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ENGINEERING STUDY AND RECOMMENDATIONS

ROADWAY IMPROVEMENTS
STONY BROOK SUBDIVISION
GORHAM, NH

Prepared for:
Town of Gorham

November 24, 2009
UPDATED: July 7, 2014

STATE OF NEW HAMPSHIRE
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Prepared by:
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Project #2009-079

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ENGINEERING STUDY AND RECOMMENDATIONS

STONY BROOK SUBDIVISION

GORHAM, NEW HAMPSHIRE

November 24, 2009
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I. INTRODUCTION

HEB Engineers, Inc. (HEB) was engaged by the Town of Gorham to perform roadway evaluation services and prepare a report of findings and recommendations for the Stony Brook Subdivision located in Gorham, NH, in accordance with our Letter Agreement dated July 31, 2009. The subdivision is located off Route 16 at the southern end of town.

The purpose of the study is to evaluate the conditions of the existing roadway infrastructure, provide recommendations for improvements, and identify the probable construction costs of the recommended improvements. The scope of the study includes:

- **Stony Brook Road** – from Route 16 to the entrance of the Stony Brook Subdivision. This section of road was not originally part of the study but it appears that improvements are needed, and the area has been added to the study.
- **Mount Carter Drive** – all portions are included in the evaluation.
- **Clay Brook Road** – from the intersection of Mount Carter Drive to Evergreen Drive. The remaining portion of Clay Brook Road is not included in the evaluation.
- **Evergreen Drive** – all portions are included in the evaluation.
- **Hemlock Road** – all portions are included in the evaluation.

These subdivision roadways have deteriorated over the years and are in need of improvements. To determine the cause of the deterioration, HEB teamed with S.W. Cole Engineering, Inc. to complete subsurface explorations and provide a geotechnical evaluation of the existing roadway infrastructure. The subsurface exploration program, conducted September 1-2, 2009, included 16 shallow test borings followed by laboratory testing of a select group of existing roadway construction materials, to determine the quality and depths of the roadway construction materials. A copy of the report prepared by S.W. Cole Engineering, Inc. is provided in Appendix B.

II. SUBSURFACE EXPLORATION FINDINGS

Development of the Stony Brook subdivision and associated roadway infrastructure began in the late 1980's/early 1990's. Roadway construction during the early development phases of the subdivision occurred prior to the full development and enforcement of Town of Gorham roadway construction standards. Since construction, these roadways have experienced significant seasonal frost heaving resulting in pavement deterioration in the form of cracking and surface irregularities. An in-depth summary of the conditions of each of the roads included in the study is included in the S.W. Cole report (see Appendix B). The general findings of the S.W. Cole report indicate the following:

- **Inadequate pavement thickness** – The existing pavement thickness is generally inadequate to support subdivision traffic. The majority of the pavement depths were observed to be less than 2 inches and only include a single course of pavement. Additionally, the pavement thickness is completely inadequate to support heavily loaded construction vehicles. Typical pavement thickness is 3 inches minimum.
- **Frost-susceptible pavement base material** – The pavement base material included in the laboratory testing contained up to 10% silt and clay passing the No. 200 sieve. This percentage of silt and clay is considered slightly frost-susceptible (8% is the maximum). The subgrade soils contain silt and clay contents greater than 30%, which is considered highly frost-susceptible. In addition, the depth of pavement base material is shallow, considering the highly frost-susceptible subgrade material.
- **Glacial till subgrade** – The subgrade soils consist of relatively impermeable glacial till soils and the pavement structure does not include shoulder ditching with adequate depth or under-drainage. These conditions allow infiltrated water to collect and become trapped, causing frost heaving in the winter and saturated soil conditions in the spring.

- **Freeze-thaw cycle** – Thawing soils, particularly those with high silt and clay content, have very low strength. Pavement loading applied to weak, saturated soils during spring thaw can cause significant damage to the pavement surface as evidenced by the alligator cracking in the roadway and the cracking of the pavement edges at the shoulders.
- **Pavement cracking** – As the roadway continues to crack (allowing a larger supply of water to enter the pavement section), it repeatedly causes frost heaving and loss of support during spring thaw.

Based on the findings above, we agree with S.W. Cole's recommended roadway improvements that include adequate pavement thickness, improved base/subbase materials, proper grading of subgrade to promote water drainage to the roadway perimeter, and adequate ditching and under-drainage to discharge water from the pavement section. Additionally, the roadway should be posted to heavy loads, especially in the spring.

III. RECOMMENDATIONS FOR REHABILITATION

The recommendations in this report are based on the findings of the subsurface exploration program conducted by S.W. Cole Engineering, Inc. The explorations identified the deficiencies of the existing roadway infrastructure and the data was used to determine recommended improvements for each roadway. We recommend that the Town of Gorham consider the following rehabilitation methods, (see Appendix A for the proposed Roadway Rehabilitation Plan):

- **Pavement Reclamation** – Reclamation is a technique in which the pavement and a predetermined portion of the underlying materials are uniformly crushed, pulverized, or blended, resulting in a stabilized base course. Substantial savings can be realized when reclamation is utilized for roadway rehabilitation. Should conditions require, additional materials can be added to further stabilize the reclaimed material.

  S.W. Cole completed a "blend analysis" of the existing pavement and underlying base materials to simulate reclamation during reconstruction. The results of the blend analysis were compared to NHDOT Specification 306, Reclaimed Stabilized Base. The reclaimed sample <u>did not</u> meet NHDOT Specification 306, but with the addition of 10% by volume of 1½ inch crushed stone (NHDOT No. 4 Stone), the sample would meet the specification.

  This rehabilitation process would require:

  1. Reclaiming 10 inches of existing pavement/base material where indicated and storing for re-use.
  2. Removing additional subbase/subgrade material to identified depth.
  3. Fine grading the subgrade to promote drainage to the perimeter of the road (2% crown).
  4. Installing or reconstructing roadway drainage culverts where necessary.
  5. Constructing or reshaping existing ditches to provide positive drainage away from road structure. Ditches should extend to a depth slightly deeper than the bottom of the pavement section.
  6. Installing under-drains where necessary to relieve high groundwater.
  7. Importing new subbase gravels meeting NHDOT Specification 304.2, Gravel, to depth identified.
  8. Installing reclaimed material to depth identified.
  9. Spreading No. 4 stone over reclaimed material and mixing into base gravel.
  10. Repaving existing roadway with adequate pavement thickness.

  The reclaimed pavement would be reconstructed with the following typical section:

  - 1 ¼" NHDOT pavement wearing course
  - 2 ¼" NHDOT pavement binder course
  - 10" NHDOT 306, Reclaimed Stabilized Base
  - 12" NHDOT 304.2, Gravel Sub-Base

- **Full Pavement Section Reconstruction** – This process involves the removal of all existing roadway construction materials to a specified depth. This is recommended on sections with both inadequate pavement thickness and gravel base materials. Reconstruction in these areas is recommended to be completed as the standard flexible asphalt pavement section.

  The standard flexible asphalt pavement typical section is as follows:
  - 1 ¼" NHDOT pavement wearing course
  - 2 ¼" NHDOT pavement binder course
  - 6" NHDOT 304.3 Crushed Gravel
  - 12" NHDOT 304.2 Gravel Sub-Base

IV. SPECIFIC ROADWAY RECOMMENDATIONS

A. Stony Brook Road

Due to its inadequate pavement thickness, cemented base, and lack of pavement base material, we recommend that Stony Brook Road be rehabilitated with Full Pavement Section Reconstruction utilizing the standard flexible asphalt pavement typical section.

B. Mount Carter Drive

Mount Carter Drive shows varying levels of deterioration along its length. For this study, we have divided Mount Carter Drive into three (3) different sections:

1. Northern Section

Due to its inadequate pavement thickness, cemented base, and lack of pavement base material, we recommend that the northern 1,000 feet of Mount Carter Drive be rehabilitated with Full Pavement Section Reconstruction utilizing the standard flexible asphalt pavement typical section. In addition, it is also recommended that the three (3) existing CMP culverts be removed and replaced with new HDPE culverts. Culvert installation should be completed with proper materials and compacted sufficiently to prevent deformation and to ensure heaving or settling does not occur.

2. Southern Section

We recommend that the portion of Mount Carter Drive beyond the northern 1,000 feet to the intersection with Clay Brook Road be rehabilitated utilizing the Reclaimed Flexible Pavement Section. The pavement thickness and gravel base materials appear to be adequate for re-use if reclaimed and reconstructed properly.

3. Cul-de-Sac

We recommend the final portion of Mount Carter Drive from the intersection with Clay Brook be rehabilitated utilizing the Reclaimed Flexible Pavement Section. The pavement thickness and gravel base materials appear to be adequate for re-use if reclaimed and reconstructed properly.

C. Clay Brook Road

We recommend that Clay Brook Road from the Mount Carter Drive intersection to the Evergreen Drive Intersection be rehabilitated utilizing the Reclaimed Flexible Pavement Section. The pavement thickness and gravel base materials appear to be adequate for re-use if reclaimed and reconstructed properly. In addition, we also recommend that the existing CMP culverts be removed and replaced with new HDPE culverts. Culvert installation should be completed with proper materials and compacted sufficiently to prevent deformation and to ensure heaving or settling does not occur.

D. Evergreen Drive

We recommend that Evergreen Drive be rehabilitated utilizing the Reclaimed Flexible Pavement Section. The pavement thickness and gravel base materials appear to be adequate for re-use if reclaimed and reconstructed properly. In addition, we recommend that the existing CMP culverts be removed and replaced with new HDPE culverts. Culvert installation should be completed with proper materials and compacted sufficiently to prevent deformation and to ensure heaving or settling does not occur.

E. Hemlock Road

We recommend that Hemlock Road be rehabilitated utilizing the Reclaimed Flexible Pavement Section. The pavement thickness and gravel base materials appear to be adequate for re-use if reclaimed and reconstructed properly. In addition, it is also recommended that the existing CMP culverts be removed and replaced with new HDPE culverts. Culvert installation should be completed with proper materials and compacted sufficiently to prevent deformation and to ensure heaving or settling does not occur.

V. PROBABLE CONSTRUCTION COSTS

Based on the above recommended roadway rehabilitation measures, HEB has prepared the following engineer's opinion of probable construction costs for each roadway section. A detailed breakdown of each item is included in Appendix C. The costs shown include a 20% contingency as well as engineering and permitting fee estimates.

Stony Brook Road.. $ 221,000

Mount Carter Drive (Northern Section)... $ 280,000

Mount Carter Drive (Southern Section, includes Cul-de-Sac)....................... $ 825,000

Clay Brook Road.. $ 487,000

Evergreen Drive.. $ 222,000

Hemlock Road.. $ 152,000

Total**..$2,187,000**

VI. CONCLUSION

The recommendations provided in this study are intended to present the most efficient and cost effective solutions for the repair/rehabilitation of the Stony Brook Subdivision roadways. We hope this report suits your needs. Should the Town of Gorham require additional information, we would be pleased to provide assistance.

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APPENDIX A

Roadway Rehabilitation Plan

APPENDIX B

Geotechnical Assessment Report
By S.W. Cole

PAVEMENT EXPLORATIONS AND EVALUATION SERVICES
STONY BROOK SUBDIVISION
EVERGREEN DRIVE, HEMLOCK DRIVE,
CLAY BROOK ROAD, MOUNT CARTER DRIVE
& STONY BROOK ROAD
GORHAM, NEW HAMPSHIRE

08-0738 S SEPTEMBER 28, 2009

PREPARED FOR:

H.E. Bergeron Engineers, Inc.
Attention: Mr. Jay Poulin, P.E.
2605 White Mountain Highway
North Conway, NH 03860

PREPARED BY:

S.W.COLE
ENGINEERING, INC.

10 Centre Road
Somersworth, NH 03878

08-0738 S

September 28, 2009

H.E. Bergeron Engineers, Inc.
Attention: Mr. Jay Poulin, P.E.
2605 White Mountain Highway
North Conway, NH 03860

Subject: Pavement Explorations & Evaluation Services
Stony Brook Subdivision
Evergreen Drive, Hemlock Drive, Clay Brook Road,
Mount Carter Drive & Stony Brook Road
Gorham, New Hampshire

1.0 INTRODUCTION

1.1 Scope of Work

In accordance with our Proposal dated August 21, 2008 and Revised Proposed dated July 30, 2009, we have completed a subsurface exploration program and made a geotechnical evaluation for the existing Evergreen Drive, Hemlock Drive, Clay Brook Road, Mount Carter Drive, and Stony Brook Road within the Stony Brook Subdivision in Gorham, New Hampshire. The purpose of our work was to explore and evaluate the existing roadway pavement sections and provide recommendations for pavement rehabilitation. The investigation has included the making of sixteen shallow test borings, laboratory testing and a geotechnical evaluation of the findings as they relate to the roadway pavement. The contents of this report are subject to the limitations set forth in Attachment A.

1.2 Existing & Proposed Conditions

The site is located at the existing Stony Brook subdivision off Route 16 in Gorham, New Hampshire. The existing road alignments for Evergreen Drive, Hemlock Drive, Clay Brook Road, Mount Carter Drive, and Stony Brook Road total about 1.2 miles in length. The subdivision was constructed in the late 1980's/early 1990's prior to the Town of Gorham requirements relative to pavement section construction. The roads have reportedly experienced seasonal frost heaving resulting in severe pavement

Evergreen Drive: Evergreen Drive is about 900 feet long and spans from its intersection with Clay Brook Drive to Hemlock Drive. The road exhibits signs of significant alligator cracking, cracking and loss of pavement at the road edges, random cracking, and high surface irregularities. This portion has been reportedly patched and repaired several times and similar deterioration has continued to be observed.

Hemlock Drive: Hemlock Drive is about 650 feet long and spans from its intersection with Evergreen Drive to the cul-de-sac at the end of Hemlock Drive. The road exhibits signs of significant alligator cracking, cracking and loss of pavement at the road edges, random cracking, and high surface irregularities.

The road alignment is shown of the attached plan entitled Roadway Investigation Plan, dated September 21, 2009, prepared by H.E. Bergeron Engineers, Inc. included in Appendix A.

2.0 EXPLORATION AND TESTING

2.1 Exploration

Sixteen test borings (B-1 through B-16) were made at the site on September 1 and 2, 2009 by S. W. COLE ENGINEERING, INC. The exploration locations were selected by S. W. COLE ENGINEERING, INC. and H.E. Bergeron Engineers, Inc. The locations depicted on the attached "Roadway Investigation Plan" were determined by H.E. Bergeron Engineers, Inc. by taped measurements from existing site features on the available site plans.

The explorations were advanced to depths varying from 14.0 to 24.0 inches below the pavement surface utilizing an electric-powered core drill through the surficial asphalt pavement and hand excavation techniques into the base, subbase, and subgrade soils. The explorations were backfilled with sand and gravel and sealed with asphalt patch material at the completion of work.

The locations of the explorations are shown on the plan entitled Roadway Investigation Plan, dated September 21, 2009, prepared by H.E. Bergeron Engineers, Inc. included in Appendix A.

sand and gravel with some silt. Below the subbase material at B-4, a 1-inch thick layer of pavement overlies 6 inches of silty gravelly sand (relic base).

Explorations B-5 through B-16 (excluding B-5, B-7, and B-9) encountered a subbase consisting of 3-inch to 6-inch minus gravelly sand with some silt varying in thickness from 6 to 8 inches. At borings B-5, B-7, and B-9, a distinct layer of subbase material was not encountered. Generally, the observed difference between the subbase and base was the maximum particle size.

Subgrade: The base/subbase material was penetrated at each exploration, except B-3 and B-7, encountering subgrade soil generally consisting of a layer of silty sand with some gravel. We obtained a sample of exposed glacial till soil from an earth cut slope along the north side of Evergreen Drive between boring B-13 and B-14. The exposed soil strata on the cut slope consisted of forest duff and topsoil overlying a subsoil layer consisting of light brown silty sand with some gravel overlying brown glacial till (heterogenous mixture of silt, sand and gravel). The subgrade soil encountered in the borings appeared to be similar to the subsoil below the topsoil in the cut slope.

Borings B-3 and B-7 were terminated on a refusal surface in the subbase fill at depths of 21.0 and 18.0 inches, respectively, on cobbles or boulders greater than the dimensions of the bottom of the hole.

For more detailed information relative to the subsurface conditions, refer to the test boring logs attached as Sheets 1 through 8.

3.2 Groundwater

Saturated soil conditions or free water were not observed within the depths explored at the test borings with the exception of B-4 and B-16, where the soils were damp below a depth of 7 and 14 inches, respectively. Water levels will fluctuate seasonally and following periods of precipitation and snow melt.

2. The pavement base material tested contains up to 10 percent silt and clay (passing the No. 200 sieve). This percentage of silt and clay is considered slightly frost susceptible. The subgrade soils contain silt and clay contents greater than 30 percent, which is considered highly frost susceptible. We anticipate the water infiltration through the pavement cracks provide a ready supply of water that in-turn causes frost heaving.

3. The subgrade soils consist of relatively impermeable glacial till soils and the pavement structure does not include prevalent shoulder ditching and does not include underdrainage. These conditions allow infiltrated water to collect and become trapped, causing frost heaving in the winter and saturated soil conditions during the spring thaw.

4. Thawing soils, particularly those with high silt and clay content, have very low strength. Pavement loading applied to weak, saturated soils during spring thaw can cause significant damage to the pavement surface as evidence by the alligator cracking and cracking of the pavement edges at the shoulders.

5. The more the roadway cracks, a larger supply of water enters the pavement section, repeatedly causing frost heaving and loss of support during spring thaw.

It is our opinion that the roadways require reconstruction to include adequate pavement thickness, improved base/subbase materials, proper grading of the subgrade to promote water drainage to the roadway perimeter, and adequate ditching to discharge the water from the pavement section. Additionally, the roadway should be posted to heavy loads during all times of the year.

4.3 Rehabilitation Recommendations

4.3.1 Pavement Reclaiming

We performed blend analyses of the existing pavement and underlying base/subbase materials to simulate a reclamation of the existing pavement section during reconstruction. Our blend analyses were performed by mathematically blending gradation results on the existing base material with gradation results representing typical bituminous pavement grindings. The actual gradation of the reclaimed pavement is to provide grading and shaping of the subgrade soil to promote drainage to the edges of the road from within the pavement section.

4.3.3 Ditching and Drainage

We recommend that following the removal of the subbase material, the existing subgrade material be re-shaped and graded to promote water to shed to the edges of the roadways. The subgrade should be proof-rolled with a minimum of 5 passes with a vibratory drum roller having a static weight of at least 10 tons. The use of the vibrator feature will be dependant on water levels and subgrade conditions.

We recommend that ditching be added where currently not present and improved where present. Ditching should extend to a depth slightly deeper than the bottom of the pavement section. The ditches should be hydraulically connected to the pavement section to allow for proper outlet of the water that enters the pavement section.

4.3.4 New Pavement Section

We offer the following recommendations for the reclaimed pavement section. Materials are based on 2006 New Hampshire Department of Transportation Specifications for Road and Bridge Construction.

RECLAIMED FLEXIBLE (ASPHALT) PAVEMENT

Material	Standard Duty
NHDOT 9.5 mm Superpave Wearing Course (50 Gyration Design)	1 ¼ inches
NHDOT 19 mm Superpave Binder Course (50 Gyration Design)	2 ¼ inches
NHDOT 306 Reclaimed Stabilized Base (Modified)[1]	12 inches
NHDOT 304.2 Gravel Subbase	9 inches
[1] A specification for 0 to 7 percent passing the No. 200 sieve based on total sample weight should be added to the NHDOT 306 specification.	

We offer the following recommendations for the new pavement section of Stony Brook Drive and a portion of Mount Carter Drive. Materials are based on 2006 New Hampshire Department of Transportation Specifications for Road and Bridge Construction.

Further, S. W. COLE ENGINEERING, INC. should be retained to provide soils engineering and testing services during the excavation and soil placement phases of the work. This is 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. S. W. COLE ENGINEERING, INC. is available to provide testing of soils and asphalt construction materials.

5.0 CLOSURE

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

Very truly yours,

S. W. COLE ENGINEERING, INC.

STATE OF NEW HAMPSHIRE
CHAD BARTLETT MICHAUD
No. 10795
LICENSED
PROFESSIONAL ENGINEER

Chad B. Michaud, P.E.
Senior Geotechnical Engineer

S.W.COLE ENGINEERING, INC.

HAND BORING LOGS

PROJECT / CLIENT: PAVEMENT EXPLORATIONS AND EVALUATION SERVICES

LOCATION: STONY BROOK SUBDIVISION / GORHAM, NEW HAMPSHIRE   PROJECT NO. 08-0738

HAND BORING B-1

DATE: 09-02-09   SURFACE ELEVATION: N/A   LOCATION: STONY BROOK RD.

SAMPLE NO.	SAMPLE DEPTH	DEPTH (IN)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	BITUMINOUS ASPHALT PAVEMENT (SINGLE COURSE)	
S-1	1.5-5.5"	5.5	1"-MINUS DARK BROWN GRAVELLY SAND WITH SOME SILT (BASE) ~ VERY DENSE AND CEMENTED 1.5" - 4.5" ~	
S-2	5.5-9"	9.0	BROWN SILTY SAND WITH SOME GRAVEL (SUBBASE) TRACE ORGANICS AT 8" - 9"	
S-3	9-14"	14.0	DARK BROWN SILTY GRAVELLY SAND WITH ORGANIC ODOR (SUBGRADE)	
			REFUSAL @ 14.0" BOULDER OR COBBLE SPANNING ENTIRE BOREHOLE COULD NOT EXCAVATE/PENETRATE AFTER SIGNIFICANT EFFORT	

COMPLETION DEPTH: 14.0" - REFUSAL   DEPTH TO WATER: NO FREE WATER OBSERVED

HAND BORING B-2

DATE: 09-02-09   SURFACE ELEVATION: N/A   LOCATION: MT. CARTER DRIVE

SAMPLE NO.	SAMPLE DEPTH	DEPTH (IN)	STRATUM DESCRIPTION	TEST RESULTS
		1.25	BITUMINOUS ASPHALT PAVEMENT (SINGLE COURSE)	
		6.0	1.5"-MINUS BROWN SILTY GRAVELLY SAND WITH TRACE ORGANICS (BASE)	
		9.0	DARK BROWN SILTY GRAVELLY SAND WITH ORANGE-BROWN LAYER @ 7.0" - 7.5" (SUBBASE) ~ VERY DENSE AND CEMENTED ~	
S-1	9-20"	20.0	GRAY-BROWN SILTY GRAVELLY SAND (SUBGRADE) ORGANIC ODOR STARTING AT APPROXIMATELY 12"	

COMPLETION DEPTH: 20.0"   DEPTH TO WATER: NO FREE WATER OBSERVED

S.W.COLE ENGINEERING, INC.

HAND BORING LOGS

PROJECT / CLIENT: PAVEMENT EXPLORATIONS AND EVALUATION SERVICES

LOCATION: STONY BROOK SUBDIVISION / GORHAM, NEW HAMPSHIRE   PROJECT NO. 08-0738

HAND BORING B-5

DATE: 09-02-09   SURFACE ELEVATION: N/A   LOCATION: MT. CARTER DRIVE

SAMPLE NO.	SAMPLE DEPTH	DEPTH (IN)	STRATUM DESCRIPTION	TEST RESULTS
		3.0	BITUMINOUS ASPHALT PAVEMENT (POSSIBLY TWO COURSES)	
S-1	3-15"	15.0	1.5"-MINUS BROWN SAND AND GRAVEL SOME SILT (BASE)	
		19.0	BROWN SILTY SAND WITH SOME GRAVEL (SUBGRADE)	

COMPLETION DEPTH: 19.0"   DEPTH TO WATER: NO FREE WATER OBSERVED

HAND BORING B-6

DATE: 09-02-09   SURFACE ELEVATION: N/A   LOCATION: MT. CARTER DRIVE

SAMPLE NO.	SAMPLE DEPTH	DEPTH (IN)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	BITUMINOUS ASPHALT PAVEMENT (WEARING COURSE)	
		3.75	BITUMINOUS ASPHALT PAVEMENT (BINDER COURSE)	
S-1	4-11"	11.0	1.5"-MINUS BROWN SAND AND GRAVEL WITH SOME SILT (BASE)	
		19.0	3" MINUS BROWN GRAVELLY SAND WITH SOME SILT (SUBBASE)	
		20.0	DARK BROWN SILTY SAND WITH SOME GRAVEL WITH ORGANICS (SUBGRADE)	

COMPLETION DEPTH: 20.0"   DEPTH TO WATER: NO FREE WATER OBSERVED

S.W.COLE ENGINEERING, INC.

HAND BORING LOGS

PROJECT / CLIENT: PAVEMENT EXPLORATIONS AND EVALUATION SERVICES

LOCATION: STONY BROOK SUBDIVISION / GORHAM, NEW HAMPSHIRE PROJECT NO. 08-0738

HAND BORING B-9

DATE: 09-02-09 SURFACE ELEVATION: N/A LOCATION: CLAY BROOK ROAD

SAMPLE NO.	SAMPLE DEPTH	DEPTH (IN)	STRATUM DESCRIPTION	TEST RESULTS
		1.75	BITUMINOUS ASPHALT PAVEMENT (WEARING COURSE)	
		3.5	BITUMINOUS ASPHALT PAVEMENT (BINDER COURSE)	
S-1	3.5-9"	9.0	2"-MINUS BROWN SAND AND GRAVEL WITH SOME SILT (BASE) (NO CLEAR SUBBASE MATERIAL ENCOUNTERED)	
S-2	9-17"	17.0	BROWN SILTY SAND WITH SOME GRAVEL (SUBGRADE)	

COMPLETION DEPTH: 17.0" DEPTH TO WATER: NO FREE WATER OBSERVED

HAND BORING B-10

DATE: 09-02-09 SURFACE ELEVATION: N/A LOCATION: CLAY BROOK ROAD

SAMPLE NO.	SAMPLE DEPTH	DEPTH (IN)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	BITUMINOUS ASPHALT PAVEMENT (WEARING COURSE)	
		3.25	BITUMINOUS ASPHALT PAVEMENT (BINDER COURSE)	
S-1	3-9"	9.25	1.5"-MINUS BROWN SAND AND GRAVEL SOME SILT (BASE)	
S-2	10-17"	17.0	5"-MINUS BROWN GRAVELLY SAND WITH SOME SILT (SUBBASE)	
		20.0	BROWN SILTY SAND WITH SOME GRAVEL (SUBGRADE)	

COMPLETION DEPTH: 20.0" DEPTH TO WATER: NO FREE WATER OBSERVED

S.W.COLE ENGINEERING, INC.

HAND BORING LOGS

PROJECT / CLIENT: PAVEMENT EXPLORATIONS AND EVALUATION SERVICES

LOCATION: STONY BROOK SUBDIVISION / GORHAM, NEW HAMPSHIRE PROJECT NO. 08-0738

HAND BORING B-13

DATE: 09-02-09 SURFACE ELEVATION: N/A LOCATION: EVERGREEN DRIVE

SAMPLE NO.	SAMPLE DEPTH	DEPTH (IN)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	BITUMINOUS ASPHALT PAVEMENT (SINGLE COURSE)	
S-1	2-8"	8.0	2"-MINUS BROWN GRAVELLY SAND SOME SILT (BASE)	
S-2	8-14"	14.0	3"-MINUS BROWN GRAVELLY SAND WITH SOME SILT (SUBBASE)	
		21.0	BROWN SILTY SAND WITH SOME GRAVEL (SUBGRADE)	

COMPLETION DEPTH: 21.0" DEPTH TO WATER: NO FREE WATER OBSERVED

HAND BORING B-14

DATE: 09-02-09 SURFACE ELEVATION: N/A LOCATION: EVERGREEN DRIVE

SAMPLE NO.	SAMPLE DEPTH	DEPTH (IN)	STRATUM DESCRIPTION	TEST RESULTS
		1.5	BITUMINOUS ASPHALT PAVMENT (SINGLE COURSE)	
S-1	2-6"	6.0	1"-MINUS BROWN GRAVELLY SAND WITH SOME SILT (BASE)	
		13.0	3"-MINUS BROWN GRAVELLY SAND WITH SOME SILT (SUBBASE)	
		13.5	DARK BROWN SILTY SAND WITH ORGANICS (SUBGRADE)	
		22.0	LIGHT BROWN SILTY SAND WITH TRACE GRAVEL (SUBGRADE)	

COMPLETION DEPTH: 22.0" DEPTH TO WATER: NO FREE WATER OBSERVED

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_u	-	unconfined compressive strength, kips/sq. ft. - based on laboratory unconfined compressive test
S_v	-	field vane shear strength, kips/sq. ft.
L_v	-	lab vane shear strength, kips/sq. ft.
q_p	-	unconfined compressive strength, kips/sq. ft. based on pocket penetrometer test
O	-	organic content, percent (dry weight basis)
W_L	-	liquid limit - Atterberg test
W_P	-	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_T	-	total soil weight
γ_B	-	buoyant soil weight

Description of Proportions:

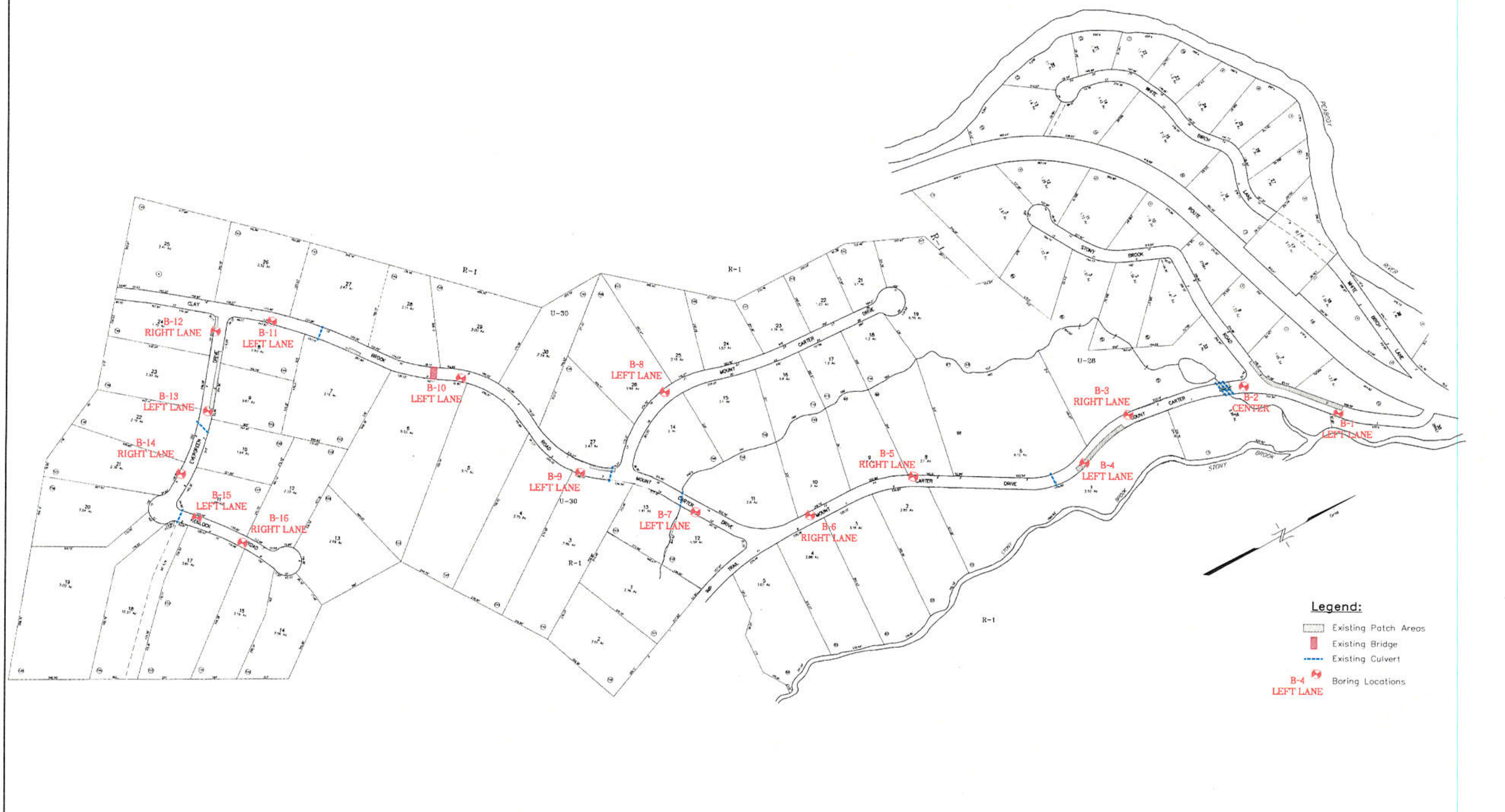
0 to 5% TRACE
5 to 12% SOME
12 to 35% "Y"
35+% AND

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.

Appendix A
Roadway Investigation Plan prepared by HEB



DRAWINGS ARE HALF SCALE WHEN PRINTED ON 11x17

200 0 200 400 800 ft

40 0 100 200 m

1 inch = 200 feet

(1 : 2400)

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NO.	REVISION	DATE	BY

HEB

H.E. BERGERON ENGINEERS, INC.
P.O. BOX 440
NORTH CONWAY, NH
03860 · (603) 356-6936

SURVEYED BY	N/A
DESIGNED BY	EJG
DRAWN BY	EJG
CHECKED BY	JJP
FIELD BOOK	
SCALE	1" = 200'
DATE	09/28/2009

Roadway Investigation Plan
for the
Stony Brook Subdivision
prepared for
Town of Gorham, New Hampshire

2009-079

C1.01

SHEET 1 OF 1

C1.01
SHEET 1 OF 1
2009-079
Roadway Investigation Plan
Town of Gorham, New Hampshire

Appendix B
Laboratory Gradation Test Results

S.W.COLE ENGINEERING, INC.

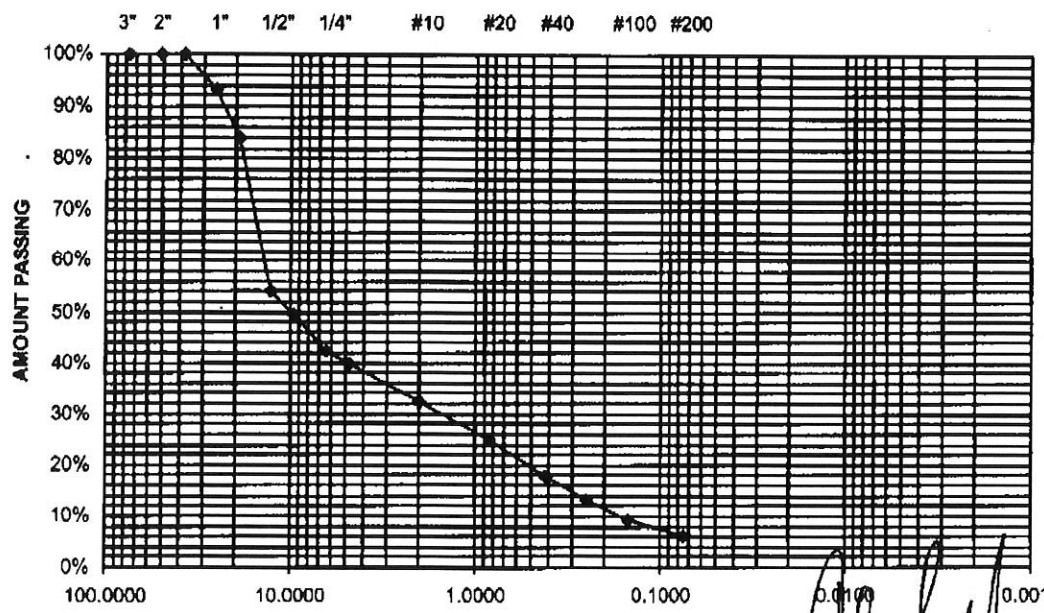
Report of Gradation

ASTM C-117 & C-136

Project Name	GORHAM NH - STONY BROOK SUBDIVISION ROAD EVALUATION - GEOTECHNICAL ENGINEERING SERVICES	Project Number	08-0738
Client	H. E. BERGERON ENGINEERS, P.A.	Lab ID	6695S
Material Type	1.5-INCH MINUS SAND AND GRAVEL SOME SILT	Date Received	9/8/2009
Material Source	B-4, BASE,	Date Complete	9/10/2009
		Tested By	SHAWN BENOIT

STANDARD DESIGNATION (MM/uM)	SIEVE SIZE	AMOUNT PASSING(%)	NHDOT 304 2 GRAVEL Specifications (%)	NHDOT 304 3 CR GRAVEL Specifications (%)
150 mm	6"	100	100	
75 mm	3"	100		100
50 mm	2"	100		95 - 100
38.1 mm	1-1/2"	100		
25.0 mm	1"	93		55 - 85 †
19.0 mm	3/4"	84		
12.5 mm	1/2"	54		
9.5 mm	3/8"	50		
6.3 mm	1/4"	42		
4.75 mm	No. 4	40	25 - 70	27 - 52
2.00 mm	No. 10	32		
850 um	No. 20	25		
425 um	No. 40	18		
250 um	No. 60	13		
150 um	No. 100	9		
75 um	No. 200	5.9		
75 um	No. 200*	14.7	0 - 12 †	0 - 12 †

* OF THE FRACTION PASSING THE NO. 4 SIEVE   † SAMPLE DOES NOT MEET SPECIFICATION



Comments

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