		Average	0.08	0.08
		Selected stabilized flow rate to be used in calculations		0.08

NOTES:

BOREHOLE PERMEABILITY TEST USING PACKERS CALCULATIONS

S&ME

PROJECT NAME AND NO.:	MNS - GWPP	**BOREHOLE NO.:**	M-96R				
LOCATION:	Huntersville, NC	**TEST INTERVAL:**	83.0	to	88.0	bgs	
TEST DATE:	5/3/2007	**TEST INTERVAL:**	664.2	to	659.2	EL	
TESTED BY:	Justin Milwood and Courtney Withers						
GROUND ELEV (ft MSL):	747.2						

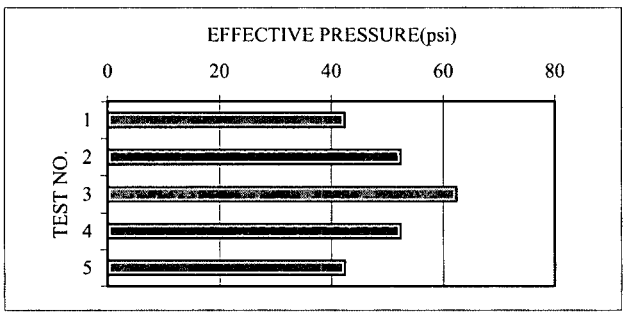
TEST METHOD: Double Packer Method using Multiple Pressure Tests
METHOD REFERENCE: Ground Water Manual, US Bureau of Reclamation, 1995, Chapter 10

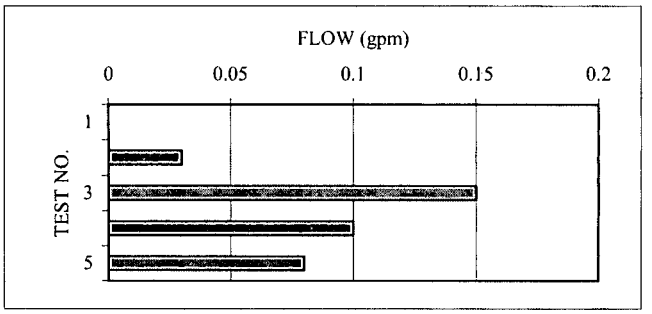
RESULTS OF PERMEABILITY CALCULATIONS
MULTIPLE STEP TEST

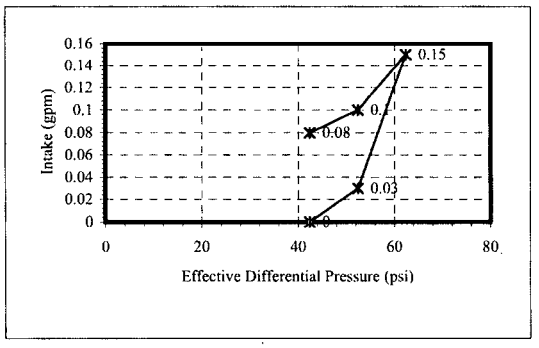
Step	Flow (Q) (gpm)	Pressure (psi) Gauge	Pressure (psi) Effective	Lugeons	Permeability (ft/sec)	Permeability (cm/sec)
1	0	30	42	0	0.00E+00	0.0E+00
2	0.03	40	52	0	6.9E-08	2.1E-06
3	0.15	50	62	1	2.9E-07	8.8E-06
4	0.1	40	52	1	2.3E-07	7.0E-06
5	0.08	30	42	1	2.3E-07	6.9E-06
			AVERAGE	0	1.6E-07	5.0E-06
			SELECTED VALUES			

Rock Description of Tested Interval:
Sound Rock - Coarse Grained Quartz Diorite, Moderately Fractured

TEST INTERPRETATION
Text here
Text here







PERMEABILITY CALCULATIONS FOR EACH STEP OF TEST

S&ME

CALCULATED PERMEABILITY FOR STEP 1

Gauge Pressure, **h2**:	30	psi	69.3	feet of water
Flow Rate, **Q**:	0	gpm	0.000	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	28.7	feet		
Value of $\mathbf{h_1}$:	28.7	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	97.9	feet	42.4	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	33.7	feet		
X = (H/Tu)*100	290.7	%		
Tu/A	6.7			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	0.00E+00	ft/sec	0.00E+00	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 2

Gauge Pressure, **h2**:	40	psi	92.4	feet of water
Flow Rate, **Q**:	0.03	gpm	0.000	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	28.7	feet		
Value of h_1:	28.7	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	121.0	feet	52.4	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	56.8	feet		
X = (H/Tu)*100	213.2	%		
Tu/A	11.4			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	6.90E-08	ft/sec	2.10E-06	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 3

Gauge Pressure, **h2**:	50	psi	115.5	feet of water
Flow Rate, **Q**:	0.15	gpm	0.000	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	28.7	feet		
Value of h_1:	28.7	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	144.1	feet	62.4	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	79.9	feet		
X = (H/Tu)*100	180.4	%		
Tu/A	16.0			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	2.90E-07	ft/sec	8.83E-06	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 4

Gauge Pressure, **h2**:	40	psi	92.4	feet of water
Flow Rate, **Q**:	0.10	gpm	0.000	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	28.7	feet		
Value of h_1:	28.7	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	121.0	feet	52.4	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	56.8	feet		
X = (H/Tu)*100	213.2	%		
Tu/A	11.4			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	2.30E-07	ft/sec	7.01E-06	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

Is Q/a * (estimated porosity) > 10?? True, Test Valid

CALCULATED PERMEABILITY FOR STEP 5				
Gauge Pressure, **h2**:	30	psi	69.3	feet of water
Flow Rate, **Q**:	0.08	gpm	0.000	ft^3/sec
Head loss per TEN foot section of pipe:	0.0	psi		(per tables)
Head Loss, ***L*** :	0.0	psi	0.0	feet of water
Distance from pressure gauge to bottom of test section, $\mathbf{h_1}$:	28.7	feet		
Value of h_1:	28.7	feet		
Effective Head, ***H*** where ***H = h1+h2-L*** :	97.9	feet	42.4	psi
Determine Saturation Zone:		-		
Select Zone 1, 2, or 3	3		Zones 1 and 2 are unsaturated, 3 is saturated	
Tu = U-D+H	33.7	feet		
X = (H/Tu)*100	290.7	%		
Tu/A	6.7			
Determine Conductivity Coefficient				
H/r	-		Value for Zone 1 analysis	
A/H	-		Value for Zone 1 analysis	
A/r	40		Value for Zone 2 and 3 analysis	
Select Cu from Fig 10-7 for Zone 1 tests:			Cu for Zone 1	
Cs for Zone 2 and 3 tests:	64		Cs for Zones 2 and 3	
Calculate K if Zone 1 and using single or double packer	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 2 and using double packer (Method 2)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using single packer (Method 1)	-	ft/sec	-	cm/sec
Calculate K if Zone 3 and using double packer (Method 2)	2.28E-07	ft/sec	6.93E-06	cm/sec

Is this step valid?

If (Q/a)*(estimated porosity) > 10 the calculations may not be valid due to turbulent flow

Calculate a, the total open area of the test section: 3.9 square feet

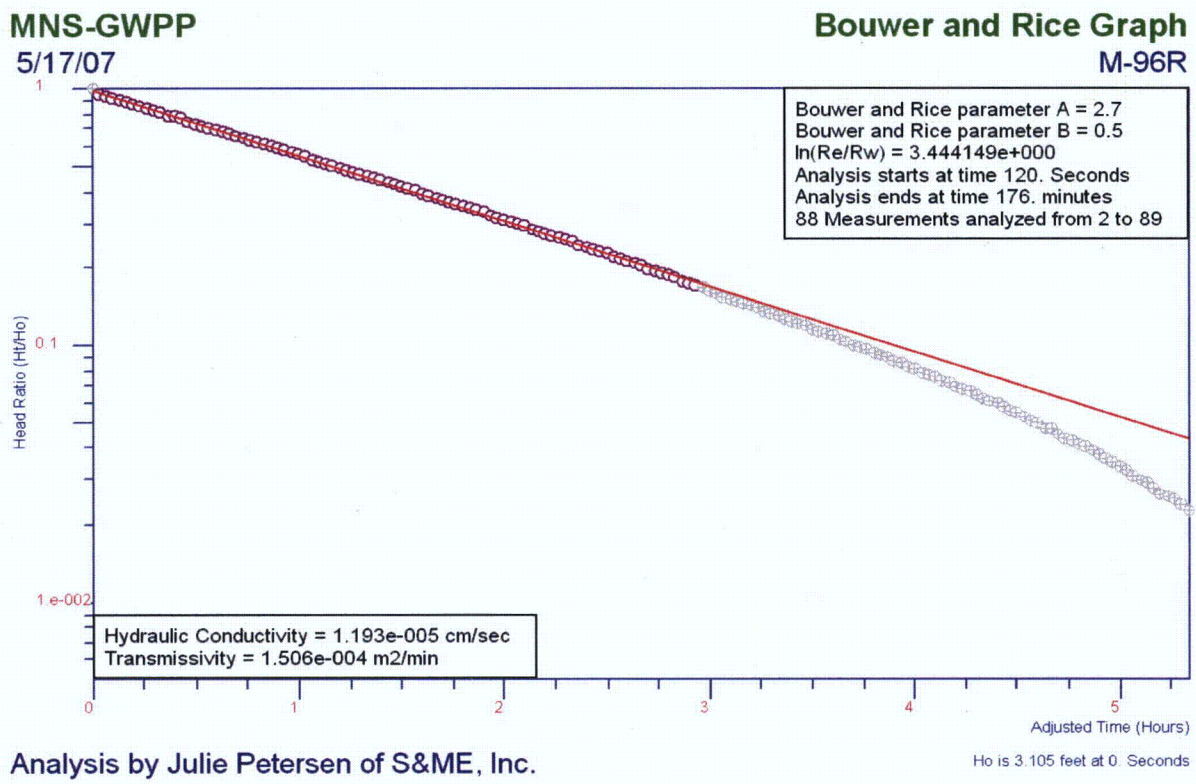
Is Q/a * (estimated porosity) > 10?? True, Test Valid

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	5/17/2007
Well Label:	M-96R
Aquifer Thickness:	69. feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	23.14 feet
Water Table to Screen Bottom:	63.86 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 161 time and drawdown measurements
Maximum head is 3.105 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

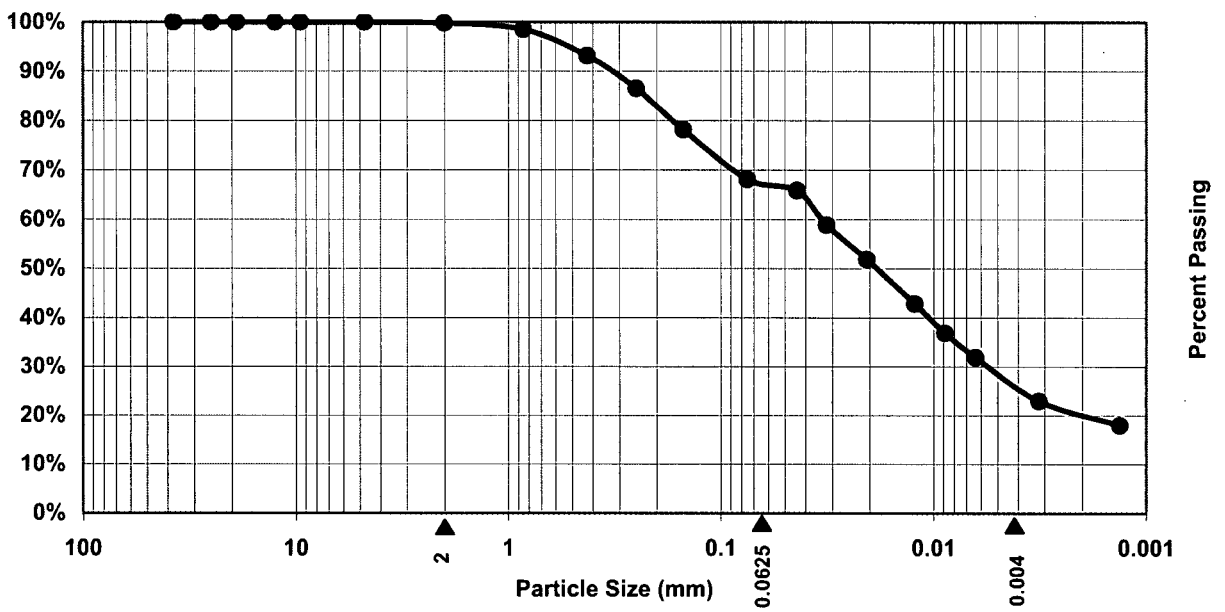
PERMEABILITY

1.19E-05 cm/sec

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-96R	SS-1	2.9 to 4.4 ft bls

Sample Description:
Red, Yellow, and Gray, Fine to Medium Sandy, Clayey, Silt With Mica



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.2%	% Sand 32.4%	% Silt 42.1%	% Clay 25.3%
Adjusted for Calculations	**0%**	**32%**	**42%**	**25%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-96R

Boring Depth: 2.9 to 4.4 ft bls

% Sand: 32%

% Silt: 42%

% Clay: 25%

Estimated Specific Yield: 5%

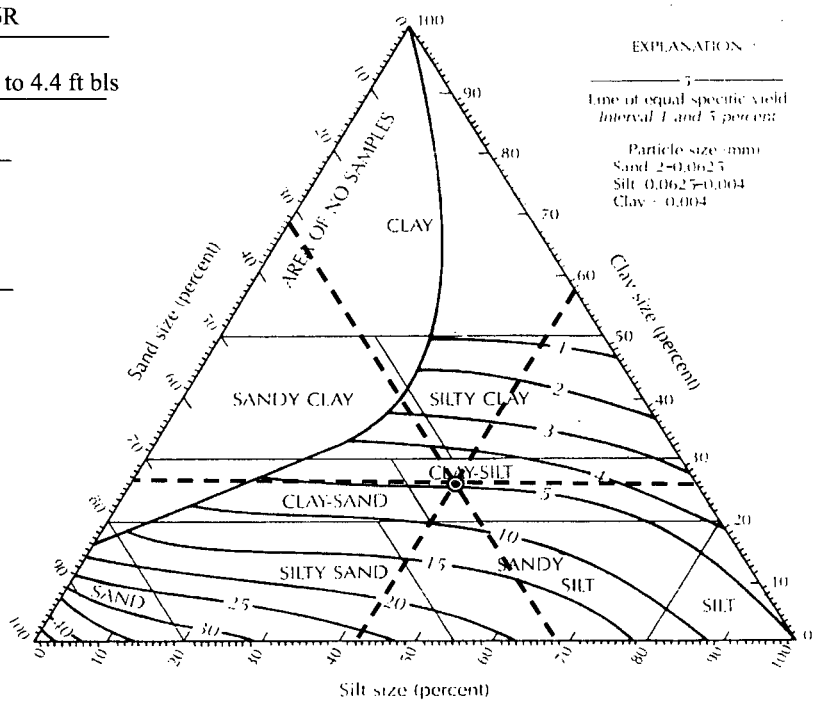
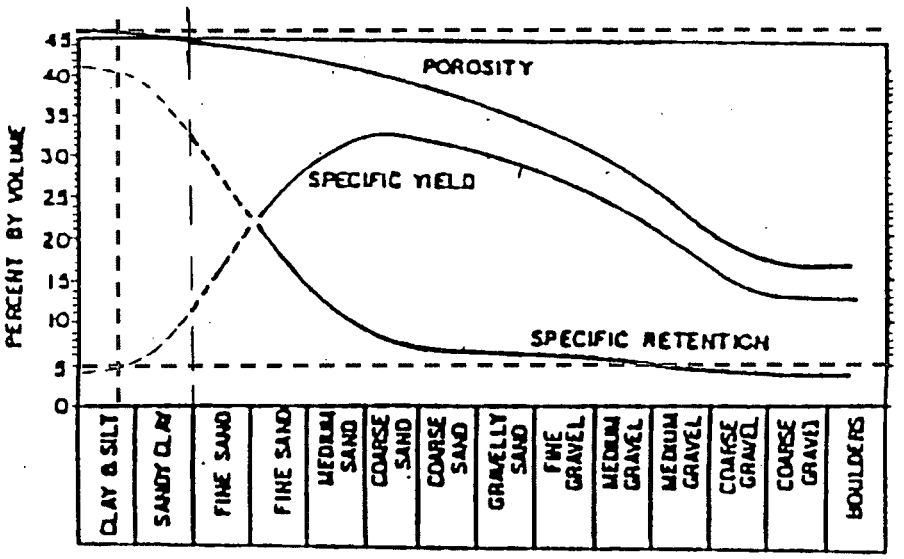


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



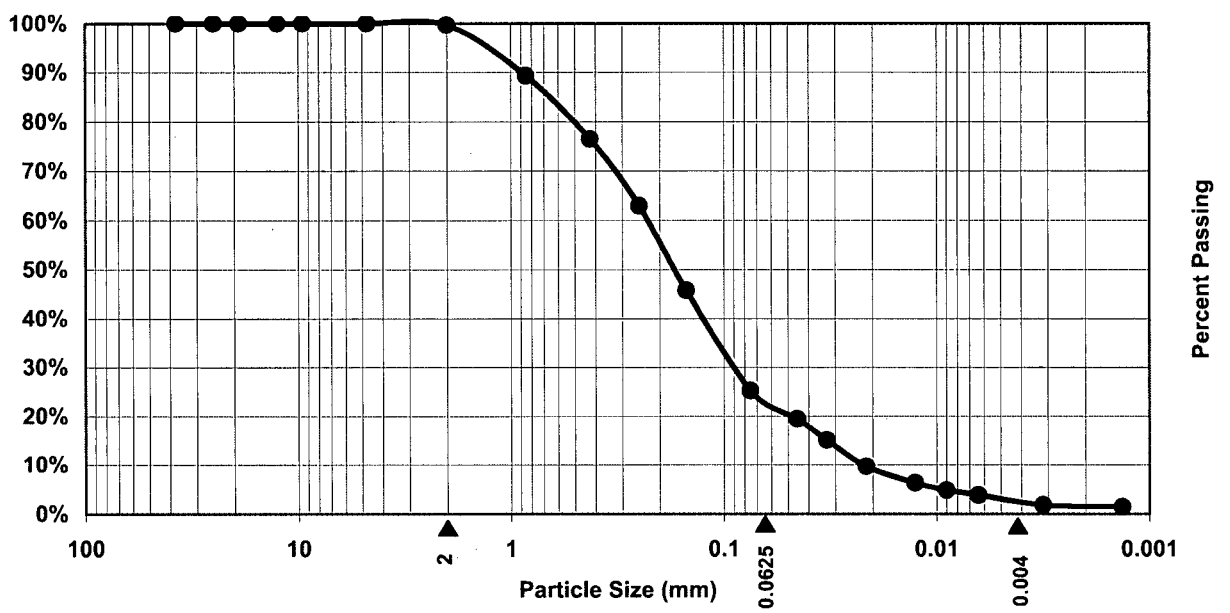
Estimated Porosity: 46%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-96R	SS-10	47.9 to 49.4 ft bls

Sample Description:
Black, White, and Orange, Silty, Fine to Medium Sand With Mica



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.3%	% Sand 76.3%	% Silt 20.9%	% Clay 2.4%
Adjusted for Calculations	**0%**	**77%**	**21%**	**2%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-96R

Boring Depth: 47.9 to 49.4 ft bls

% Sand: 77%

% Silt: 21%

% Clay: 2%

Estimated Specific Yield: 28%

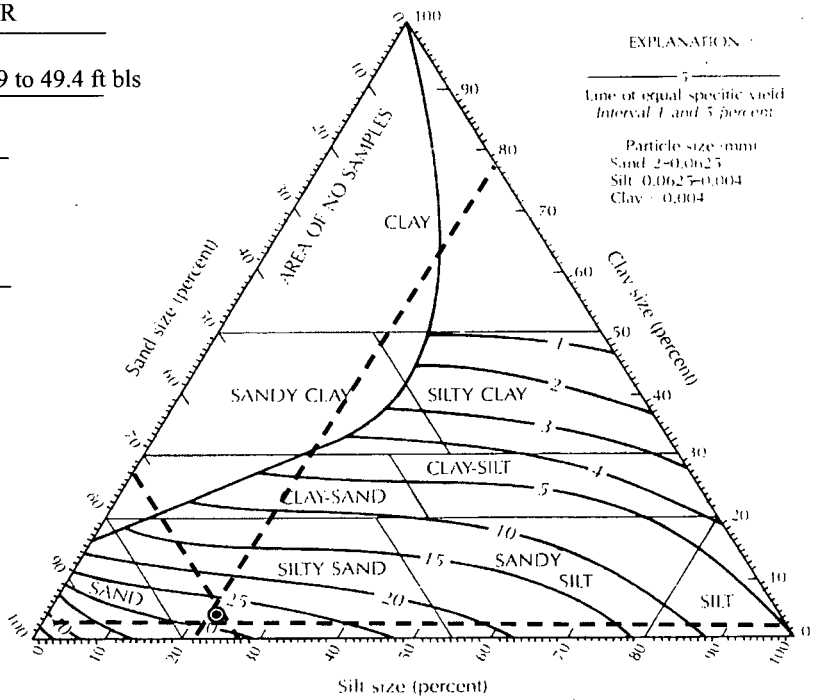
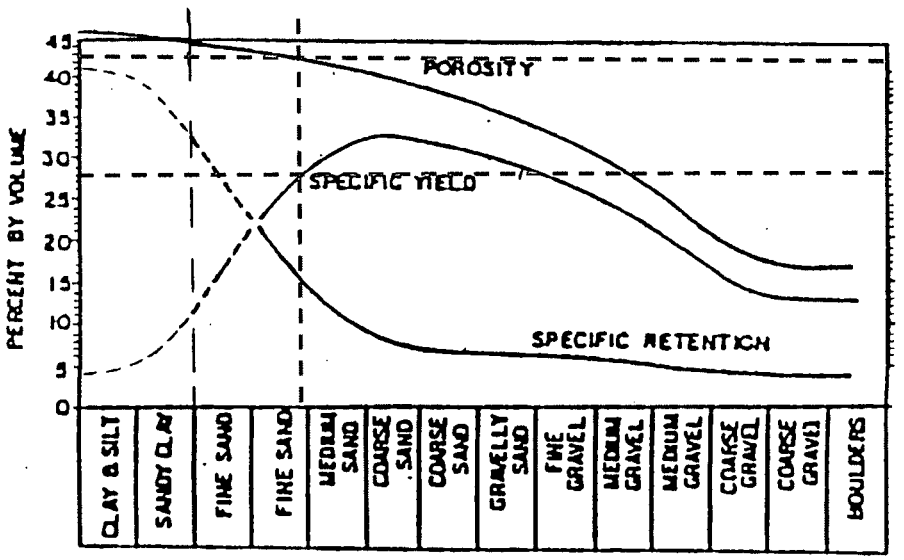


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 42.5%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

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ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

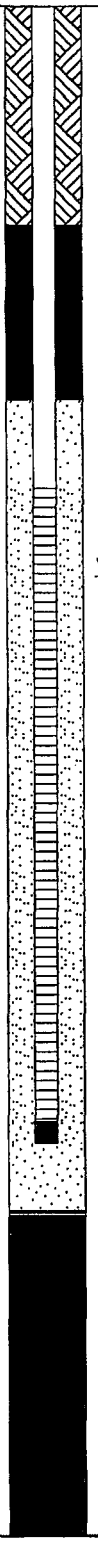
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

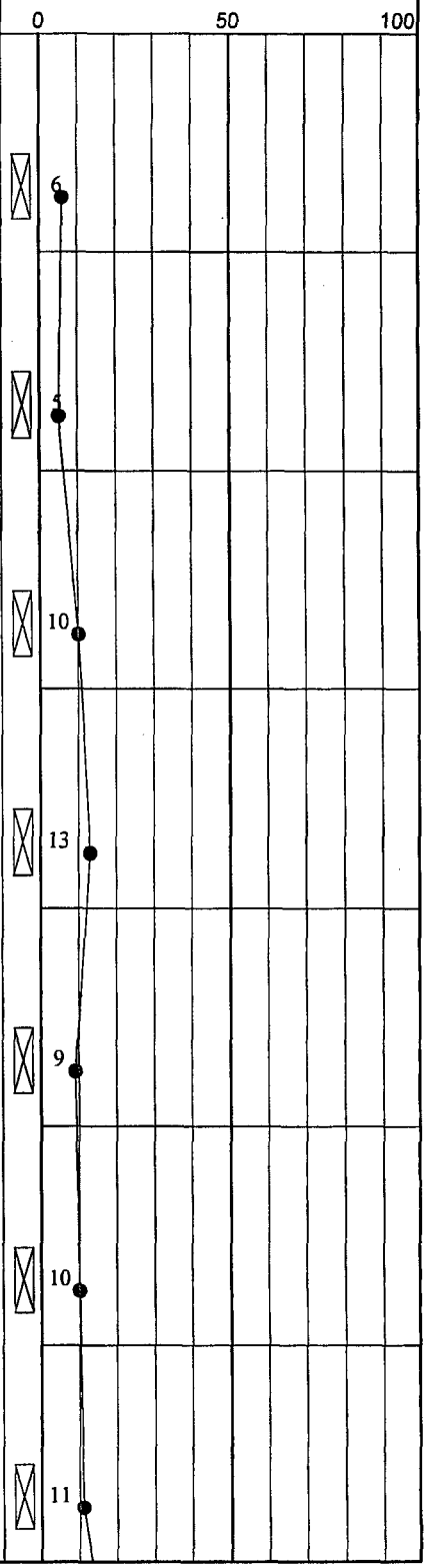
Project: **MNS - Groundwater Protection Project**			**Boring No. M-97**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 1 of 3
Boring Depth (ft): **99.4**	Elevation (ft): **747.8**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **5/8/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 13.04 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description
			ASPHALT
			GRAVEL
745			SOIL/SAPROLITE (M1): Reddish-Brown and White, Slightly Clayey, **SILT** With Manganese Staining
	5		
740			
	10		
735			
	15		SOIL/SAPROLITE (M1): Brown, Micaceous, **SILT** With Manganese Staining; White, Coarse to Fine Sandy, Silt Lense From 18.50 to 18.65 ft bls
730			
	20		
725			SOIL/SAPROLITE (M1): White, Tan, and Black, Silty, Medium to Fine **SAND** With Manganese Staining and Quartz Veins (Granitic)
	25		
720			
	30		SOIL/SAPROLITE (M1): White and Tan, Micaceous, Slightly Clayey, Silty, Medium to Fine **SAND** With Manganese Staining (Granitic)
715			

Well Construction



Penetration Resistance (Blows/Foot)



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Project: **MNS - Groundwater Protection Project**			**Boring No. M-97**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 2 of 3
Boring Depth (ft): **99.4**	Elevation (ft): **747.8**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **5/8/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 13.04 ft bls**		Drilling Method: **Mud Rotary**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
710	40				20
705	45		SOIL/SAPROLITE (M1): Reddish-Brown, White, and Black, Slightly Clayey, **SILT** With Manganese Staining; Gray, Slightly Clayey, Silt Lense From 43.65 to 44.65 ft bls		15
700	50		SOIL/SAPROLITE (M1): White, Brown, Reddish-Brown, and Black, Micaceous, Fine Sandy, **SILT** With Manganese Staining **Roller Cone Refusal at 51.90 ft bls**		43
695	55		SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**, Slightly Fractured		
			SOUND ROCK (D): Fine-Grained **DIORITE**, Slightly Fractured		
690	60		SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**, Slightly Fractured		
685	65				
680					

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Project: **MNS - Groundwater Protection Project**			**Boring No. M-97**
Location: **Huntersville, North Carolina**		Number: **1264-06-724**	Sheet No. 3 of 3
Boring Depth (ft): **99.4**	Elevation (ft): **747.8**	Driller: **Justin Millwood, NC Cert. No. 3439**	Date Drilled: **5/8/07**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 13.04 ft bls**		Drilling Method: **Mud Rotary**

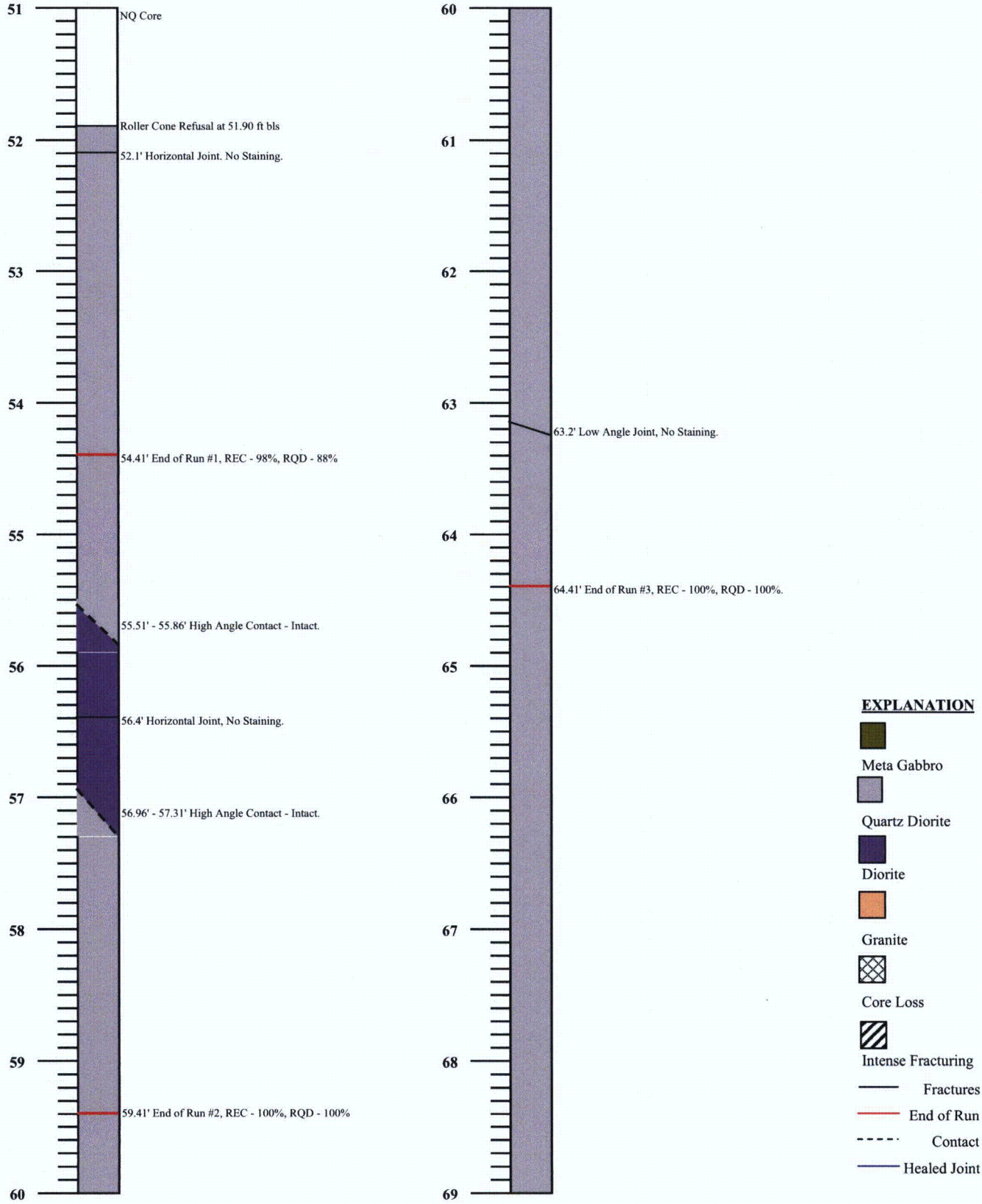
Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
675					
	75		SOUND ROCK (D): Fine-Grained, Quartz-Rich **GRANITE**, Unfractured		
670			SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**, Slightly Fractured		
	80				
665					
	85				
660					
	90				
655			SOUND ROCK (D): Fine-Grained **DIORITE**, Unfractured		
	95		SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE** With Intermittent Blobs of Fine-Grained Diorite, Slightly Fractured		
650					
			Boring Terminated at 99.41 ft bls		

FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-97

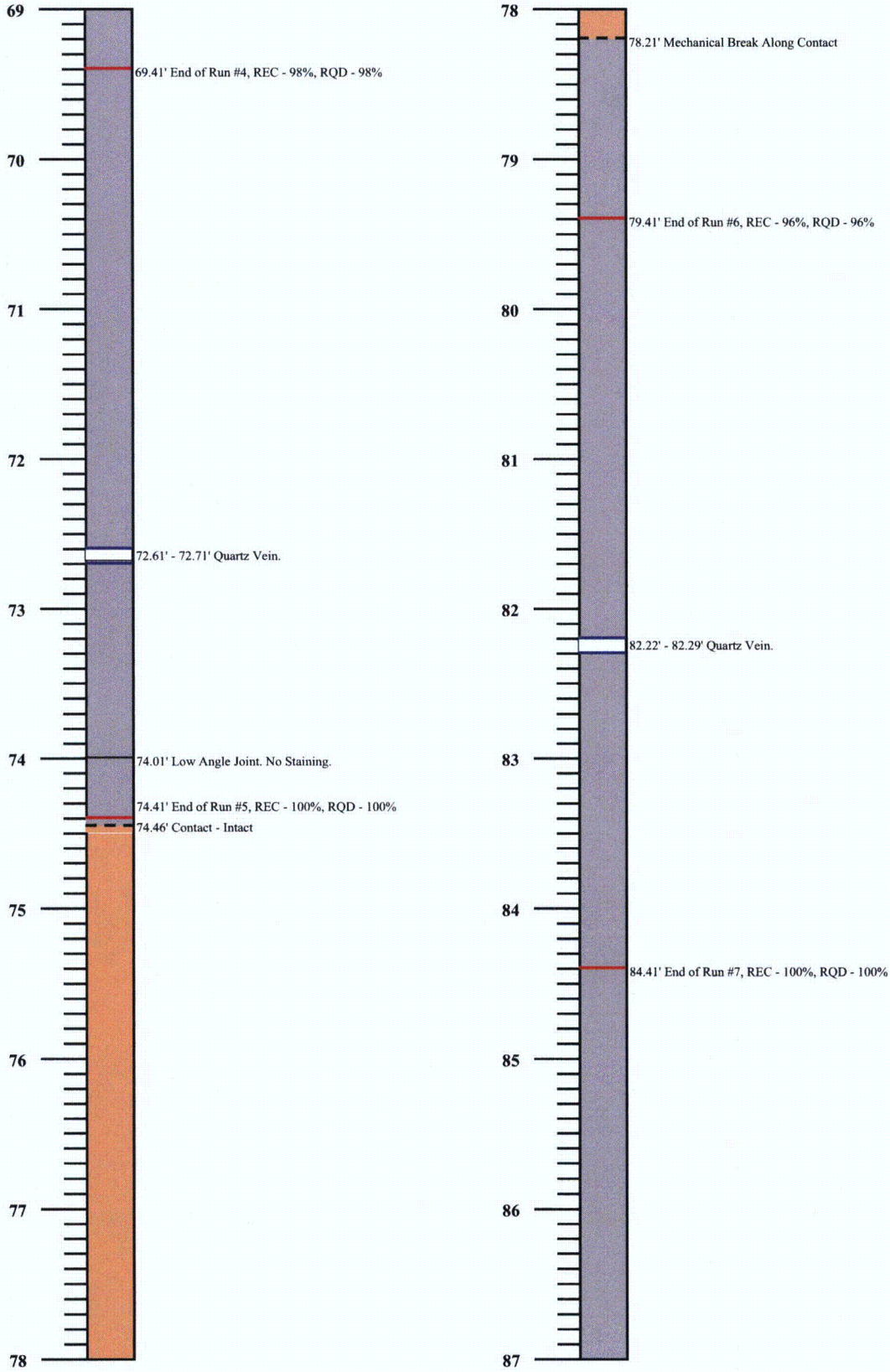


FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-97



EXPLANATION

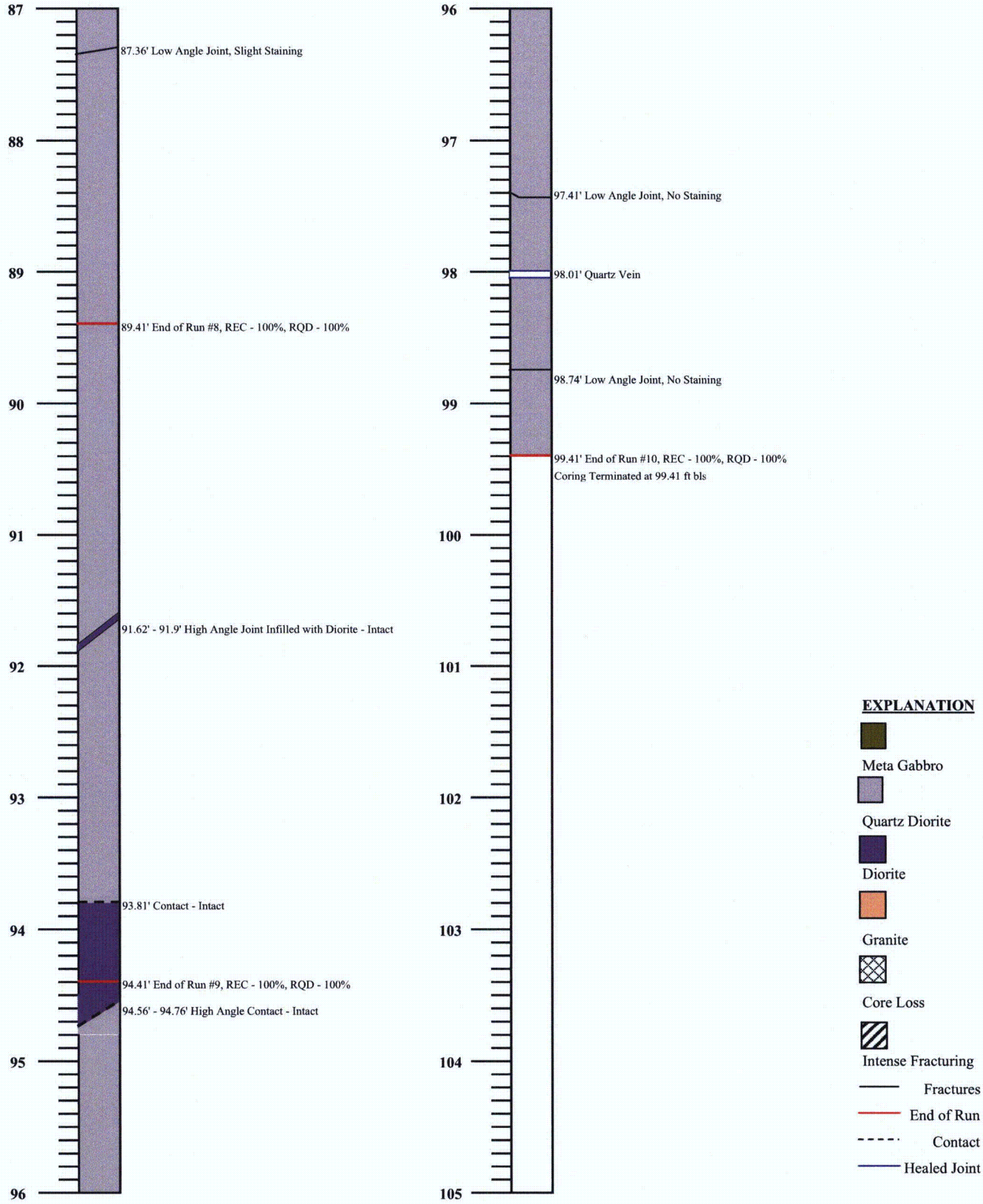
- Meta Gabbro
- Quartz Diorite
- Diorite
- Granite
- Core Loss
- Intense Fracturing
- Fractures
- End of Run
- Contact
- Healed Joint

FIELD ROCK CORE LOG

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-97



COMPLETION REPORT OF WELL No. M-97

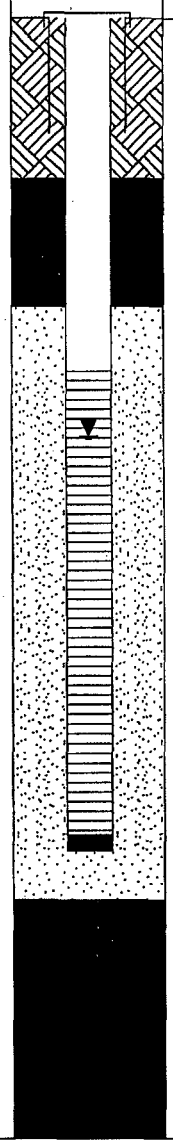
PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

WATER LEVEL: **Stabilized Water Level at 13.04 ft bls**

LATITUDE: **35 25 52.14**
LONGITUDE: **80 56 50.46**
TOP OF CASING ELEVATION: **747.44**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **Mud Rotary**
DATE DRILLED: **5/8/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
		0		0.00		747.78
ASPHALT						
GRAVEL						
SOIL/SAPROLITE (M1): Reddish-Brown and White, Slightly Clayey, **SILT** With Manganese Staining		5		5.00		742.78
				9.00		738.78
		10				
SOIL/SAPROLITE (M1): Brown, Micaceous, **SILT** With Manganese Staining; White, Coarse to Fine *Sandy, Silt Lense* From 18.50 to 18.65 ft bls		15				
		20				
SOIL/SAPROLITE (M1): White, Tan, and Black, Silty, Medium to Fine **SAND** With Manganese Staining and Quartz Veins (Granitic)		25		25.50		722.28
				26.00		721.78
				27.50		720.28
SOIL/SAPROLITE (M1): White and Tan, Micaceous, Slightly Clayey, Silty, Medium to Fine **SAND** With *Manganese Staining* (Granitic)		30				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **8"**
Type: **Steel Flush Mount**
Interval: **At Grade**

RISER CASING
Diameter: **2"**
Type: **Sch. 40 PVC**
Interval: **0 to 11 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 5 ft bls**

SEAL
Type: **Bentonite**
Interval: **5 to 9 ft bls**

FILTERPACK
Type: **#1 Filter Sand**
Interval: **9 to 27.5 ft bls**

SCREEN
Diameter: **2"**
Type: **0.010 Slotted Sch. 40 PVC**
Interval: **11 to 26 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-97

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION:
LOGGED BY: **747.8**
CHECKED BY: **Courtney Wither**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOIL/SAPROLITE (M1): White and Tan, Micaceous, Slightly Clayey, Silty, Medium to Fine **SAND** With Manganese Staining (Granitic) *(continued)*		35, 40					
SOIL/SAPROLITE (M1): Reddish-Brown, White, and Black, Slightly Clayey, **SILT** With Manganese Staining; Gray, Slightly Clayey, Silt Lense From 43.65 to 44.65 ft bls		45					
SOIL/SAPROLITE (M1): White, Brown, Reddish-Brown, and Black, Micaceous, Fine Sandy, **SILT** With Manganese Staining		50					
SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**, Slightly Fractured		55					
SOUND ROCK (D): Fine-Grained **DIORITE**, Slightly Fractured		60					
SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**, Slightly Fractured		65, 70					
SOUND ROCK (D): Fine-Grained, Quartz-Rich **GRANITE**, *Unfractured*		75					

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-97

PROJECT: **MNS - Groundwater Protection Project**
PROJECT NO: **1264-06-724**
PROJECT LOCATION: **Huntersville, North Carolina**

GROUND SURFACE ELEVATION:
LOGGED BY: **747.8**
CHECKED BY: **Courtney Withe**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE**, Slightly Fractured *(continued)*		80					
		85					
		90					
SOUND ROCK (D): Fine-Grained **DIORITE**, Unfractured		95					
SOUND ROCK (D): Medium-Grained **QUARTZ DIORITE** With Intermittent Blobs of Fine-Grained Diorite, Slightly Fractured				99.41		648.37	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MNSLOG.GPJ S&ME.GDT 3/26/08

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COMPLETION REPORT OF WELL No. M-97

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

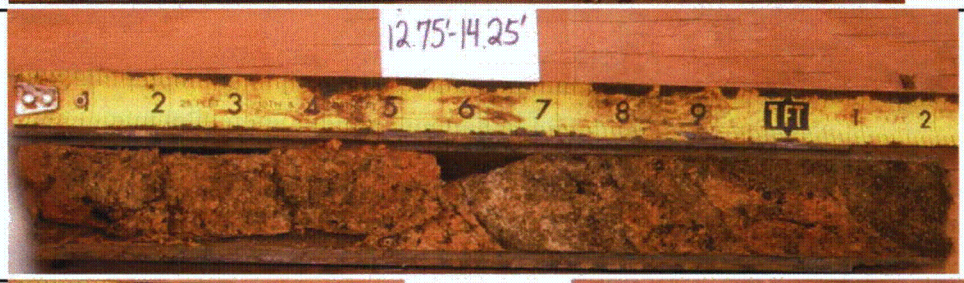
S&ME Project No: 1264-06-724

Boring Number: M-97

Sample No: 1
Depth (ft-bls): 2.75 - 4.25
Blow Count: 1 * 2 * 4

Sample No: 2
Depth (ft-bls): 7.75 - 9.25
Blow Count: 1 * 2 * 3

Sample No: 3
Depth (ft-bls): 12.75 - 14.25
Blow Count: 3 * 3 * 7



Sample No: 4
Depth (ft-bls): 17.75 - 19.25
Blow Count: 4 * 5 * 8

Sample No: 5
Depth (ft-bls): 22.75 - 24.25
Blow Count: 3 * 3 * 6

Sample No: 6
Depth (ft-bls): 27.75 - 29.25
Blow Count: 2 * 4 * 6

SPLIT SPOON SAMPLE PICTURES

McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Boring Number: M-97

Sample No: 7
Depth (ft-bls): 32.75 - 34.25
Blow Count: 3 * 4 * 7

Sample No: 8
Depth (ft-bls): 37.75 - 39.25
Blow Count: 6 * 7 * 13

Sample No: 9
Depth (ft-bls): 42.75 - 49.25
Blow Count: 3 * 5 * 10

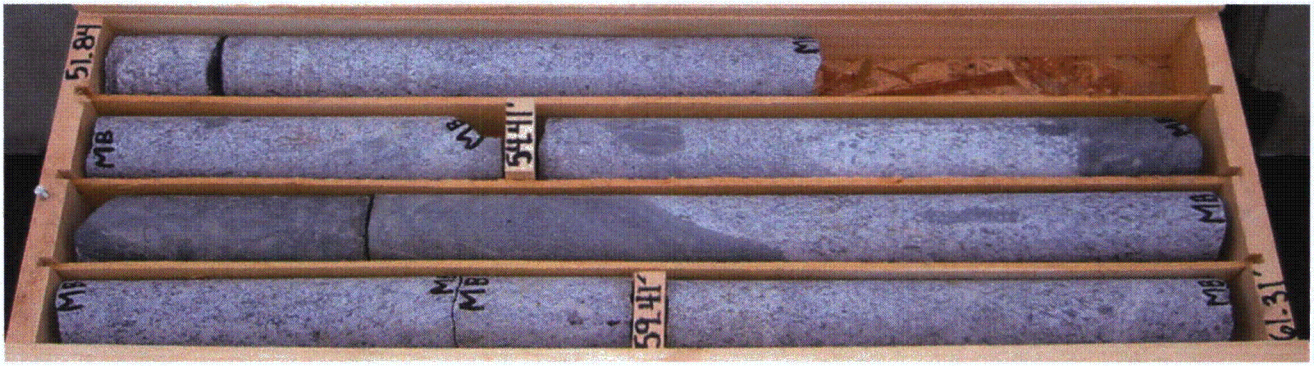
Sample No: 10
Depth (ft-bls): 47.75 - 49.25
Blow Count: 5 * 11 * 32

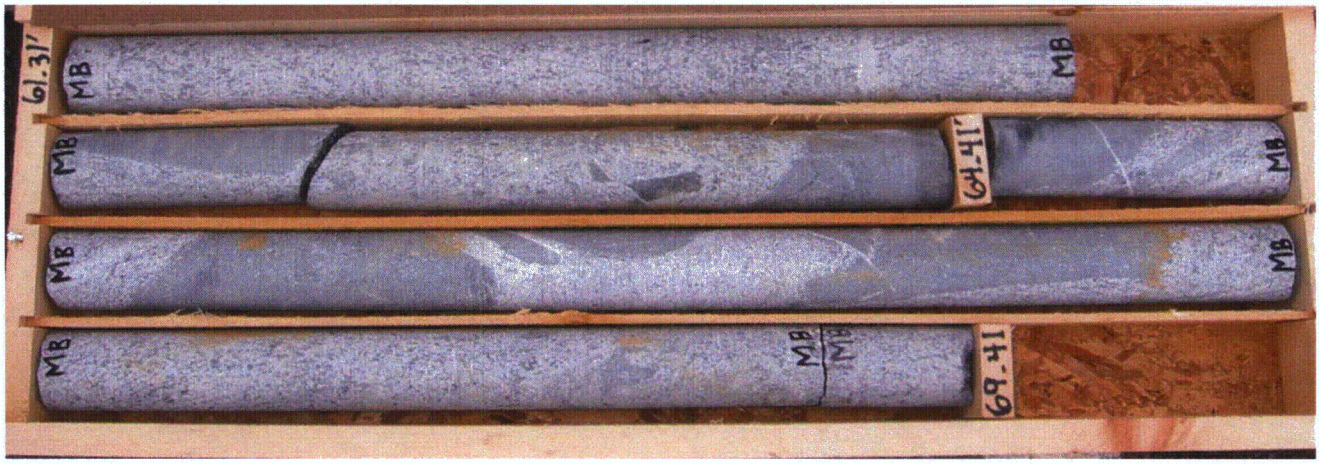
ROCK CORE PICTURES

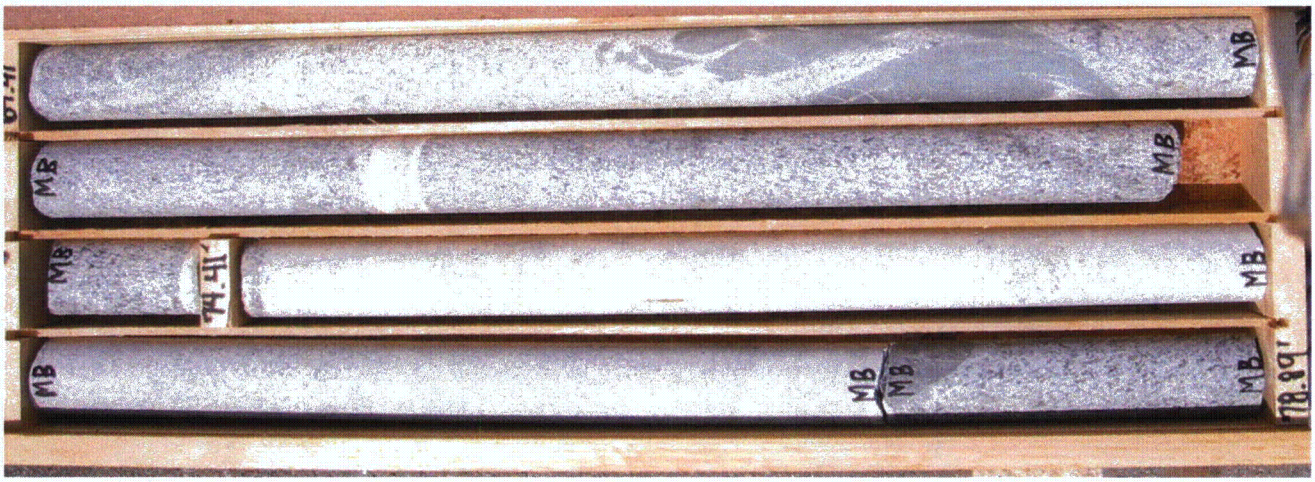
McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-97





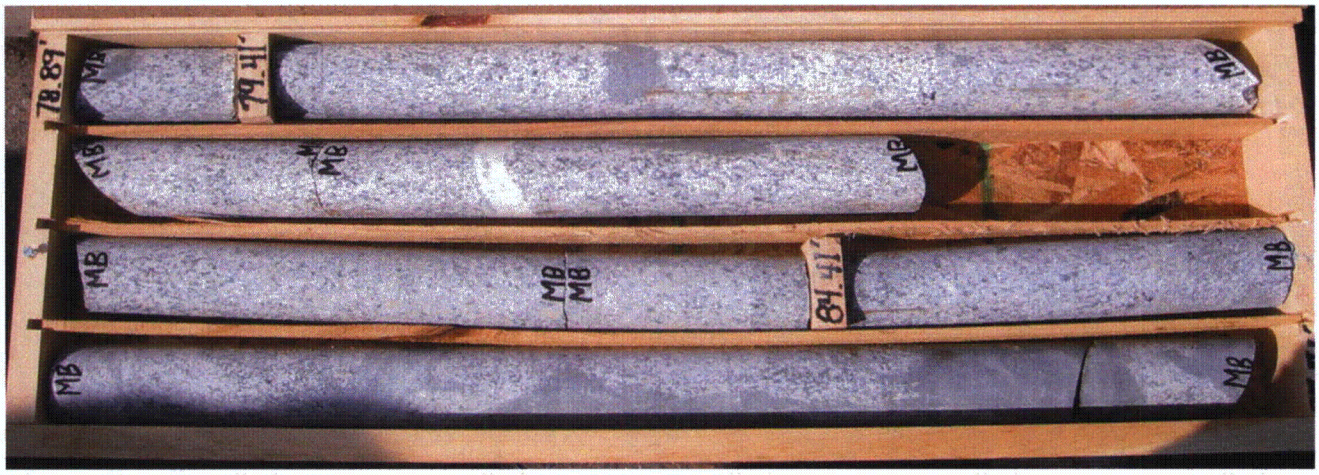


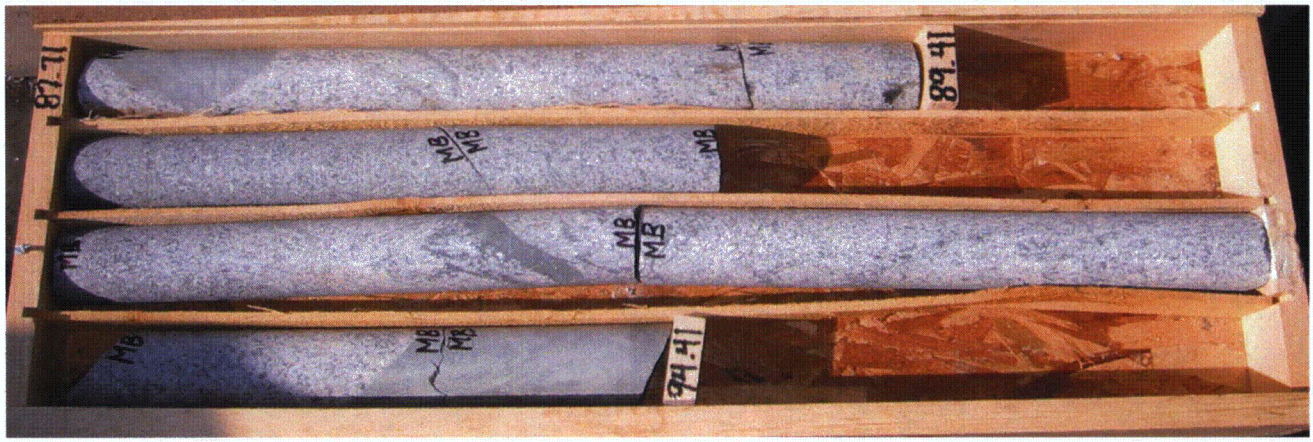
ROCK CORE PICTURES

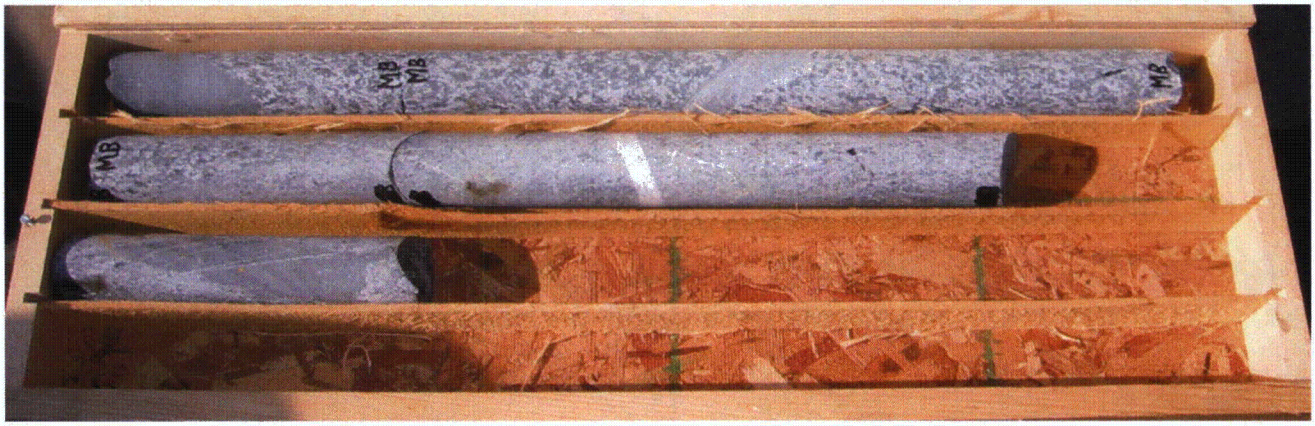
McGuire Nuclear Station - Groundwater Protection Project

S&ME Project No: 1264-06-724

Core Location: M-97







CLASSIFICATION:

51.9' to 55.65' Medium Grained Quartz Diorite

55.65' to 57.2' Fine Grained Diorite

57.2' to 74.46' Medium Grained Quartz Diorite

74.46' to 78.21' Fine Grained Granite

78.21' to 93.81' Medium Grained Quartz Diorite

93.81' to 94.76' Fine Grained Diorite

94.76' to 99.41' Medium Grained Quartz Diorite

CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

S&ME

Site Name:	MNS - GWPP		
Date:	5/8/2007		
Boring I.D.	M-97	(Soil/Saprolite)	
Test Interval:	28 to 31		
Total Depth of Hole:	31 ft		945.12 cm
Length of Open Hole:	3 ft		91.46 cm
Transformation Ratio m=	1		
Performed by:	Julie Petersen		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	979.05	
60	974.82	1.82E-05
120	968.20	2.86E-05
180	961.80	2.79E-05
240	955.49	2.77E-05
300	949.36	2.70E-05
360	943.35	2.67E-05
420	937.47	2.63E-05
480	931.65	2.62E-05
540	926.01	2.55E-05
600	920.46	2.53E-05
900	893.99	2.45E-05
1200	869.66	2.32E-05
1500	847.13	2.21E-05
1800	826.37	2.09E-05
2400	789.21	1.93E-05
3000	757.07	1.75E-05
3600	728.81	1.60E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} > 4$

Where:

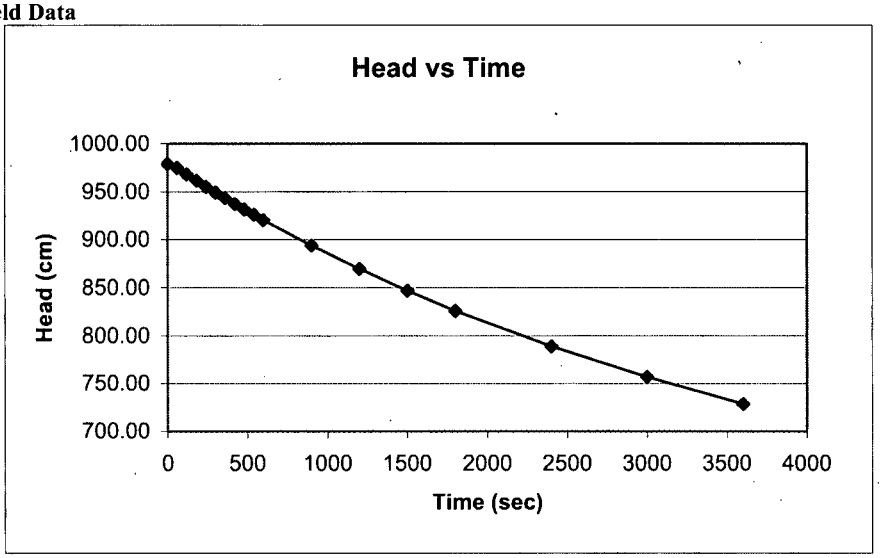
K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where
	$m = \sqrt{K_h / K_v}$ — K_h is the Horizontal Permeability; K_v is the Vertical Permeability
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec)

2.37E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

S&ME

Site Name:	MNS - GWPP		
Date:	5/9/2007		
Boring I.D.	M-97	(Sound Rock)	
Test Interval:	51.84 to 59.41		
Total Depth of Hole:	59.41 ft		1811.28 cm
Length of Open Hole:	7.57 ft		230.79 cm
Transformation Ratio m=	1		
Performed by:	Julie Petersen		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1860.15	
60	1825.58	4.04E-05
120	1793.93	3.76E-05
180	1764.91	3.51E-05
240	1738.35	3.26E-05
300	1713.90	3.05E-05
360	1691.34	2.85E-05
420	1670.52	2.66E-05
480	1651.10	2.52E-05
540	1633.26	2.34E-05
600	1616.89	2.17E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} > 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

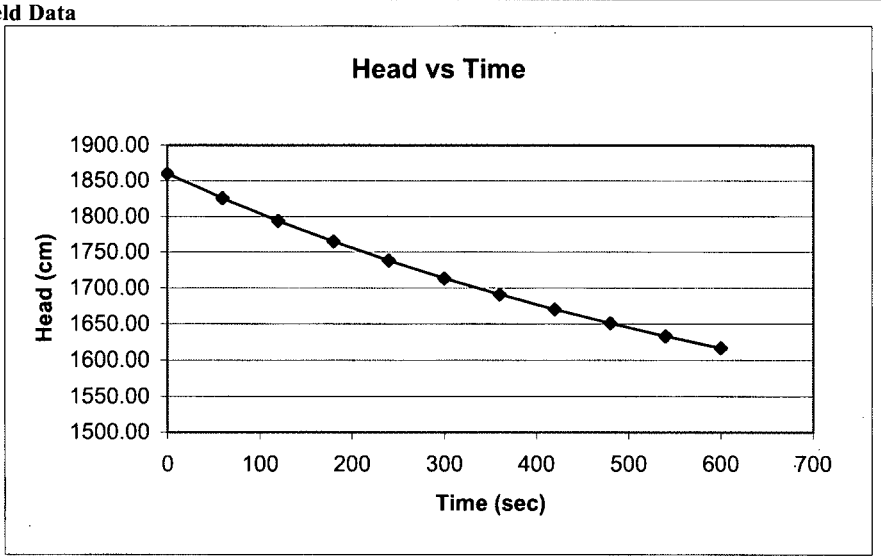
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec)

3.01E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

S&ME

Site Name:	MNS - GWPP	
Date:	5/9/2007	
Boring I.D.	M-97	(Sound Rock)
Test Interval:	51.84 to 64.41	
Total Depth of Hole:	64.41 ft	1963.72 cm
Length of Open Hole:	12.57 ft	383.23 cm
Transformation Ratio m=	1	
Performed by:	Julie Petersen	

Time (sec)	Head (cm)	Permeability (cm/sec)
0	2017.32	
60	1986.16	2.27E-05
120	1956.59	2.18E-05
180	1929.24	2.05E-05
240	1904.21	1.90E-05
300	1881.13	1.77E-05
360	1859.79	1.66E-05
420	1840.15	1.54E-05
480	1821.92	1.45E-05
540	1805.00	1.36E-05
600	1789.24	1.28E-05
900	1724.70	1.07E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} > 4$

Where:

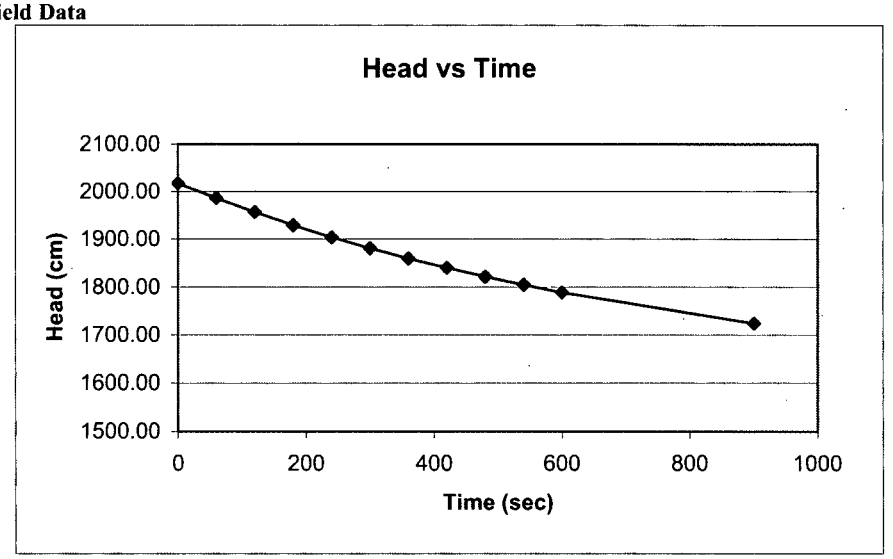
K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where $m = \sqrt{K_h / K_v}$ — K_h is the Horizontal Permeability; K_v is the Vertical Permeability
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; NQ Hole, OD = 3"

MEAN PERMEABILITY (cm/sec)

1.68E-05

Graph of Field Data

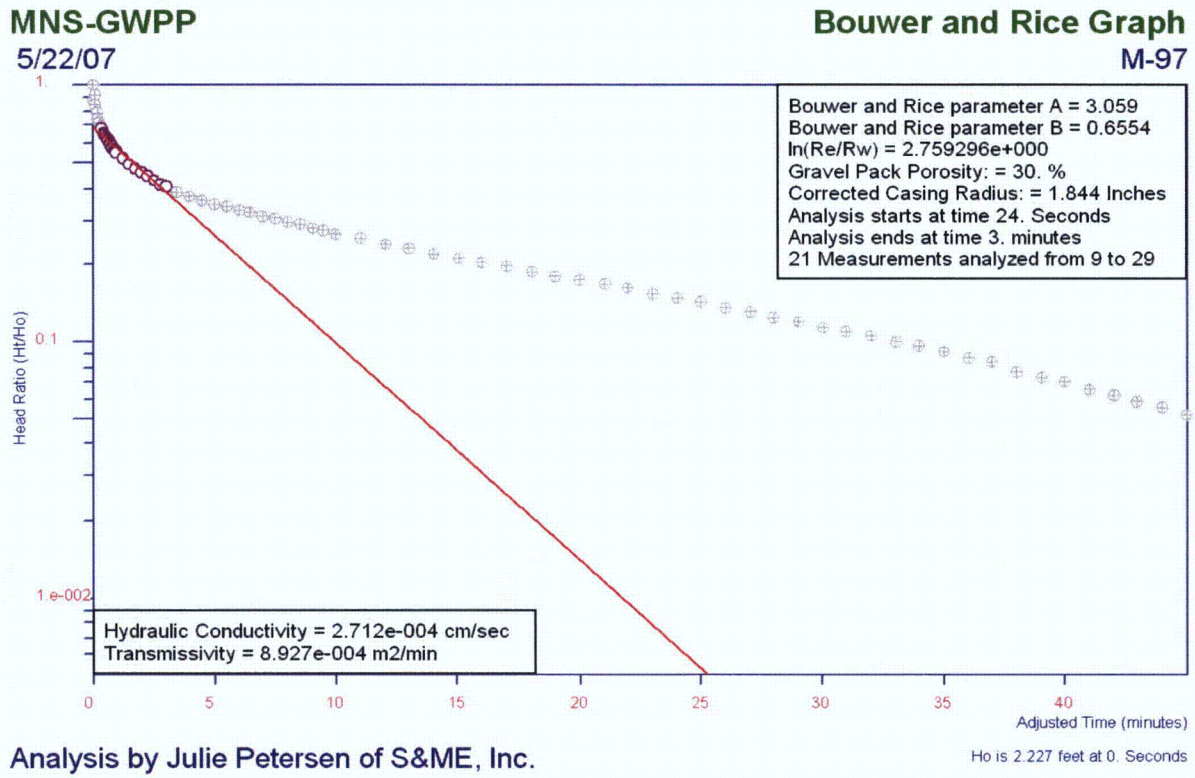


Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MNS-GWPP
Test Date:	5/22/2007
Well Label:	M-97
Aquifer Thickness:	18. feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	13.04 feet
Water Table to Screen Bottom:	12.96 feet
Anisotropy Ratio:	1

Time Adjustment: 0. Seconds
Test starts with trial 0
There are 78 time and drawdown measurements
Maximum head is 2.227 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



Analysis by Julie Petersen of S&ME, Inc.

Ho is 2.227 feet at 0. Seconds

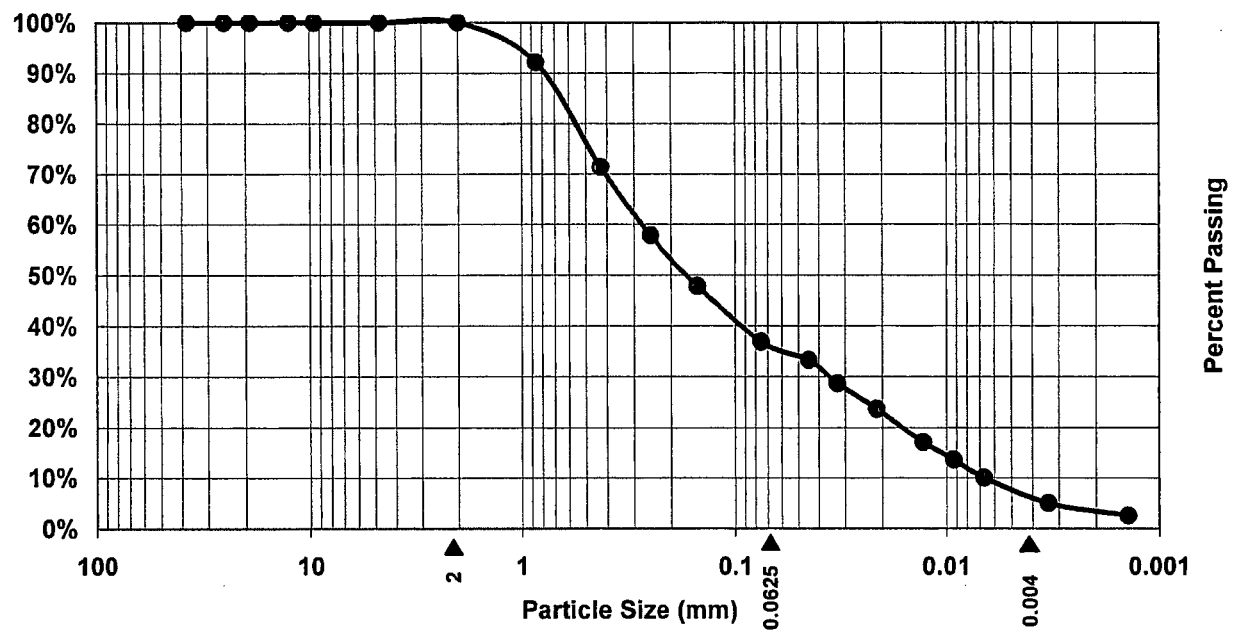
PERMEABILITY

2.71E-04 cm/sec

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-97	SS-6	27.75 to 29.25 ft bls

Sample Description:
White, Tan, and Black, Silty, Fine to Medium Sand



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 64.4%	% Silt 29.6%	% Clay 6.0%
Adjusted for Calculations	**0%**	**64%**	**30%**	**6%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
McGuire Nuclear Station - GWPP

S&ME Project No.:
1264-06-724

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: McGuire Nuclear Station - GWPP
S&ME PROJECT NO.: 1264-06-724

Boring No. M-97

Boring Depth: 27.75 to 29.25 ft bls

% Sand: 64%

% Silt: 30%

% Clay: 6%

Estimated Specific Yield: 22.5%

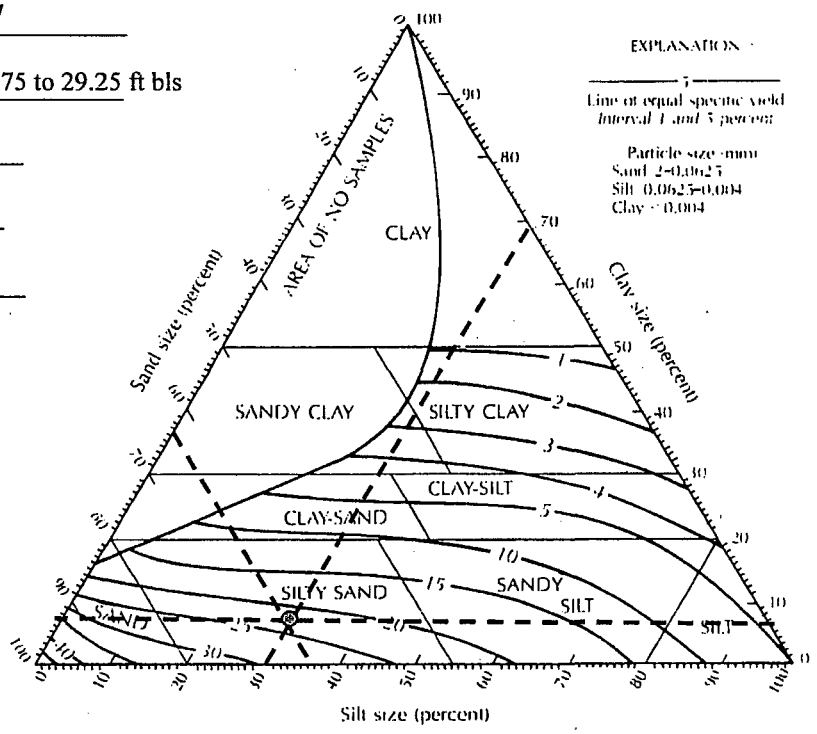
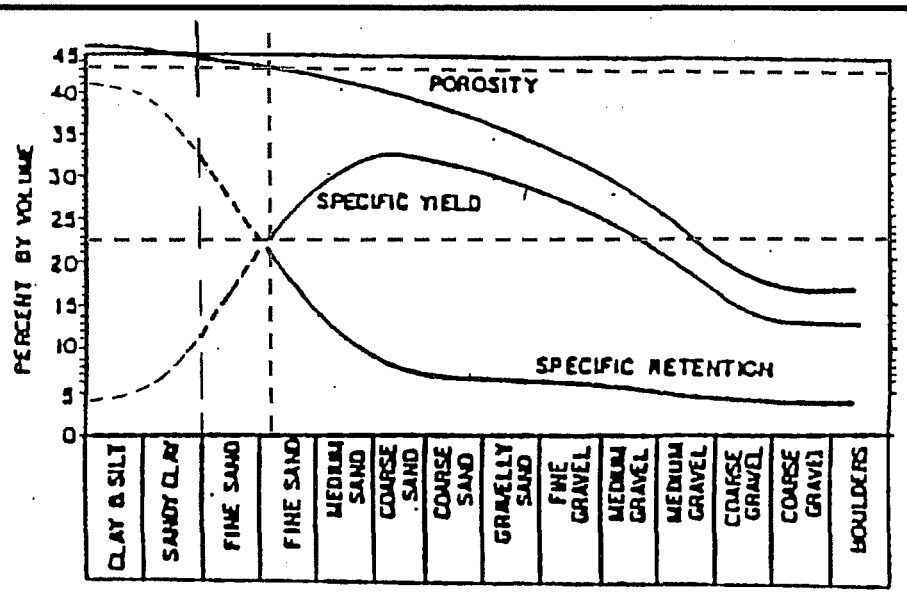


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 43%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)