



**S.W. COLE**  
ENGINEERING, INC.

• Geotechnical Engineering • Field & Lab Testing • Scientific & Environmental Consulting

03-0804

February 14, 2006

Maine Mountain Power, LLC  
Attention: Jason Huckaby  
57 Ryder Road  
Yarmouth, Maine 04096

Subject: Geotechnical Engineering Services  
Proposed Redington Mountain Wind Farm Project  
Carrabasset Valley, Maine

Dear Mr. Huckaby:

In accordance with our Agreement dated September 22, 2006, we have made a subsurface investigation at three of the wind tower sites as part of the Redington Mountain Wind Farm Project in Carrabasset Valley, Maine. The purpose of the investigation was to obtain subsurface information in order to provide recommendations relative to foundation design and earthwork associated with the proposed construction. This report contains findings and recommendations for tower location numbers 22, 26 and 29 only. The contents of this report are subject to the limitations set forth in Attachment A.

### **PROPOSED CONSTRUCTION**

We understand that the project includes construction of 30 wind towers. The towers will be 240 feet in height, un-stayed and designed for 100+ mph winds. The blades will be 120 feet in length. We understand that the tower foundations will be primarily one of two designs as follows: 1) gravity foundation typically 60 to 70 foot square, placed 10 feet below grade; or 2) 30 feet Patrick and Henderson, Inc. tensionless foundation. Selection of the foundation system will be based on confirmed subsurface conditions at each tower site.

### **EXPLORATION AND TESTING**

Three test borings were made at the tower sites during the period of October 23 through 28, 2005, by Maine Test Borings, Inc. of Brewer, Maine. The exploration locations were selected and established in the field by Maine Mountain Power, Inc. The approximate

locations of each exploration are noted on the exploration logs. Test boring and probe logs are attached as Sheets 1 through 4. Rock core logs are attached as Sheets 5 through 7. A key to the notes and symbols used on the logs is attached as Sheet 8.

Laboratory testing was performed on representative samples of the bedrock core recovered from the test borings. Unit weight and unconfined compressive strength results are noted on the attached test boring logs.

### **SUBSURFACE CONDITIONS**

Test borings B-1 through B-3 were made for proposed wind tower numbers 22, 26, and 29, respectively. The borings encountered 0.2 to 1.0 feet of forest duff/ topsoil overlying 1.8 to 2.2 feet of dense to very dense brown gravelly silty sand (glacial till). Test boring B-2 did not encounter the glacial till. Each of the test borings encountered weathered rock below the forest duff/ topsoil or glacial till. The weathered rock was generally 0.7 to 2.0 feet in thickness. The borings were advanced below the weathered rock utilizing a rock core barrel.

Bedrock samples were obtained from test boring B-1 from depths of 4.1 to 19.1 feet. The bedrock was classified as gray Mica Schist with Rock Quality Designator values (RQD's) of 82 to 95 percent. Bedrock samples were obtained from test boring B-2 from depths of 2.0 to 16.6 feet. The bedrock was classified as gray Mica Schist with RQD's of 76 to 95 percent. Bedrock samples were obtained from test boring B-3 from depths of 3.7 to 18.7 feet. The bedrock was classified as white Granite with RQD's of 70 to 94 percent.

Two test probes P-1 and P-2 were made along a portion of the access road. The test probes generally encountered a surficial layer of topsoil overlying glacial till. Test probes P-1 and P-2 were terminated at depths of 10 and 9 feet, respectively.

Groundwater was not observed in the test borings at the time of exploration work. Groundwater was observed in P-2 at a depth of 4.0 feet after removal of the solid stem

augers. Due to the short time period the borehole was left open, accurate groundwater levels could not be obtained. Long term groundwater information is not available.

**EVALUATION AND RECOMMENDATIONS**

The site of each wind tower is underlain by a surficial layer of forest duff/ topsoil, which overlies a thin (or absent) layer of dense to very dense glacial till and relatively shallow bedrock with RQD values generally 70 percent or greater.

Based on discussions during the meeting on November 17, 2005, we understand each tower will likely be constructed on a gravity foundation. Based on the subsurface findings and proposed construction, we anticipate that each tower will be founded on 6 inches of crushed stone placed on fractured bedrock. We recommend that all over-blasted bedrock be removed. We recommend that foundation design consider the following:

- Design Frost Depth for Carrabasset Valley, Maine      5.5 feet
- Net Allowable bearing pressure      10.0 ksf (fractured bedrock)
- Base friction factor      0.45 (mass concrete to fractured bedrock)
- Passive Soil Pressure Coefficient      3.0 (Structural Fill)

We recommend that foundation backfill soils within the frost zone consist of clean granular material meeting the gradation for Structural Fill as follows:

STRUCTURAL FILL	
Sieve Size	Percent Finer by Weight
4 inch	100
3 inch	90 to 100
1/4 inch	25 to 90
# 40	0 to 30
# 200	0 to 5

Fill should be placed in horizontal lifts and be compacted to at least 95 percent of its maximum dry density in accordance with ASTM D-1557.

We recommend that exterior peripheral underdrain systems be provided within the 6 inch crushed stone layer beneath the foundations. Rigid underdrain pipe, 4 inches in diameter, should be utilized. We recommend that at least 6 inches of  $\frac{3}{4}$  inch crushed stone bedding be provided around the underdrains and that the stone be wrapped with a geotextile filter fabric such as Mirafi 140N or equivalent. The underdrain pipe should have perforations of  $\frac{1}{4}$  to  $\frac{5}{8}$  inch. The underdrains must have positive gravity outlets. Exterior foundation backfill should be sealed with a surficial layer of clayey or loamy soil in order to reduce surface water infiltration into the backfill. General underdrain details are provided on Sheet 9. If positive gravity outlets are not feasible and the underdrains are not provided, then design will need to consider buoyant conditions and full hydrodynamic pressure on the foundation.

It is recommended that S. W. COLE ENGINEERING, INC. be retained to provide supplemental engineering and testing services during the excavation and foundation phases of the work. An S. W. COLE ENGINEERING, INC. representative should be on-site to observe subgrade conditions prior to concrete placement, as well as sampling and testing of concrete and soil.

These and other testing elements are to observe compliance with the design concepts, specifications, and design recommendations and to allow design changes in the event that subsurface conditions are found to differ from those anticipated prior to the start of construction.

## **CLOSURE**

We request that S.W. COLE ENGINEERING, INC. be provided the opportunity to review the final design and specifications to determine that our earthwork and foundation recommendations have been properly interpreted and implemented. We would be pleased to provide a scope of services for field and laboratory materials testing services.



03-0804  
February 14, 2006

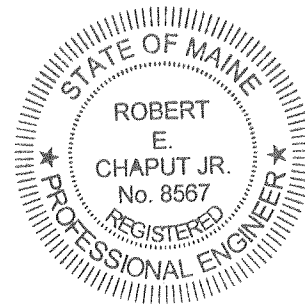
It has been a pleasure to be of assistance to you with this phase of your project. If you have any questions or if we may be of further assistance, please do not hesitate to contact us.

Very truly yours,

**S. W. COLE ENGINEERING, INC.**

A handwritten signature in cursive script that reads 'Robert E. Chaput, Jr.'.

Robert E. Chaput, Jr., P.E.  
Senior Geotechnical Engineer



REC:kml

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## ATTACHMENT A LIMITATIONS

This report has been prepared for the exclusive use of Maine Mountain Power, LLC for specific application to the Proposed Redington Mountain Wind Farm Project in Carrabasset, Maine. S. W. COLE ENGINEERING, INC. has endeavored to conduct the work in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

The soil profiles described in the report are intended to convey general trends in subsurface conditions. The boundaries between strata are approximate and are based upon interpretation of exploration data and samples.

The analyses performed during this investigation and recommendations presented in this report are based in part upon the data obtained from subsurface explorations made at the site. Variations in subsurface conditions may occur between explorations and may not become evident until construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and to review the recommendations of this report.

Observations have been made during exploration work to assess site groundwater levels. Fluctuations in water levels will occur due to variations in rainfall, temperature, and other factors.

Recommendations contained in this report are based substantially upon information provided by others regarding the proposed project. In the event that any changes are made in the design, nature, or location of the proposed project, S. W. COLE ENGINEERING, INC. should review such changes as they relate to analyses associated with this report. Recommendations contained in this report shall not be considered valid unless the changes are reviewed by S. W. COLE ENGINEERING, INC.



# BORING LOG

BORING NO.: **B-1**  
 SHEET: **1 OF 1**  
 PROJECT NO.: **03-0804**  
 DATE START: **10/25/2005**  
 DATE FINISH: **10/25/2005**  
 ELEVATION: **NOT AVAILABLE**  
 SWC REP.: **SLA**

PROJECT: **PROPOSED REDINGTON MOUNTAIN WIND PROJECT**  
 CLIENT: **MAINE MOUNTAIN POWER, LLC**  
 LOCATION: **CARRABASSETT VALLEY, MAINE**  
 DRILLING FIRM: **MAINE TEST BORINGS, INC.** DRILLER: **JERRY RUDNICKI**

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	NW	3"	300 LB	16"
SAMPLER:	SS	1 3/8"	140 LB	30"
CORE BARREL:	NQ2	2"		

**WATER LEVEL INFORMATION**  
 NO GROUNDWATER OBSERVED

CASING BLOWS PER FOOT	SAMPLE				SAMPLER BLOWS PER 6"				DEPTH	STRATA & TEST DATA
	NO.	PEN.	REC.	DEPTH @ BOT	0-6	6-12	12-18	18-24		
									0.2'	FOREST DUFF/ TOPSOIL
	1D	0.0'	0	2.0'	50				2.0'	BROWN GRAVELLY SILTY SAND (TILL) ~DENSE~
									4.0'	WEATHERED BEDROCK
										GRAY MICA SCHIST
	1R	5.0'	4.6'	9.1'						RQD 82%
										qu = 863 ksf
										γ <sub>Dry</sub> = 177.0 pcf
	2R	5.0'	5.0'	14.1'						RQD 95%
	3R	5.0'	5.0'	19.1'					19.1'	qu = 735 ksf
										γ <sub>Dry</sub> = 174.0 pcf
										RQD 85%
										BOTTOM OF EXPLORATION AT 19.1'

SAMPLES: D = SPLIT SPOON  
 C = 3" SHELBY TUBE  
 U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

<input checked="" type="checkbox"/>	DRILLER - VISUALLY
<input checked="" type="checkbox"/>	SOIL TECH. - VISUALLY
<input type="checkbox"/>	LABORATORY TEST

REMARKS: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

LOCATION: LATITUDE 45.02086926  
 LONGITUDE 70.47426587

1

BORING NO.: **B-1**



# BORING LOG

BORING NO.: **B-2**  
 SHEET: **1 OF 1**  
 PROJECT NO.: **03-0804**  
 DATE START: **10/25/2005**  
 DATE FINISH: **10/25/2005**  
 ELEVATION: **NOT AVAILABLE**  
 SWC REP.: **SLA**

PROJECT: **PROPOSED REDINGTON MOUNTAIN WIND PROJECT**  
 CLIENT: **MAINE MOUNTAIN POWER, LLC**  
 LOCATION: **CARRABASSETT VALLEY, MAINE**  
 DRILLING FIRM: **MAINE TEST BORINGS, INC.** DRILLER: **JERRY RUDNICKI**  
 TYPE: \_\_\_\_\_ SIZE I.D.: \_\_\_\_\_ HAMMER WT.: \_\_\_\_\_ HAMMER FALL: \_\_\_\_\_  
 CASING: **NW** **3"** **300 LB** **16"**  
 SAMPLER: \_\_\_\_\_  
 CORE BARREL: **NQ2** **2"**

**WATER LEVEL INFORMATION**  
**NO GROUNDWATER OBSERVED**

CASING BLOWS PER FOOT	SAMPLE				SAMPLER BLOWS PER 6"				DEPTH	STRATA & TEST DATA
	NO.	PEN.	REC.	DEPTH @ BOT	0-6	6-12	12-18	18-24		
									0.2'	FORST DUFF/TOPSOIL
									2.0'	WEATHERED BEDROCK
										GRAY MICA SCHIST qu = 601 ksf γ <sub>Dry</sub> = 176.0 pcf
	1R	5.0'	5.0'	7.0'						RQD 76%
	2R	5.0'	5.0'	12.0'						RQD 95%
										qu = 788 ksf γ <sub>Dry</sub> = 176.0 pcf
	3R	4.6'	4.6'	16.6'					16.6'	RQD 95%
										BOTTOM OF EXPLORATION AT 16.6'

SAMPLES: \_\_\_\_\_ SOIL CLASSIFIED BY: \_\_\_\_\_  
 D = SPLIT SPOON  DRILLER - VISUALLY  
 C = 3" SHELBY TUBE  SOIL TECH. - VISUALLY  
 U = 3.5" SHELBY TUBE  LABORATORY TEST

REMARKS: LOCATION: LATITUDE 45.01778003  
 LONGITUDE 70.47249997  
 STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

2

BORING NO.: **B-2**





# BORING LOG

BORING NO.: **B-3**  
 SHEET: 1 OF 1  
 PROJECT NO.: 03-0804  
 DATE START: 10/28/2005  
 DATE FINISH: 10/28/2005  
 ELEVATION: NOT AVAILABLE  
 SWC REP.: SLA

PROJECT: PROPOSED REDINGTON MOUNTAIN WIND PROJECT  
 CLIENT: MAINE MOUNTAIN POWER, LLC  
 LOCATION: CARRABASSETT VALLEY, MAINE  
 DRILLING FIRM: MAINE TEST BORINGS, INC. DRILLER: JERRY RUDNICKI

	TYPE	SIZE I.D.	HAMMER WT.	HAMMER FALL
CASING:	NW	3"	300 LB	16"
SAMPLER:	SS	1 3/8"	140 LB	30"
CORE BARREL:	NQ2	2"		

**WATER LEVEL INFORMATION**  
 NO GROUNDWATER OBSERVED

CASING BLOWS PER FOOT	SAMPLE				SAMPLER BLOWS PER 6"				DEPTH	STRATA & TEST DATA
	NO.	PEN.	REC.	DEPTH @ BOT	0-6	6-12	12-18	18-24		
									1.0'	TOPSOIL / FOREST DUFF
	1D	1.0'	1.0'	3.0'	21	43			3.0'	BROWN GRAVELLY SILTY SAND (TILL) ~VERY DENSE~
									3.7'	WEATHERED BEDROCK
										qu = 1760 ksf γ <sub>dry</sub> = 165.0 pcf
	1R	5.0'	5.0'	8.7'						WHITE GRANITE RQD 70%
	2R	5.0'	5.0'	13.7'						RQD 72%
										qu = 1587 ksf γ <sub>dry</sub> = 165.0 pcf
	3R	5.0'	5.0'	18.7'					18.7'	RQD 94%
										BOTTOM OF EXPLORATION AT 18.7'

SAMPLES: D = SPLIT SPOON  
 C = 3" SHELBY TUBE  
 U = 3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

<input checked="" type="checkbox"/>	DRILLER - VISUALLY
<input checked="" type="checkbox"/>	SOIL TECH. - VISUALLY
<input type="checkbox"/>	LABORATORY TEST

REMARKS: LOCATION: LATITUDE 45.02272  
 LONGITUDE 70.45030

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

PROJECT/CLIENT PROPOSED REDINGTON MOUNTAIN WIND PROJECT/ MAINE MOUNTAIN POWER, LLC      PROJECT NO. 03-0804  
 LOCATION: CARRABASSETT VALLEY, MAINE      AUGER PROBE SIZE O.D. 4"  
 DRILLING FIRM: MAINE TEST BORING, INC.      DRILLER: JERRY RUDNIKKI

BORING NO.	<u>P-1</u>
LOCATION	<u>45.02292</u>
	<u>70.45139</u>
GROUND ELEV.	<u>NOT AVAILABLE</u>
DATE	<u>10-28-05</u>
DEPTH	STRATUM DESCRIPTION
0.8'	TOPSOIL
10.0'	BROWN GRAVELLY SILTY SAND, SOME COBBLES(TILL)
10.0'	BOTTOM OF EXPLORATION AT 10.0'
8.0'	CAVED AND DRY @ 8.0'

BORING NO.	<u>P-2</u>
LOCATION	<u>45.02265</u>
	<u>70.45475</u>
GROUND ELEV.	<u>NOT AVAILABLE</u>
DATE	<u>10-27-05</u>
DEPTH	STRATUM DESCRIPTION
0.5'	TOPSOIL
6.5'	BROWN GRAVELLY SILTY SAND (TILL)
9.0'	BROWN GRAVELLY SILTY SAND, WITH SOME COBBLES (TILL)
9.0'	BOTTOM OF EXPLORATION AT 9.0'
7.0'	CAVED AT 7.0', WATER AT 4.0'

SOIL CLASSIFIED BY: \_\_\_\_\_ SLA

- DRILLER - VISUALLY
- SOIL TECHNICIAN - VISUALLY
- LABORATORY TESTS

PROJECT NAME / LOCATION: REDINGTON MOUNTAIN WIND FARM PROJECT / CARRABASSET, MAINE

CLIENT: MAINE MOUNTAIN POWER, LLC

LOGGED BY JWM

DATE 11/3/2005

CHECKED BY \_\_\_\_\_

DATE \_\_\_\_\_

CORE SIZE 2"

DEPTH BELOW SURFACE (ft)	CORE RUN	CORE INTERVAL (ft)	CORE RECOVERY (ft)	RQD%	ROCK QUALITY	GRAPHIC LOG	ROCK DESCRIPTION AND IDENTIFICATION
4.1'							WEATHERED BEDROCK ABOVE 4.1'
5.0'							
6.0'							
7.0'	R-1	5.0	4.6	82%	GOOD	20°	GRAY MICA SCHIST
8.0'						35°	WEATHERING IS SLIGHT AND JOINTS ARE CLOSE (2" TO 12") TO MODERATELY CLOSE (12" TO 36")
9.1'						20°	
10.0'						70°	
11.0'							
12.0'	R-2	5.0	5.0	95%	EXCELLENT	20°	
13.0'						45°	
14.1'						60°	
15.0'						20°	
16.0'						85°	
17.0'	R-3	5.0	5.0	85%	GOOD	85°	
18.0'						20°	
19.1'						25°	
20.0'						10°	
							BOTTOM OF EXPLORATION AT 19.1'

PROJECT NAME / LOCATION: REDINGTON MOUNTAIN WIND FARM PROJECT / CARRABASSET, MAINE

 CLIENT: ENDLESS ENERGY CORP.

 LOGGED BY JWM

 DATE 11/3/2005

CHECKED BY \_\_\_\_\_

DATE \_\_\_\_\_

 CORE SIZE 2"

DEPTH BELOW SURFACE (ft)	CORE RUN	CORE INTERVAL (ft)	CORE RECOVERY (ft)	RQD%	ROCK QUALITY	GRAPHIC LOG	ROCK DESCRIPTION AND IDENTIFICATION
2.0'							WEATHERED BEDROCK ABOVE 2.0'
3.0'							65°
4.0'	R-1	5.0	5.0	76%	GOOD		GRAY MICA SCHIST
5.0'							WEATHERING IS SLIGHT AND JOINTS ARE CLOSE (2" TO 12") TO MODERATELY CLOSE (12" TO 36")
6.0'							10°
7.0'							75°
8.0'							45°
9.0'	R-1	5.0	5.0	95%	EXCELLENT		10°
10.0'							60°
11.0'							65°
12.0'							80°
13.0'							25°
14.0'	R-1	5.0	5.0	95%	EXCELLENT		30°
15.0'							40°
16.0'							
16.6'							
							BOTTOM OF EXPLORATION AT 16.6'

PROJECT NAME / LOCATION: REDINGTON MOUNTAIN WIND FARM PROJECT / CARRABASSET, MAINE

 CLIENT: ENDLESS ENERGY CORP.



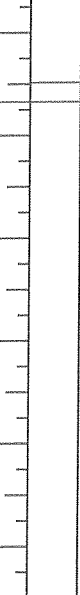
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 DATE 11/3/2005

CHECKED BY \_\_\_\_\_

DATE \_\_\_\_\_

 CORE SIZE 2"

DEPTH BELOW SURFACE (ft)	CORE RUN	CORE INTERVAL (ft)	CORE RECOVERY (ft)	RQD%	ROCK QUALITY	GRAPHIC LOG	ROCK DESCRIPTION AND IDENTIFICATION	
3.7'							OVERBURDEN	
4.0'	R-1	5.0	5.0	70%	FAIR		WHITE GRANITE WITH SLIGHT WEATHERING AND CLOSE JOINTS (2" TO 12")	
5.0'							10°	15°
6.0'							15°	80°
7.0'	R-2	5.0	5.0	72%	FAIR		WHITE GRANITE WITH MODERATE WEATHERING AND CLOSE (2" TO 12") TO MODERATELY CLOSE (12" TO 36" ) JOINTS	
8.0'							25°	15°
8.7'							10°	35°
9.0'	R-3	5.0	5.0	94%	EXCELLENT		WHITE GRANITE WITH SLIGHT WEATHERING AND CLOSE (2" TO 12") TO MODERATELY CLOSE (12" TO 36" ) JOINTS	
10.0'							10°	
11.0'							10°	
12.0'								
13.0'								
13.7'								
14.0'								
15.0'								
16.0'								
17.0'								
18.0'								
18.7'								
19.0'							BOTTOM OF EXPLORATION AT 18.7'	

## KEY TO THE NOTES & SYMBOLS Test Boring and Test Pit Explorations

All stratification lines represent the approximate boundary between soil types and the transition may be gradual.

### Key to Symbols Used:

w	-	water content, percent (dry weight basis)
q <sub>u</sub>	-	unconfined compressive strength, kips/sq. ft. - based on laboratory unconfined compressive test
S <sub>v</sub>	-	field vane shear strength, kips/sq. ft.
L <sub>v</sub>	-	lab vane shear strength, kips/sq. ft.
q <sub>p</sub>	-	unconfined compressive strength, kips/sq. ft. based on pocket penetrometer test
O	-	organic content, percent (dry weight basis)
W <sub>L</sub>	-	liquid limit - Atterberg test
W <sub>P</sub>	-	plastic limit - Atterberg test
WOH	-	advance by weight of hammer
WOM	-	advance by weight of man
WOR	-	advance by weight of rods
HYD	-	advance by force of hydraulic piston on drill
RQD	-	Rock Quality Designator - an index of the quality of a rock mass. RQD is computed from recovered core samples.
γ <sub>T</sub>	-	total soil weight
γ <sub>B</sub>	-	buoyant soil weight

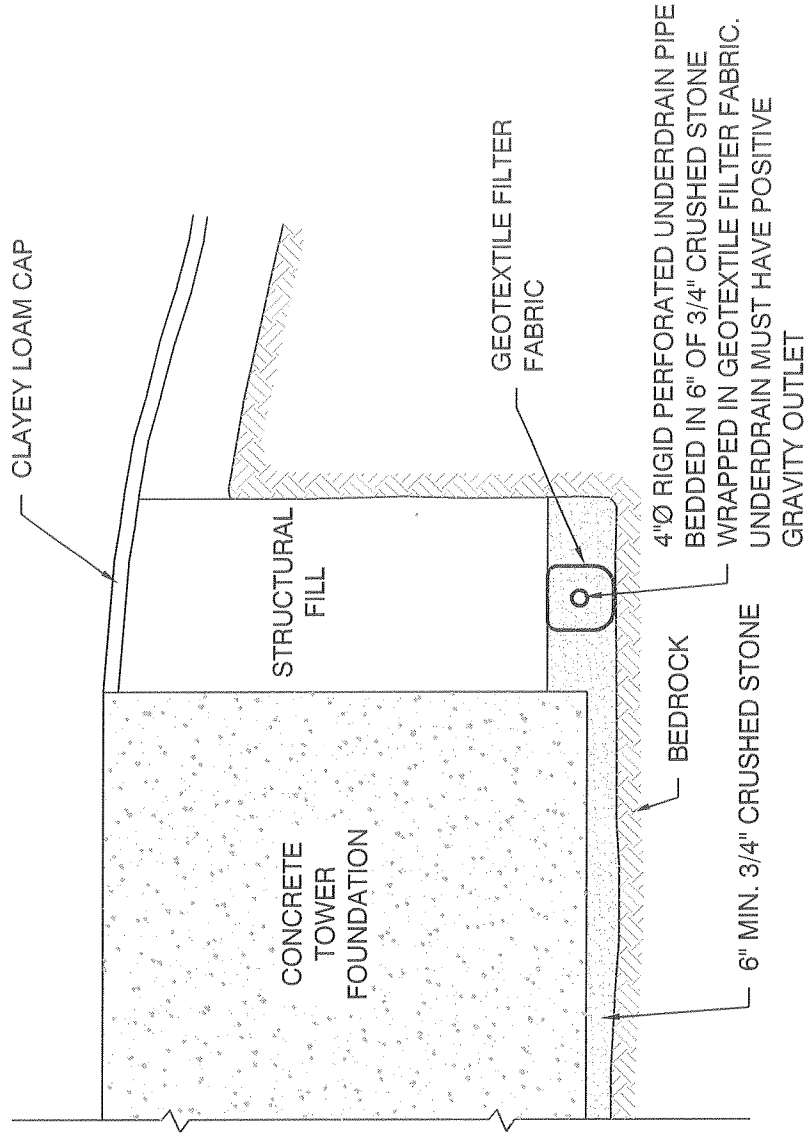
### Description of Proportions:

0 to 5% TRACE  
5 to 12% SOME  
12 to 35% "Y"  
35+% AND

**REFUSAL: Test Boring Explorations** - Refusal depth indicates that depth at which, in the drill foreman's opinion, sufficient resistance to the advance of the casing, auger, probe rod or sampler was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

**REFUSAL: Test Pit Explorations** - Refusal depth indicates that depth at which sufficient resistance to the advance of the backhoe bucket was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

Although refusal may indicate the encountering of the bedrock surface, it may indicate the striking of large cobbles, boulders, very dense or cemented soil, or other buried natural or man-made objects or it may indicate the encountering of a harder zone after penetrating a considerable depth through a weathered or disintegrated zone of the bedrock.



**NOTES:**

1. UNDERDRAIN INSTALLATION AND MATERIAL GRADATION REQUIREMENTS ARE CONTAINED WITHIN THIS REPORT.



MAINE MOUNTAIN POWER, LLC

**GENERAL UNDERDRAIN AND BACKFILL DETAIL**

PROPOSED REDINGTON MOUNTAIN WIND FARM PROJECT  
CARRABASSET VALLEY, MAINE

Job No. 03-0804

Date: 02/14/06

Scale

Sheet

Not to Scale

9