SURVEY OF HIGHWAY CONSTRUCTION MATERIALS

IN WARREN GORE, ESSEX COUNTY, VERMONT

Prepared by

Engineering Geology Section, Materials Division

Vermont Department of Highways

in cooperation with

United States Department of Transportation

Federal Highway Administration

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Acknowledgments

The work of this Project was implemented with the cooperation and assistance of many groups and individuals. The following were particularly helpful in carrying out the Project's objectives.

1. Various departments and individuals of the Vermont State Department of Highways; notably the Planning Division and Mapping Section and the Materials Division.

2. Professor D. P. Stewart of Miami University, Oxford, Ohio.

3. Professor C. G. Doll, Vermont State Geologist, University of Vermont, Burlington, Vermont.

4. United States Department of Commerce, Federal Highways Administration.

History

The Materials Survey Project was formed in 1957 by the Vermont Department of Highways with the assistance of the Federal Highway Administration. Its prime objective was to compile an inventory of highway construction materials in the State of Vermont. Originally, investigations for highway construction materials were conducted only as the immediate situation required and only limited areas were surveyed; thus, no over-all picture of material resources was available. Highway contractors or resident engineers were required to locate the materials for their respective projects and samples were tested by the Materials Division. The additional cost of exploration for construction materials was passed on to the State bringing about higher construction costs. The Materials Survey Project was established to eliminate or minimize this factor by enabling the State and the contractors to proceed with information on available material resources and to project cost estimates. Knowledge of locations of suitable material is an important factor in planning future highways.

The sources of construction materials are located by this Project through ground reconnaissance, study of maps and aerial photographs and geological and physiographic interpretation. Maps, data sheets and work sheets for reporting the findings of the Project are used to furnish information of particular use to the contractor or construction man. For maximum benefit, the maps, data sheets and this report should be studied together.

Enclosures

Included in this report are two surface-geology maps, one defining the location of tests on bedrock, the other defining the location of tests on granular materials. These maps are based on 15-minute or 7-1/2-minute quadrangles of the United States Geological Survey enlarged or reduced to 1:31250 or 1" = 2604'. Delineated on the Bedrock Map are the various rock formations and types in the township. This information was obtained from: Vermont Geological Survey Bulletins, Vermont State Geologist Reports, United States Geological Survey Bedrock Maps, Centennial Geological Map of Vermont, the Surficial Geologic Map of Vermont and other references.

The granular materials map shows areas covered by various types of glacial deposits (outwash, moraines, kames, kame terraces, eskers, etc.) by which potential sources of gravel and sand may be recognized. This information was obtained primarily from a survey conducted by Professor D. P. Stewart of Miami University, Oxford, Ohio, who mapped the glacial features of the State of Vermont during the summer months from 1956 to 1966. Further information is obtained from the Soil Survey (Reconnaissance) of Vermont (conducted by the Bureau of Chemistry and Soils of the United States Department of Agriculture), Vermont Geological Survey Bulletins, United States Geological Survey Quadrangles, aerial photographs and other sources. On both maps, the areas tested are represented by Identification Numbers. The number and location of tests taken in each area represented by an Identification

Number is determined by the nature of the material or its topographic feature.

Also included in this report are data sheets for both the Bedrock and Granular Materials Survey, which contain detailed information for each test conducted by the Project as well as information obtained from an active card file compiled and updated by the Engineering Geology Section of the Materials Division over a period of years. Transfer of information from the cards to the data sheets was made and the location of the deposits was plotted on the maps. However, some cards in the file were not used because of incomplete or unidentifiable information on the location of the deposit. Caution should be exercised wherever this information appears incomplete.

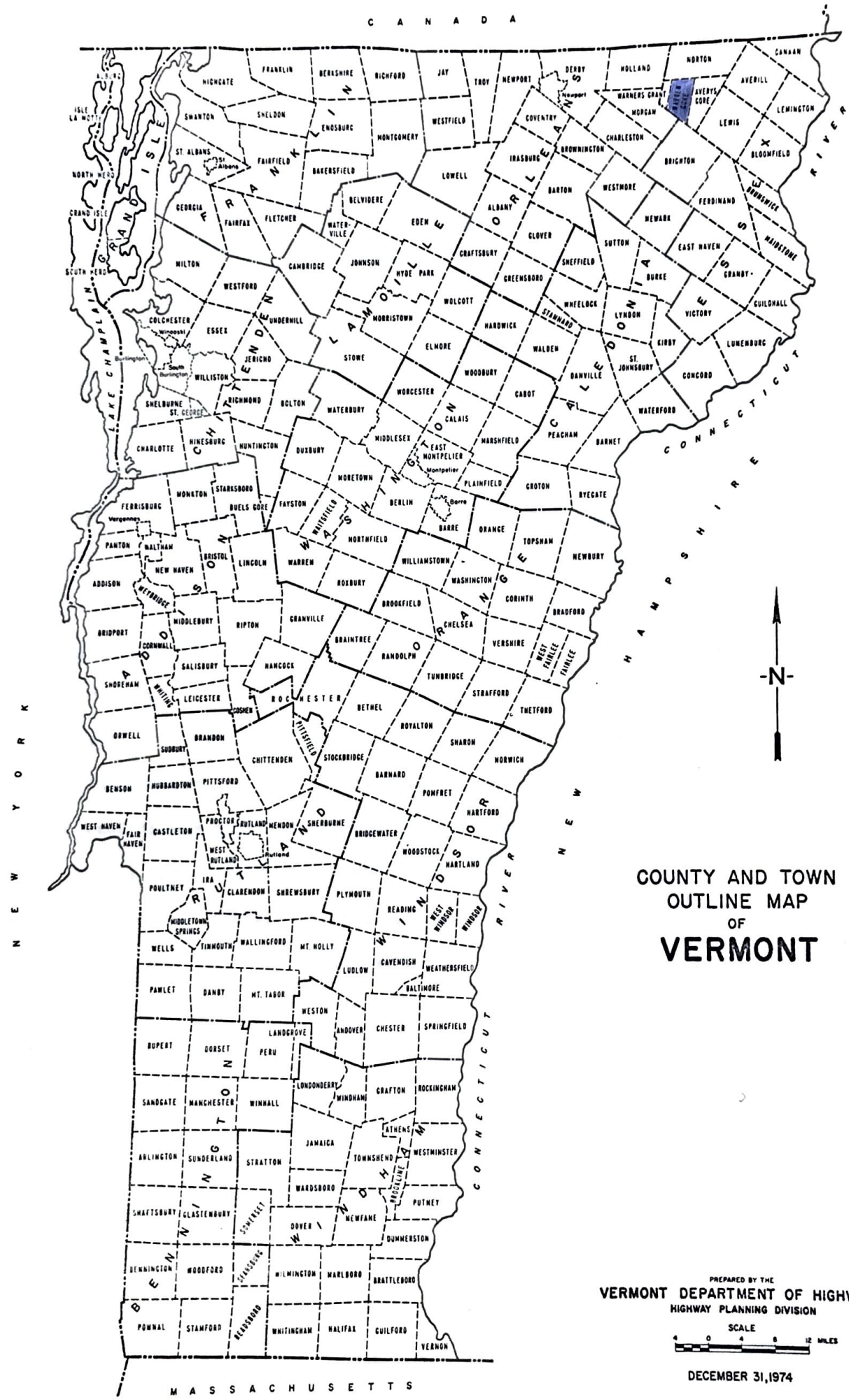
Work sheets, containing more detailed information and a field sketch of the area represented by the Identification Number, and laboratory reports are on file in the Materials Division of the Vermont Department of Highways.

LOCATION

Warren Gore is in the northwest corner of Essex County in northeastern Vermont. It is bounded on the north by Norton, on the east by Avery's Gore, on the southeast by Brighton, on the southwest by Morgan, and on the west by Warner's Grant. (See County and Town Outline Map of Vermont of following page). The western two-thirds of Warren Gore lies within the Vermont Piedmont (a region of broad valleys and rounded hills). The eastern third of Warren Gore is in the Northeastern Highlands physiographic sub-division of the New England Upland, which is characterized by rugged, steep-sided mountainous terrain. Elevations range from 2,780 feet atop an unnamed peak on the eastern boundary, to 1,320 feet on the southern border where the Pherrins River crosses the Morgan Town Line.

Southeast drainage into Norton Pond is via Hurricane and Coaticook Brooks; Sucker Brook flows westward into Norton Pond. Pine Brook flows westward into Pherrins River which flows south into Morgan. Norton Pond is the only large body of water in Warren Gore. Significant drainage occurs via many unnamed brooks and rivulets.

Heavy woods nearly cover Warren Gore, and support large-scale logging operations of the Brown Co.



COUNTY AND TOWN OUTLINE MAP OF VERMONT

PREPARED BY THE
VERMONT DEPARTMENT OF HIGHWAYS
HIGHWAY PLANNING DIVISION

SCALE
4 0 4 8 12 MILES

DECEMBER 31, 1974

SURVEY OF ROCK SOURCES

Procedure for Rock Survey

The method employed by the project in a survey of possible sources of rock for highway construction is divided into two main stages: office and field investigations.

The office investigation is conducted primarily during the winter months and comprises the mapping and description of rock types as indicated in the many reference sources, as indicated in the bibliography. These references differ considerably in dependability due to new developments and studies that have contributed to the obsolescence of a number of reports. In addition, the results of samples taken by other individuals are analyzed, and the location at which these samples were taken, is mapped when possible. As complete a correlation as possible is made of all the available information concerning the geology of the area under consideration.

The field investigation is begun by making a cursory survey of the entire town. The information obtained from this preliminary survey, as well as that assimilated in the office investigation, is used to determine the areas where sampling will be concentrated. When a promising source has been determined by rock type, volume of material, accessibility, and adequate exposure and relief, chip samples are taken with a hammer across the strike or trend of the rock, and are submitted to the Materials Division for abrasion testing by the Deval Method (AASHTO T-3) and the Los Angeles Method (AASHTO T-96). Samples taken by the chip method are often within the weathered zone of the outcrop and consequently may give a less satisfactory test result than fresh material deeper in the rock structure. When the rock is uniform, and the chip samples yield acceptable abrasion test results, the material source is included in this report as being satisfactory.

Discussion of Rock and Rock Sources

The information on the Rock Materials Map (Plate II) is simplified. (For a more detailed description of the respective rock formations, see the summary included in this report). In the summary, it is apparent that igneous rock of the undifferentiated granites of the New Hampshire Plutonic Series comprises the lithology of the northern four-fifths of Warren Gore, and complex metamorphic rocks comprise the southern fifth. There were no samples taken because dense woods and much glacial drift cover any exposures. The most promising areas for future rock exploration would be in wooded plots on the slopes east of Vermont Route 114. Some bedrock control was noted in stream beds of a logging area southwest of Norton Pond; however, the high number of brooks and low relief might cause problems in developing a quarry.

There was a small mapped zone of the Gile Mountain Formation phyllite or schist in the south part of Warren Gore, but it was not located.

SURVEY OF SAND AND GRAVEL SOURCES

Procedure for Sand and Gravel Survey

The method employed by the project in a survey of possible sources of sand and gravel for highway construction is divided into two main stages: office and field investigations.

The office investigation is conducted primarily during the winter months and comprises the mapping of potentially productive areas from various references. Of these references, the survey of glacial deposits mapped by Professor Stewart proves to be particularly helpful when used in conjunction with other references such as soil-type maps, aerial photographs, and United States Geological Survey Quadrangles. The last two are used in the recognition and location of physiographic features indicating glacial deposits, and in the study of drainage patterns. The locations of existing pits are mapped, as are the locations in which samples were taken by other individuals.

The field investigation is begun by making a cursory survey of the entire town. All pits, and any areas that show evidence of glacial or fluvial deposition are noted, and later investigated by obtaining samples of materials from pit faces and other exposed surfaces. Test holes in pit floors and extensions are dug with a backhoe to a depth of approximately 11 feet to obtain samples which are submitted to the Materials Division where they are tested for stone abrasion by the AASHTO T-4 Method, and sieved for gradation.

Discussion of Sand and Gravel Deposits

Results of this survey showed that granular materials suitable for highway and related construction purposes were deposited in Warren Gore: along the western shore of Norton Pond in a mapped kame terrace; around the western lobe of Norton Pond in an area of kame moraines and eskers; and flanking the Pherrins River in an area mapped as being kame moraine and esker. These deposits were formed by glaciofluvial and glaciolacustrine processes at elevations between 1,340 and 1,400 feet.

The area along the western shore of Norton Pond was inaccessible, but may contain a considerable amount of material. Most of the areas were along logging or access roads leading from the Hurricane Brook Wildlife Preserve access road west of Vermont Route 114.

There was a widespread skim of coarse material over finer material (usually gravel over sand), which indicates a shoal origin of deposition.

The most promising sources for Gravel for Sub-base, Item 704.05 are pits at Map Identification Numbers 12, 13 and 16.

The most promising sources for Sand Borrow and Cushion, Item 703.03 are pits at Map Identification Numbers 14,11, and 12.

The pit at Map Identification Number 4 yielded material which was not acceptable for Granular Borrow.

Brown Co. owns all the pits except those at Map Identification Numbers 4 and 9.

Summary of Rock Formations in Avery's Gore

Gile Mountain Formation: Gray quartz-muscovite phyllite or schist, interbedded and intergradational with gray micaceous quartzite (graywacke northeast of Nulhegan River), calcareous mica schist, and, locally quartzose and micaceous crystalline limestone like that of the Waits River Formation. The phyllite and schist commonly contain porphyroblasts of biotite, garnet, staurolite, and locally kyanite, andalusite, or sillimanite.

Undifferentiated Granitic Rocks of the New Hampshire Plutonic Series: Mostly granitic bodies emplaced during or slightly after the regional metamorphism. Sillimanite and locally cordierite occur near many contacts in northern part of state in small dikes and sills too narrow to show on map.

Glossary of Selected Geologic Terms

Andalusite: A variously colored orthorhombic aluminum silicate, Al_2SiO_5, found in schistose rocks.

Bedrock: Solid, undisturbed rock in place at the surface or just beneath surficial deposits.

Bedrock Control: Land Features which show bedrock on, or close to, the surface. It is used to describe part of the topography.

Biotite: A platy silicate commonly known as black mica.

Calcareous: Pertaining to, or containing from 10- to 50- percent calcium carbonate ($Ca\ CO_3$).

Cordierite: A blue silicate of magnesium, aluminum, and iron.

Dike: A sheet-like igneous rock that fills a fissure in older rocks while still in a molten state. It varies from less than an inch wide and a few yards long, to thousands of feet in width and many miles in length. May radiate in groups from a center, or occur singly and isolated from other igneous bodies.

Drainage: The manner in which water of an area passes off by surface streams and rivers, or by subsurface channels.

Drift: A deposit of earth, sand, gravel and boulders, carried by glaciers (glacial drift), or by water flowing from glaciers (fluvioglacial drift). Large areas of North America and Europe are drift-covered in higher latitudes.

Esker: Long, narrow, winding ridges of sand and gravel deposited by meltwater streams flowing through crevasses and tunnels in stagnant ice sheets.

Graywacke: Dark-colored, hard sandstone consisting of angular grains of quartz, feldspar, and rock fragments embedded in a fine, compact matrix of micas, clay minerals, and chlorite.

Interbedded: Occurring between beds, or adjacent and parallel to, other beds of a different nature.

Kame Moraine: Stratified sands and gravels deposited by water flowing beneath a glacier.

Kame Terrace: Stratified sands and gravels deposited by water flowing between a glacier and an adjacent valley wall.

Kyanite: A blue aluminum silicate occurring in thin-bladed crystals, or crystalline aggregates.

Muscovite: An important member of the mica group, known also as white mica, potash mica, or isinglass.

Outcrop: A part of a body of rock that appears, bare and exposed, at, or just below the surface.

Phyllite: A fine-grained, foliated metamorphic rock intermediate and gradational between the mica schists and slates. The foliation is caused by large amounts of potash mica (Sericite) which gives the rock its distinctive silvery appearance.

Porphyroblasts: Large crystals which have grown in place within the fine-grained groundmass of a metamorphic rock. They have been formed by heat, pressure, and infiltrating solutions occurring later than the rocks in which they form.

Rock Flour: Glacially ground, angular, unweathered, silt and clay size rock material which does not possess the cohesion characteristic of clay minerals.

Schist: A crystalline metamorphic rock with a secondary foliation or lamination based on parallelism of platy or needle-like grains. The name refers to the tendency to split along the foliation.

Sediments: All material deposited from water (streams, lakes or seas), wind, or ice.

Shoal: A sandbar or gravel bar that forms in shallow water; specifically, an elevation which is not rocky and on which there is a depth of water of six fathoms (36 feet) or less.

Sill: A tabular body of igneous rock which has been injected while molten between layers or foliations of rock. Sills have relatively great lateral extent as compared to thickness.

Sillimanite: A brown, grayish or pale green aluminum silicate, $Al_2 SiO_5$, forming in long, slender, and often fibrous crystals.

Staurolite: A brown to black, iron aluminum silicate, $HFeAl_5Si_2O_{13}$, occurring in prismatic crystals, often twinned in the form of a cross.

Water Table: The upper surface of a zone of saturation, except where the surface is formed by an impermeable body.

Weathered: Showing the effects of exposure to the atmosphere.

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PARTIAL SPECIFICATIONS FOR HIGHWAY CONSTRUCTION MATERIALS

Listed below are partial specifications for Highway Construction Materials as they apply to this report at date of publication. For a complete list of specifications see Standard Specifications for Highway and Bridge Construction, approved and adopted by the Vermont Department of Highways, January, 1972.

DIVISION 700 - MATERIALS

703.03 SAND BORROW AND CUSHION. Sand borrow shall consist of material reasonably free from silt, loam, clay, or organic matter. It shall be obtained from approved sources and shall meet the requirements of the following table:

TABLE 703.03A - SAND BORROW AND CUSHION

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
2"	100	
1½"	90-100	
½"	70-100	
No. 4	60-100	100
No. 100		0- 30
No. 200		0- 12

703.05 GRANULAR BORROW. Granular borrow shall be obtained from approved sources, consisting of satisfactorily graded, free draining, hard, durable stone and coarse sand reasonably free from loam, silt, clay, or organic material.

The Granular Borrow shall meet the requirements of the following table:

TABLE 703.05A - GRANULAR BORROW

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
No. 4	20-100	100
No. 200		0- 15

The maximum size stone particles of the Granular Borrow shall not exceed 2/3 of the thickness of the layer being spread.

704.05 GRAVEL FOR SUB-BASE. Gravel for Sub-base shall consist of material reasonably free from silt, loam, clay, or organic matter. It shall be obtained from approved sources and shall meet the following requirements:

(a) Grading. The gravel shall meet the requirements of the following table:

TABLE 704.05A - GRAVEL FOR SUB-BASE

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
No. 4	20-60	100
No. 100		0- 18
No. 200		0- 8

The stone portion of the gravel shall be uniformly graded from coarse to fine, and the maximum size stone particles shall not exceed 2/3 the thickness of the layer being placed.

(b) Percent of Wear. The percent of wear of the gravel shall be not more than 25 when tested in accordance with AASHTO T-4, or more than 40 when tested in accordance with AASHTO T-96.

704.06 CRUSHED STONE FOR SUB-BASE. Crushed stone for sub-base shall consist of clean, hard, crushed stone, uniformly graded, reasonably free from dirt, deleterious material, pieces which are structurally weak and shall meet the following requirements:

(a) Source. This material shall be obtained from approved sources and the area from which this material is obtained shall be stripped and cleaned before blasting.

(b) Grading. This material shall meet the requirements of the following table:

TABLE 704.06A - CRUSHED STONE FOR SUB-BASE

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE
4½"	100
4"	90-100
1½"	25- 50
No. 4	0- 15

(c) Percent of Wear. The percent of wear of the parent rock shall be not more than 8 when tested in accordance with AASHTO T-3, or the crushed stone a percent of wear of not more than 40 when tested in accordance with AASHTO T-96.

(d) Thin and Elongated Pieces. Not more than 30 percent, by weight, of thin and elongated pieces will be permitted.

Thin and elongated pieces will be determined on the material coarser than the No. 4 sieve.

(e) Filler. The filler shall be obtained from approved sources and shall meet the requirements as set up for Sand Cushion, Subsection 703.03.

(f) Leveling Material. The leveling material shall be obtained from approved sources and may be either crushed gravel or stone screening produced by the crushing process. The material shall consist of hard durable particles, reasonably free from silt, loam, clay or organic matter.

This material shall meet the requirements of the following table:

TABLE 704.06B - LEVELING MATERIAL

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE
3/4"	100
1/2"	70-100
No. 4	50- 90
No. 100	0- 20
No. 200	0- 10

704.07 CRUSHED GRAVEL FOR SUB-BASE. Crushed gravel for sub-base shall consist of material reasonably free from silt, loam, clay or organic matter. It shall be obtained from approved sources and shall meet the following requirements:

(a) Grading. The crushed gravel shall be uniformly graded from coarse to fine and shall meet the requirements of the following table:

TABLE 704.07A - CRUSHED GRAVEL FOR SUB-BASE

GRADING	Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
COARSE	4"	100	
	No. 4	25- 50	100
	No. 100		0- 20
	No. 200		0- 12
	2"	100	
	1½"	90-100	
FINE	No. 4	30- 60	100
	No. 100		0- 20
	No. 200		0- 12

(b) Percent of Wear. The percent of wear of the parent gravel shall be not more than 20 when tested in accordance with AASHTO T-4, or the crushed gravel a percent of wear of not more than 35 when tested in accordance with AASHTO T-96.

(c) Fractured Faces. At least 30 percent, by weight, of the stone content shall have at least one fractured face.

Fractured faces will be determined on the material coarser than the No. 4 sieve.

704.09 DENSE GRADED CRUSHED STONE FOR SUB-BASE. Dense graded crushed stone for sub-base shall consist of clean, hard, crushed stone, uniformly graded, reasonably free from dirt, deleterious material and pieces which are structurally weak, and shall meet the following requirements:

(a) Source. This material shall be obtained from approved sources and the area from which this material is obtained shall be stripped and cleaned before blasting.

(b) Grading. This material shall meet the requirements of the following table:

TABLE 704.09A - DENSE GRADED CRUSHED STONE FOR SUB-BASE

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE
3½"	100
3"	90-100
2"	75-100
1"	50- 80
½"	30- 60
No. 4	15- 40
No. 200	0- 10

(c) Percent of Wear. The percent of wear of the parent rock shall be not more than 8 when tested in accordance with AASHTO T-3, or the crushed stone a percent of wear of not more than 40 when tested in accordance with AASHTO T-96.

(d) Thin and Elongated Pieces. Not more than 30 percent, by weight, of thin or elongated pieces will be permitted.

Thin and elongated pieces will be determined on the material coarser than the No. 4 sieve.

704.10 GRAVEL BACKFILL FOR SLOPE STABILIZATION. Gravel backfill for slope stabilization shall be obtained from approved sources, consisting of satisfactorily graded, free draining, hard, durable stone and coarse sand reasonably free from loam,

silt, clay, and organic material.

The gravel backfill shall meet the requirements of the following table:

TABLE 704.10A - GRAVEL BACKFILL FOR SLOPE STABILIZATION

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
No. 4	20-50	100
No. 100		0- 20
No. 200		0- 10

The stone portion of the gravel backfill shall be uniformly graded from coarse to fine, and the maximum size stone particles shall not exceed 2/3 the thickness of the layer being placed.

704.11 GRANULAR BACKFILL FOR STRUCTURES. Granular backfill for structures shall be obtained from approved sources, consisting of satisfactorily graded, free draining granular material reasonably free from loam, silt, clay, and organic material.

The granular backfill shall meet the requirements of the following table:

TABLE 704.11A - GRANULAR BACKFILL FOR STRUCTURES

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves TOTAL SAMPLE	SAND PORTION
3"	100	
2½"	90-100	
No. 4	50-100	100
No. 100		0- 18
No. 200		0- 8

TABLE I

WARREN GORE GRANULAR DATA SHEET NO. 1

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Existing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
1	1-A	1975	2-17	0-2	Yes	87	84	76	64	4	2	18.2%	Gran. Borrow (Gravel)	Owner: Brown Co. Area is a wooded esker trending nearly north-south with pit on west edge. Access is via Hurricane Brook access road which passes west of pit. Pit is 1.65 miles northwest of the junction of the Hurricane Brook access road and Vermont Route 114. The esker was on the west shore of Norton Pond, and had a crest from 30 to 50 feet wide. Test No. 1-A was on northeast face of pit. Material was: 2'-8', pebbly sand; 8'-9', gravel; 9'-10', sand; 10'-17', pebbly sand or fine gravel.
	1-B	1975	17-33	0-2	Yes			LOST						Test No. 1-B was below Test No. 1-A. Material was: 17'-33', interbedded pebbly sand and sand. Material was clean, sharp and gritty and may be good winter sand.
2	1	1975	2-15	0-2	Yes	92	86	73	62	20	9		Gran. Borrow (Gravel)	Owner: Brown Co. Area is small bank on west side of Hurricane Brook road, 1.4 miles northwest of its junction with Vermont Route 114. Pit is at junction of logging road to the north-west, and 140 feet north of a culvert across road. Test No. 1 was on face of bank.

WARREN GORE GRANULAR DATA SHEET NO. 2

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
														Material was: 2'-4', silty sand; 4'-7', crude gravel with angular stone fragments; 7'-15', silt-clay and angular pebbles; bottoms in angular boulders and sloughed material.
3	1	1975	2-18	0-2	Yes	100	100	100	100	38	15		Gran. Borrow (Sand)	Owner: Brown Co. Area is pit on east edge of partly cleared, flat-topped, granular lobe which may be of deltaic origin. Pit is on west side of Hurricane Brook Road, 0.7 mile northwest of its junction with Vermont Route 114. Test No. 1 was on northwest face of pit. Material was: 2'-18', silty sand and sand with some layers of pebbles; bottoms on sloughed material and angular boulders.
	2	1975	2-14	0-2	Yes			LOST						Test No. 2 was on west face. Material was: 2'-14', interbedded sand and pebbly sand with occasional small cobbles; bottoms on sloughed material. Test No.2 material was coarser than Test No. 1 and may have been a stream bed.

TABLE I

WARREN GORE GRANULAR DATA SHEET NO. 3

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing						Abrasion AASHTO T-4-35	Passes VIID Spec.	Remarks
						2"	1-1/2"	1/2"	#4	#100	#200			
4	1	1975	1-7	0-1	Yes	100	100	90	84	43	19		----	Owner: State of Vermont. Area is small, shallow pit adjacent to the west side of Vermont Route 114, 0.84 mile north of the Morgan town line and just east of the Canadian National Railway tracks. Pit is on a wooded knoll 225 feet long and 80 feet wide. Excess hot mix has been dumped in pit. Test No. 1 was on north face of pit. Material was: 1'-3', dusty gravel; 3'-7', silty sand.
5	1	1975	1-11	0-11	Yes	94	89	74	68	22	9	23.0%	Gran. Borrow (Gravel)	Owner: Brown Co. Area is a small pit on northwest end of a wooded knoll on the east side of Hurricane Brook access road, 0.63 mile northwest of its junction with Vermont Route 114. The crest of the knoll is 70'x70'. Test No. 1 was on face at north end of bank. Material was: 1'-4', gravel; 4'-11', interbedded sand, pebbly sand, and fine gravel seams; bottoms at 11' on road. The gravel in the 4'-11' interval is gap-graded (just cobbles and sand).
	2	1975	1-11	0-1	Yes	79	70	52	44	11	7	23.0%	Gravel	Test No. 2 was on south face of bank, 55 feet south-southeast of Test No. 1. Material was: 1'-7', coarse gravel and 12 to 24 inch boulders; 7'-9', sand; 9'-11', fine gravelly sand;

TABLE I

WARREN GORE GRANULAR DATA SHEET NO. 4

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
														bottoms on sloughed material.
6	1	1975	0-22	----	Yes	81	72	59	52	18	10		Gran. Borrow (Gravel)	Owner: Brown Co. Area is pit on southwest end of wooded, lobate, 200' x 100' knoll northeast of Hurricane Brook access road, 0.56 mile northwest of its junction with Vermont Route 114. Test No. 1 was on north-northeast face of pit. Material was: 0'-1', gravel; 1'-2', silty fine sand; 2'-4', sand; 4'-22', gravel and random boulders with some layers of silty fine sand; bottoms in boulders and sloughed material. This test represents material in pit extension.
7	1	1975	2-12	0-2	Yes	94	85	67	57	19	7	19.9%	Gran. Borrow (Gravel)	Owner: Brown Co. Area is pit adjacent to north side of logging road near old sheds, 0.53 mile northwest of the junction of the Hurricane Brook access road with Vermont Route 114. Pit is on the southeast edge of a wooded, gently sloping ridge which rises to the west, and may be a tributary to the main esker nearby. Test No. 1 was on face adjacent to logging road. Material was: 2'-12', gravel with random boulders; bottoms on boulders and sloughed material.

TABLE I

WARREN GORE GRANULAR DATA SHEET NO. 5

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
8	1	1975	1-11	0-1	Yes	90	83	68	58	13	9		Gran. Borrow (Gravel)	Owner: Brown Co. Area is an overgrown pit on southwest end of wooded ridge, which may be the continuation of an esker to the southwest. The pit is just west of a marshy area and is 0.5 mile northwest of the junction of the Hurricane Brook access road and Vermont Route 114. Test No. 1 was on northeast face of pit and represents the material in the ridge to the northeast. Material was: 1'-11', gravel with random boulders and a few minor silt seams (hard digging); bottoms on boulders and sloughed material.
9	1	1975	1-11	0-1	Yes	93	87	80	75	9	4		Gran. Borrow (Gravel)	Owner: State of Vermont. Former owner: Brown Co. Area is small, low pit on west side of Vermont Route 114 and east of railroad tracks. Pit is on low wooded knoll with a steep west slope, 2.26 miles north of the Morgan Town Line. Excess hot mix has been dumped in pit. Test No. 1 was on north face of pit. Material was: 1'-4', gravel; 4'-11', sand and pebbly sand.
	2	1975	1-10	0-1	Yes	85	85	85	81	14	7		Gran. Borrow (Sand)	Test No. 2 was on southeast face of pit, 65 feet southeast of Test No. 1.

TABLE I

WARREN GORE GRANULAR DATA SHEET NO. 6

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
														Material was: 1'-3.5', sand; 3.5'-4.5', gravelly sand; 4.5'-10', sand with an occasional small cobble. Screening would yield an acceptable sand. There was a pit on the east side of Vermont Route 114, 120 feet southeast of Test No. 2, but it was too overgrown and had too much sloughed material to sample.
10	1-A	1975	0-22	----	Yes	86	78	61	50	15	10	21.0%	Gran. Borrow (Gravel)	Owner: Brown Co. Area is a pit on east side of a long wooded ridge (which is probably an esker), on west side of the Hurricane Brook access road, 0.28 mile northwest of its junction with Vermont Route 114. Test No. 1-A was on south face of pit. Material was: 0'-22', coarse gravel in bouldery gravel; very hard digging; bottoms on bouldery gravel.
	1-B	1975	22-37	----	Yes	91	85	68	56	14	9	23.8%	Gran. Borrow (Gravel)	Test No. 1-B was below Test No. 1-A. Material was: 22'-37', coarse gravel and bouldery gravel; bottoms on piles of sloughed boulders.
	2-A	1975	2-13	0-2	Yes	75	75	61	49	15	10	25.6%	Gran. Borrow (Gravel)	Test No. 2-A was on north face of pit, 150 feet north-northeast of Test No. 1. Material was: 2'-13', coarse bouldery gravel. Material seems similar to that of eskers.

TABLE I

WARREN GORE GRANULAR DATA SHEET NO. 7

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
	2-B	1975	13-35	-----	Yes	89	89	69	56	14	9	21.8%	Gran. Borrow (Gravel)	Test No. 2-B was below Test No. 2-A. Material was: 13'-35', bouldery coarse gravel with some pockets of fine gravel on the lower part of the face; bottoms on boulders and sloughed material.
	3	1975	1-12	0-1	Yes	94	84	66	54	14	9		Gran. Borrow (Gravel)	Test No. 3 was on east face of esker along access road, 300 feet north-northeast of pit access. Material was: 1'-12', well-nested, coarse bouldery gravel; bottoms on sloughed boulders. Test represents the lower part of the esker's flanks.
	4	1975	0-25	----	Yes	81	76	62	55	15	9	21.6%	Gran. Borrow (Gravel)	Test No. 4 was on east face of south lobe of pit, 60 feet northeast of Test No. 1. Material was: 0'-6', gravel with small boulders; 6'-12', sand and pebbly sand; 12'-13', silty fine sand with cobbles; 13'-25'; gravel. This face was sampled to give an indication of the southern extension.
11	1-A	1975	0.5-14	0-0.5	Yes	85	80	69	60	14	7		Gravel (Grad-ing only)	Owner: Brown Co. Area is a wooded knoll with 2 pits west of logging road, 0.39 mile southwest of the Hurricane Brook access road, and 0.91 mile from the junction of the Hurricane Brook access road and Vermont Rt. 114.

TABLE I

WARREN GORE GRANULAR DATA SHEET NO. 8

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
														broad and rather flat-topped, and 500 feet long by 100 feet wide. Test No. 1-A was on face of northern pit. Material was: 0.5'-2.5', sand and silty sand; 2.5'- 14', interbedded sand and gravel with some random 6" to 20" boulders. There was a layer of 4" to 6" cobbles at the 4'-5' interval.
	1-B	1975	14-20	----	Yes	100	100	82	75	9	3		Sand	Test No. 1-B was below Test No. 1-A. Material was: 14'-20', interbedded sand and pebbly sand with boulders; bottoms on sloughed material.
	2-A	1975	0.5-12	0-0.5	Yes	72	72	67	60	6	4		Gran. Borrow (Sand)	Test No. 2-A was on north face of south pit, 500 feet southwest of Test No. 1. Material was: 0.5'-1', sand; 1'-3', pebbly sand; 3'-3.5', silt -clay seam; 3.5'-4', coarse sand; 4'-8', pebbly gravel; 8'-10', layers of pebbles and coarse sand; 10'-10.5', fine gravel with a few scattered cobbles; 10.5'-11.5', sand; 11.5'-12', pebbly fine gravel. Some gravel is present, but overall the material is sand or granular borrow.
	2-B	1975	12-21	----	Yes	100	100	87	83	5	4		Sand	Test No. 2-B was below Test No. 2-A. Material was: 12'-21', interbedded fine sand and pebbly fine sand; bottoms in sloughed material. Floor was wet in places.

TABLE I

WARREN GORE GRANULAR DATA SHEET NO. 9

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
12	1-A	1975	3-18	0-3	Yes	94	85	66	55	14	10	24.2%	Gravel	Owner: Brown Co. Area is a high face on east slope of wooded esker, 0.17 mile west of Vermont Route 114. The esker is west of marshes at the first sharp curve in the Hurricane Brook access road, and trends nearly north-south. It ranges up to 75 feet above the road; its summit is flat-topped and 20 feet to 40 feet wide by over 600 feet long. Test No. 1-A was on upper part of face. Material was: 3'-5', gravel; 5'-18', interbedded gravel and pebbly fine gravel seams and some large boulders; there was much vegetation and some sloughed material on upper face. The gravel was well-nested and hard to dig.
	1-B	1975	18-40	----	Yes	100	100	88	76	12	9		Sand	Test No. 1-B was below Test No. 1-A. Material was: 18'-40', sand and pebbly sand with some boulders; there was much sloughed material; uncertain if material was in place. The 0'-3' interval of overburden was boulders which could be used (or crushed).
13	1	1975	3-9	0-3	Yes	71	66	61	55	14	8		Gravel (grading only)	Owner: Brown Co. Area is a wooded ridge with a pit on both sides of small logging road, 0.65

TABLE I

WARREN GORE GRANULAR DATA SHEET NO.10

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
														mile south of main access road, and 1.17 miles west of the junction of the Hurricane Brook access road and Vermont Route 114. The ridge is broad and fairly flat-topped, and slopes down from northwest to southeast. Test No. 1 was on south face of small pit on southeast side of haul road. Material was: 3'-4', dusty, cemented gravel; 4'-6.5', fine gravel and pebbly gravel beds; 6.5'-9', sand and pebbly sand; bottoms on sloughed material. The 0'-3', interval was boulders.
	2	1975	0-7	---	Yes	79	69	53	40	13	7	18.6%	Gravel	Test No. 2 was face of small pit, 75 feet northwest across logging road from Test No. 1. Material was: 0'-7', well-nested, coarse gravel with some cementation; there were many plus 4" stones, but none were included in sample; bottoms on sloughed material and boulders. The material at this site was coarser than that at Test No. 1.
	3	1975	3-11	0-3	Yes	92	87	69	57	16	9	22.4%	Gran. Borrow (Gravel)	Test No. 3 was on north face of bull-dozed trench on wooded hillside northwest across haul road from Test No. 1. Material was: 3'-9', coarse gravel; 9'-11', pebbly sand; bottoms in silt-clay and sloughed material. The 0'-3'

WARREN GORE GRANULAR DATA SHEET NO. 11

Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VIID Spec.	Remarks
														interval was boulders. The test was offset, but represents a vertical distance.
14	1	1975	1-15	0-1	Yes	100	94	88	81	4	2		Sand	Owner: Brown Co. Area is a small pit on curve in logging road, 0.2 mile east of main logging road, and 0.86 mile south of the Hurricane Brook access road. Area is 1.6 miles from junction of Hurricane Brook access road and Vermont Route 114. The pit is on the east edge of a wooded, low, nearly flat-topped ridge which rises gently to the west. Test No. 1 was on face of pit. Material was: 1'-6', dusty gravel over fine gravel; 6'-15', inter-bedded sand, pebbly sand, and fine gravel layers.
15	1	1975	2-8	0-2	Yes	83	80	69	59	24	14		Gran. Borrow (Gravel)	Owner: Brown Co. Area is a small bull-dozed trench in low bank adjacent to west side of logg-ing road, 1.2 miles south of Hurricane Brook access road, and 1.72 miles southwest of its junction with Vermont Route 114. Test No. 1 was on south face of trench. Material was: 2'-4', dusty gravel; 4'-6', angular boulders and some sand; 6'-8', hard-packed, compact, silt-clay coated, angular pebbles and sand; from 5'-8', the material was gray, indicating a high water table.

TABLE I

WARREN GORE GRANULAR DATA SHEET NO. 12

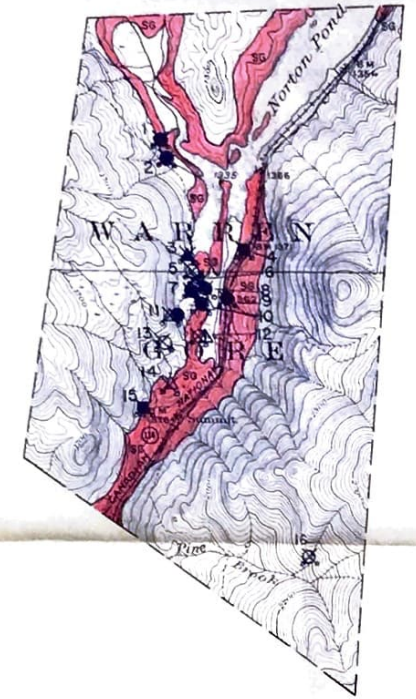
Map Ident. No.	Field Test No.	Year Field Tested	Depth of Sample (Ft)	Over-burden (Ft)	Exist-ing Pit	Sieve Analysis % Passing 2"	1-1/2"	1/2"	#4	#100	#200	Abrasion AASHTO T-4-35	Passes VHD Spec.	Remarks
16	1	1975	1-6	0-1	Yes	86	75	58	46	20	12	20.3%	Gran. Borrow (Gravel)	Owner: Brown Co. Area is a pit on logging road near the summit of Bluff Mountain in the southeast corner of town. Area is being used to make logging roads. The key to a locked cable across the access road near Vermont Route 114 can be obtained from Roland Devost in Norton, who cuts by contract for Brown Co. The pit is 2.47 miles east of Vermont Route 114, and 0.97 mile north of the Morgan town line. The irregular-shaped pit is 250' long and 150' wide; its faces slope up to the north. Test No. 1 was on west face of east trench in pit. Material was: 1'-3.5', fine gravel; 3.5'-4.5', silt-clay and angular rock fragments; 4.5'-6', sandy gravel; the material was hard-packed, and contained mostly granitic stones.
	2	1975	2-11	0-2	Yes	100	81	63	50	14	7	20.3%	Gravel	Test No. 2 was on west face of west trench. Material was: 2'-4', fine gravel; 4'-6', gravelly sand; 6'-9', nearly white sand with scattered small cobbles; 9'-11', silt-clay and angular rock fragments.

Table I
Supplement

WARREN GORE PROPERTY OWNERS - GRANULAR

	Map Identification No.
Brown Co.	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16
Vermont, State of	4, 9

N



LEGEND

- ○ GRAVEL, ACCEPTABLE FOR ITEM 704.05 (gravel for sub-base)
- ● GRAVEL, DEPLETED OR NOT ACCEPTABLE FOR ITEM 704.05
- △ SAND, ACCEPTABLE FOR ITEM 703.03 (sand borrow and cushion)
- ▲ SAND, DEPLETED OR NOT ACCEPTABLE FOR ITEM 703.03
- □ GRANULAR BORROW, ITEM 703.05
- ■ MATERIAL NOT ACCEPTABLE FOR ITEM 703.05
- ✕ EXISTING PIT
- SAND and GRAVEL DEPOSIT
- SAND DEPOSIT
- 3 IDENTIFICATION NUMBER (refer to data sheets)

WARREN GORE

SCALE 1:31,250

CONTOUR INTERVAL 20 FEET

1976

GRANULAR MATERIALS MAP

BY

VERMONT DEPARTMENT OF HIGHWAYS

IN COOPERATION WITH

U.S. BUREAU OF PUBLIC ROADS

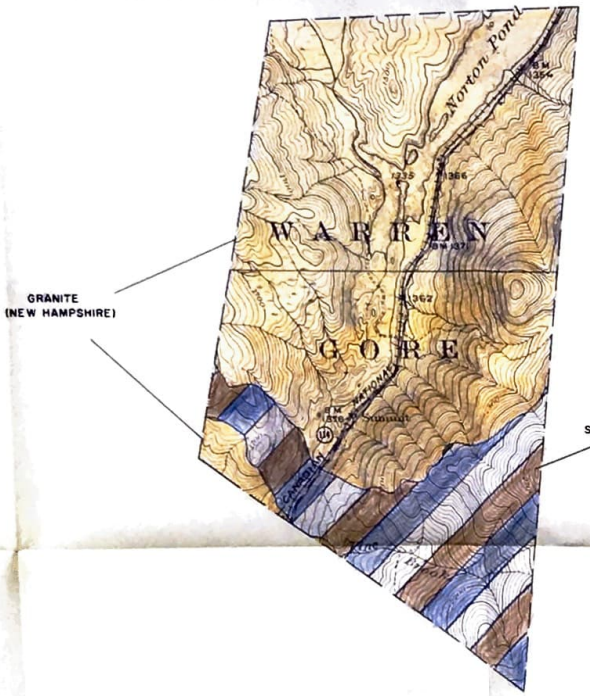
NOTE: BASED ON U.S.G.S. TOPOGRAPHIC MAPS

ESSEX COUNTY VT. HWY. DISTRICT NO. 9

REVISIONS

DATE						
BY						

N



LEGEND

- ROCK, ACCEPTABLE FOR ITEM 704.06 (crushed stone for sub-base)
- ROCK, NOT ACCEPTABLE FOR ITEM 704.06
- EXISTING QUARRY
- GRANITE TO DIORITE (light to intermediate igneous rocks)
- AMPHIBOLITE, GABBRO, DIABASE, METADIABASE, GREENSTONE, TRAP DIKES (basic or dark igneous rocks)
- PERIDOTITE, PYROXENITE, SERPENTINITE (ultra-basic igneous rocks)
- GNEISS
- QUARTZITE
- DOLOMITE
- MARBLE, LIMESTONE
- SCHISTS, SLATES, PHYLLITES, SHALES, CONGLOMERATES
- 3 IDENTIFICATION NUMBER (refer to data sheets)

WARREN GORE

SCALE 1:31,250

0.5 0 1 MILE

CONTOUR INTERVAL 20 FEET

1976

ROCK MATERIALS MAP

BY

VERMONT DEPARTMENT OF HIGHWAYS

IN COOPERATION WITH

U.S. BUREAU OF PUBLIC ROADS

NOTE: BASED ON U.S.G.S. TOPOGRAPHIC MAPS

ESSEX COUNTY VT. HWY. DISTRICT NO. 9

REVISIONS

DATE						
BY						

PLATE II ROCK