1978


Jordan Gorrill Associates

Edward C. Jordan Co., Inc.

United States Department of Energy

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GEOTECHNICAL IMPACT STUDY

PREFACE

On October 1, 1977, the responsibility for marketing federally generated power (under provisions of the Flood Control Act of 1944) was transferred from the Department of the Interior to the newly formed Department of Energy. The power transmission portions of the Dickey-Lincoln School Lakes Project were included in that transfer.

The U.S. Departments of the Interior and Energy have conducted system planning, location, and environmental studies for the transmission facilities required for the Dickey-Lincoln School Hydroelectric project. These studies of many alternate routes have resulted in identification of a proposed transmission line route and an environmental impact statement, as required by the National Environmental Policy Act of 1969. This report, one of several prepared under contract to the DOE by various consultants, is published as an appendix to that statement.

Appendix F, Geotechnical Impact Study (two volumes, the second being a map volume), documents a study performed by E. C. Jordan, Inc., Portland, Maine. The contract for this work was awarded in April 1977. At that time, the Department had completed system planning and regional corridor studies, and identified a system of alternative transmission line routes, substations, and microwave additions (delineated on the map inserted in this report). The contractor's responsibility was to assess and report the geotechnical factors affecting the suitability of the alternative routes, and also the impact of facility construction, operation and maintenance on erosion, sedimentation, mineral extraction, etc. This assessment was important to the Department's overall studies, which provided input into the route decision process, as well as necessary information for the environmental impact statement.

E. C. Jordan, Inc., was selected to perform this study through a comprehensive competitive evaluation process which considered, among other factors, past performance on similar studies, technical qualifications, management capabilities, and familiarity with the northern New England area. This firm was found to be well qualified.

Harry D. Hurless
Project Manager
DICKEY-LINCOLN SCHOOL LAKES TRANSMISSION
ENVIRONMENTAL IMPACT STATEMENT PROJECT

ENVIRONMENTAL ASSESSMENT OF ALTERNATIVE ROUTES
GEOTECHNICAL STUDY

Prepared For:
U.S. DEPARTMENT OF INTERIOR
Bangor, Maine

Prepared By:
JORDAN GORRILL ASSOCIATES
Edward C. Jordan Co., Inc.
Portland, Maine

1977
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I. INTRODUCTION

The U.S. Department of Interior entered into a contract with the Edward C. Jordan Co., Inc., in April 1977, to conduct an assessment of the geotechnical impacts of alternative 345 kv transmission routes required to bring power generated by the proposed Dickey-Lincoln hydroelectric project across northern Maine, New Hampshire and into Vermont. Dating back to 1873, the Jordan Company is one of New England's most experienced consulting organizations. The firm's specialized geotechnical branch, Jordan Gorrell Associates, was founded in 1958, and has grown in size and reputation to become the largest geotechnical firm in northern New England. The firm's experience and knowledge of the pedologic and surficial geologic conditions of northern New England have become a valuable element of some of the region's most prominent planning, engineering and construction projects.

To address the Dickey-Lincoln transmission impact study, the Jordan Company's project team drew from experience on several related large-scale impact assessments and geotechnical investigations. Examples of related assignments include impact studies for the Dickey-Lincoln School impoundments in northern Maine and the proposed New England Energy Company's oil refinery and pipeline project from Sanford to Portland, Maine. Jordan Gorrell Associates has conducted specialized geotechnical investigations for Central Maine Power transmission projects and for many other research and consulting projects in New England for various areawide land use and water quality studies.

The E.C. Jordan Company's interdisciplinary approach to this study has brought together the efforts of our geologists, soil scientists and soil engineering personnel. Our approach to this study element has been designed to meet the EIS objectives expressed by the Department of Interior.

The geotechnical data was identified, mapped, described and analyzed along the proposed transmission corridor, microwave tower and substation sites associated with the Dickey-Lincoln School Lakes project. An assessment of the environmental impact of the proposed action related to the geotechnical variables was made in terms of construction, maintenance and operation. The potential effects of impact mitigating measures related to the proposed action were also assessed. Based on our assessment of the geotechnical elements, we have identified those effects which we believe cannot be avoided, temporal and permanent disturbances, and irreversible actions and/or irretrievable conditions related to earth resources should the proposed action be implemented.

The geotechnical data was developed both from existing available information and the interpretation of recent low-level color, and black and white, aerial photographs. A continuous map of the surficial geologic material along the one-half mile wide right-of-way for each link from Fort Kent, Maine to Essex, Vermont was prepared from the assembled data.

-1-
The geotechnical characteristics of erosion potential, sedimentation potential, slope and soil instability and mineral and aggregate potentials were described for each link both in tabular (Tables 1, 2 and 3) and written format. Analyses of these characteristics were made and the resulting comparative and quantitative impacts are summarized on Table 4. Alternate route selection was made from the individual and cumulated link impacts as shown in Table 4, and are described in the text.
II. EXISTING CONDITIONS

A. ASSUMPTIONS & CONSIDERATIONS

In order to proceed with the study, certain assumptions had to be made concerning the methodology, area to be studied, the accuracy and interpretation of data.

1. In general, description of the existing environment was limited to the one-half mile corridor. In some instances, it was necessary to identify those geotechnically related features that were outside the actual corridor as part of the identification of these features within the corridor. Mapping and tabulation only included those geotechnical variables within the corridor. Where discrepancies existed between the photos and maps supplied; it was assumed the photos were correct.

2. The primary source of geotechnical information was the aerial photographs (scale of 1:24,000) supplied by the D.O.I. Existing pedologic and geologic information was used for those areas that have been previously mapped.

3. While the geotechnical variables were mapped for the entire one-half mile wide corridor, the tabulations were measured in tenths of miles along the corridor centerline. Significant changes of the existing conditions across the corridor (perpendicular to the centerline) were identified in Table 1 (Appendix II).

4. In order to minimize the numerous tabulated units (Table 1), weighted values for slopes and erosion potentials were given for each surficial material unit where significant variations occurred within each mapped unit.

5. While an attempt was made to identify exposed rock areas, the heavy vegetation cover and limited outcrop size resulted in most of the categories being mapped with the shallow glacial till units.

6. All clean moderate to coarse textured granular deposits were assumed to be potential aggregate sources.

7. Additional sources of pertinent geotechnical information was obtained from personal contact with the state geologist from Maine, New Hampshire and Vermont.
B. METHODOLOGY

The methodology used for the identification, mapping, tabulation, and description of the existing environment in terms of geotechnical variables will be described by task.

1. Data Assembly

In this task an effort was made to assemble all existing available data from both the DOI and outside sources. The DOI supplied the following: aerial photographs at a scale of 1" to 2,000', topographic maps at a scale of 1:62,500 (15' series), and all previous project material pertaining to geotechnical variables. Geologic and pedologic material was obtained from State and Federal sources. (Note: Less than 50 percent of the proposed transmission routes are covered by these sources.) A large portion of the pedologic information had to be obtained by personal visits by our soil scientist to the local Soil Conservation Service County Offices. Additional information pertaining to slopes and water features was obtained through the DOI. In addition, personal contacts were made with the state geologists from Maine, New Hampshire and Vermont.

2. Photo Interpretation of Geotechnical Data

This task was started concurrently with the acquisition of existing data (Task No. 1) and was completed before all this data was received. Simply, this task involved viewing the aerial photographs as stereoscopic pairs and the identification of mappable surficial materials. The identification was made through a combination of processes that involved professional experience and judgements based on the visual recognition of topographic expression, relief and orientation, soil characteristics that are reflected by topographic position and vegetation changes, the assumption that man's activities and land use patterns reflect soil characteristics, an understanding of the historic geologic processes, and the correlation with available data at the time. Modification of the geotechnical data identified from the aerial photographs was made as the existing data from outside sources was received. The most significant problem to arise during this task was one of scale differences between the photos, topographic, geologic and pedologic information. The actual annotation to the base maps was made visually as the identification was made on the aerial photographs. No annotation was made on the photographs.

a. Slope Identification. The digitized computer maps supplied by the DOI were reviewed by our staff and found to be insufficient for the degree of accuracy needed to evaluate the potential geotechnical problems. In place of this information source, the slopes were identified with the use of a transparent overlay template. The slopes were measured for each mapped surficial material unit. In order to minimize the already numerous units, a weighted, average value was assigned to each mapped unit where slope variation occurred.
b. Tabulation of Geotechnical Data. The surficial material units and slope categories from the base maps were tabulated by the actual mile segments along the centerline for each link. A weighted average was used where material variation occurred adjacent to the centerline (see Table 1, Appendix B). The erosion potential is based on an identified or assumed "K" values and was calculated for each soil material and slope category combination. A quasi-quantitative value for erosion potential was assigned to those units (see Figure 1).

c. Compilation of Geotechnical Data. From Table 1 a compilation of total miles for each surficial material and slope category was made. Table 3 (Compilation of Surficial Material-Slope-Sedimentation Potential) shows the miles/link and percent/link for each category (Appendix C).

C. DESCRIPTION

1. Segment A

Segment A covers the area from Dickey to Fort Kent along the southeast side of the St. John River Valley. See Figure 2 for segment identification and location. The topographic setting is one of moderate relief with mature stream development. Relief ranges from approximately 500 feet to slightly over 1,500 feet (MSL). Most ridge and hill summits range between 1,300 and 1,400 feet. The major topographic high is Bossy Mountain, located between Links 1 and 2 west of the town of Fort Kent. Between Dickey and St. Francis, the St. John River is moderately restricted within the well-drained valley walls. Below St. Francis to Fort Kent, the river valley broadens with a moderately well developed flood plain. The soils are predominantly glacial till with some outwash and alluvial soil found mostly along the St. John River.

Bedrock throughout Segment A is confined to the Seboomook formation. This sequence of rocks is predominantly a cyclically bedded sequence of gray slate, sandstone, and some graywacke of Early Devonian age. The northeast trend of rocks in this area can be readily identified by the linear topographic expression that is the result of the differential erosion between the less resistant, highly fissile slates and the more resistant sandstone and graywacke beds. Slopes range from low to excessive. In general, this segment has a high percentage of excessive slopes. Soil stability problems are mostly related to erosion with the resulting sedimentation of water features. Relatively extensive areas of potential aggregate sources are located in the topographically low areas along the St. John River.

Most of Segment A has been mapped by the USDA Soil Conservation Service. The medium intensity soil survey (Soil Survey, Aroostook County, Maine) published by SCS indicates that two basic soil associations are found in this segment. These are Thorndike-Howland and Stetson-Allagash-Hadley-Winooski Associations. The Thorndike-Howland Association consists of
QUALITATIVE EROSION POTENTIAL
Based on Slope Class and Erodibility Class For Each Segment Length

<table>
<thead>
<tr>
<th>EROSION POTENTIAL</th>
<th>SLOPES</th>
<th>SLOPE ( k ) VALUE</th>
<th>CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>S - SLIGHT</td>
<td>0-5%</td>
<td>LOW ( .10-.22 )</td>
<td>LOW</td>
</tr>
<tr>
<td>M - MODERATE</td>
<td>5-15%</td>
<td>MODERATE ( .23-.34 )</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>H - HIGH</td>
<td>15-35%</td>
<td>STEEP ( .35-.52 )</td>
<td>HIGH</td>
</tr>
<tr>
<td>VH - VERY HIGH</td>
<td>&gt; 35%</td>
<td>EXCESSIVE ( .53-.78 )</td>
<td>VERY HIGH</td>
</tr>
</tbody>
</table>

- **SLOPES**
  - LOW
  - LOW TO MODERATE
  - MODERATE
  - MODERATE TO STEEP
  - STEEP
  - STEEP TO EXCESSIVE
  - EXCESSIVE

- **ERODIBILITY**
  - LOW
  - MEDIUM
  - HIGH
  - VERY HIGH
Segment Map

Figure 2
soils derived from glacial tills. They are mostly shallow to bedrock Thorndike soils on the hills and the deeper, moderately well-drained Howland soils in the lower areas. Topography is generally irregular in this association and erodibility is classified as medium. The Stetson-Allagash-Hadley-Winooski Association consists of soils formed in floodplains and terraces. They consist of water-deposited sands and gravels and some silts. Most of the soils in the association are well-drained. Hadley and Winooski soils are floodplain soils found along streams and the St. John River. These soils are highly erodible. The well-drained Allagash and Salmon soils and the moderately well-drained Madawaska and Nicholville soils are found on the lower terraces. These soils, due to their glacial outwash origin, are mostly sandy and generally have a medium erodibility but have high erodibility in the wetter areas. Stetson and Machias soils are found in the higher terraces and are usually more gravelly. These soils have low to medium erodibility, the association in general has a high erodibility. Soils of this association are found in most stream valleys in Segment A.

Link No. 1

This link runs from the Lincoln School to Fort Kent between the St. John River and bordering valley walls. The link alternates from the moderate to steep hillsides and the flatter outwash and alluvial valley fill materials. Approximately 70 percent of the route is across granular outwash and alluvial material, and nearly 60 percent of the area has a low slope. Potential aggregate sources exist along this link. Limited areas of potential erosion and sedimentation problems exist on the steeper slopes.

Link No. 1A

This short connector link is between the Lincoln School Substation and the junction of Links 1B and 3. This link is over outwash material with low slope conditions. Potential aggregate sources exist in this area.

Link No. 1B

This short connector link is between the 1A and Links 1, 2, and 3, and is entirely over outwash material with low slope conditions. Potential aggregate sources exist in this area.

Link No. 1C

This short connector link between the Fish River substation and Links 1 and 2 ranges from low to moderate slopes and will require the crossing of the Fish River. The surficial materials range from 50 percent outwash to 50 percent glacial till. The outwash is a potential source of aggregate material.
Link No. 2

This link runs between Lincoln School and Fort Kent along the topographic low in which Petite, Paradis and Wheelock Brooks head up. Bran, Hunnewell, and Wheelock Lakes are also located along this depression. The linear topographic feature has been identified by Boudette, Hatch and Harwood (1976 Reconnaissance Geology of the Upper St. John and Allagash River Basins, Maine), as the Hunnewell Lake lineament. The above authors conclude that this linear feature may be related to a major fault. Twenty-five percent of this link was mapped as having steep to excessive slopes and 95 percent of the surficial materials are glacial till. Soil instability, erosion and sedimentation potentials are high due to the slope conditions.

Link No. 3

This link runs between the Dickey and Lincoln School Substations along the southeast side of the St. John River. Nearly 40 percent of this route has slopes in the steep to excessive category. The route crosses and parallels the "Hunnewell Lake Lineament" as described by Boudette, Hatch and Harwood (1976) Glacial till accounts for approximately 90 percent of the surficial materials. A potential for soil instability, erosion and sedimentation problems exist on the steeper slopes and in particular where shallow soil material occurs on these slope conditions.

2. Segment B

This series of links covers the area from Dickey to Jackman/Moose River and includes Links 4 through 10 and the northeastern portions of Links 11 and 12 (11A and 12A). The links in Segment B run southwest and south-southwest across relatively flat to moderately rolling topography. A more detailed discussion of the topographic setting will be made by individual links. Slopes are predominantly low to moderate with only short stretches of steep to excessive slope conditions. Glacial till is the predominant surficial material with some outwash, ice contact, alluvial and alluvial mixtures with peat and muck located in topographic low areas and stream valleys.

The bedrock underlying Segment B is comprised entirely of metasedimentary rocks of upper Silurian and lower Devonian age (Seboomook formation). Although the rocks have been tightly folded, only low grade thermalmetamorphism has occurred in this segment. The rocks in this segment appear to be of the biotite metamorphic grade. The lithologic changes and geologic structure of the area appears to influence the topography. A massive argillaceous sandstone including some volcanics forms a zone of more resistant rocks from Lake Caucomgomoc through Seboomook and Canada Falls Lakes southwestward toward the Canadian border. These more resistant rocks of the Frontenac and possibly the
Tarratine formation may also include the area around Green Mountain. In general, the volcanics and graywackes, due to differential erosion with the less resistant shales, slates, and phyllites, form the higher topographic features.

Most of the soils along Segment B have been formed in glacial tills. Little is known about the soils found in this area. The Soil Conservation Service is presently conducting reconnaissance soil investigations in the area. Preliminary information indicates that soils of the Perham-Daigle soil association are found along the segment from Dickey to Allagash Stream and Doucie Brook. These soils are deep, usually greater than 3 feet to bedrock, but in the higher and steeper areas of this section of Segment B, shallow-to-bedrock soils are present. Perham and Daigle soils are silty to sandy and have a dense, compact substratum. Perham soils are well-drained and are found on upper slopes. Daigle soils are poorly drained and are found on the lower slopes. Erodibility of these soils is medium.

In the southern section of the segment, the glacial till soils have been identified as the Chesuncook-Telos-Monson association. These soils are silty and stony. Chesuncook and Telos soils have a very firm compact substratum. Monson soils are shallow to bedrock. Chesuncook soils are well-drained and are found on the upper slopes and Telos soils are poorly drained and are found in the lower area. Erodibility is medium. Soils of this type are common in northern Maine areas where steep slopes and great relief are present.

Most of the outwash derived soils of Segment B belong to the Colton-Stetson-Allagash association. These soils are usually gravelly and well-drained. Erodibility is low.

The areas of floodplain and alluvial soils are of the Hadley-Winooski association. Erodibility is high. These soils are of minor extent along the segment.

Peat and muck deposits are present in the lower areas of the segment, and are highly erodible if disturbed.

**Link No. 4**

This link runs from Dickey Substation to an area several miles northwest of Chemquasabanticook Lake at the junction with Links 5 and 9. In general, the topographic relief gradually diminishes from approximately 1,000 feet over the first 10 miles to 300 to 400 feet by the end of this link. Summit elevations range from 1,250 to 1,500 feet (MSL). Slopes are predominantly low to moderate for the entire route with only 3 percent classified as steep. The steeper slopes are encountered in the first short stretch where the route leaves the St. John River Valley. The area surrounding this
Link can be characterized as a uniformly dissected plateau of low relief. Ninety percent of the route is glacial till with limited areas of granular and alluvial material restricted to the shallow stream valleys. The bedrock of the entire route is identified as the Seboomook formation. Potential soil instability, erosion and sedimentation problems are low as a result of the topographic setting.

Link No. 5

Link 5 runs from the junction of Links 4 and 9 northwest of Chamquasabamticook Lake southwestward toward Baker Lake and continues south and southwest to the junction of alternate Links 6 and 7 west of Big Bog. The topographic relief varies between 200 and 300 feet over the entire link. The low topographic expression is due to the erosional uniformity of the bedrock material within the Seboomook formation. Ninety-two percent of the surface is of low slope. No steep or excessive slopes were identified as mappable units. More than 90 percent of the route is over glacial till materials. Alluvial mixtures with peat and muck material were identified along most of the stream valleys.

Link No. 6

Link 6 starts in the area of low topographic relief similar to the entire stretch of Link No. 5 and trends more southward to the junction with Link No. 8 northwest of Canada Falls Lake. The southern half of this link has slightly higher relief near Green Mountain Ridge, the major topographic high in the area. While overall relief is slightly over 1,000 feet, the area around Green Mountain is more significant. In this area, the route runs through a natural gap in the Green Mountain ridge line. Within the actual half-mile wide link boundaries, more than 50 percent of the slopes are moderate with no steep or excessive areas. Again, the glacial till soils account for nearly 90 percent of the surficial material along the route. This route crosses the North Branch of the Penobscot River twice.

Link No. 7

Relief, slope and surficial materials along this link are very similar to Link No. 6. This route runs slightly west of Link No. 6 and follows a natural low around the west end of the Green Mountain ridge near the south end of Long Pond. The higher relief in the southern half of both Link 6 and 7 are the result of differential erosion between more highly resistant argillaceous sandstone and possible volcanics and the softer, less resistant, slates and phyllites of the Frontenac and possibly Tarratine formations.
Link No. 8

This route continues southward from the junction of Links 6 and 7 passing the west end of Canada Falls Lake. Southward from this point, the route proceeds through an area of moderately high topographic relief (similar to that encountered in Links 6 and 7). The proposed transmission route follows a natural gap east of Trickey Bluffs and between the western extension of the Ironbound Mountain ridge and Boundary Bald Mountain along Alder Brook to the junction of Links 10 and 11A. While this route crossed an area of moderately high relief, the actual link boundaries do not encompass any mappable areas of steep or excessive slopes. Nearly 95 percent of the surficial materials are glacial till in origin.

Link No. 9

Link 9 starts at the junction with Links 4 and 5 northwest of Chemquasabamticook Lake and proceeds south toward Caucomgomoc Mountain. The topographic relief gradually increased from about 250 feet immediately south of the link junction to 600 to 800 feet along the west flank of the Caucomgomoc Mountain ridge. The increased topographic expression in this area is due to the differential resistance to erosion between the metavolcanic and metasedimentary sequences of rocks. Southward from the Caucomgomoc Mountain area the topographic relief gradually decreased to less than 200 feet at the crossing of the West Branch of the Penobscot River near Seboomook Dam. The route turns southwestward between Seboomook and Moosehead Lakes and proceeds to the junction of Links 9A and 10A. The relief along the portion of the link is generally between 200 and 300 feet. Glacial tills account for over 90 percent of the surficial materials along this link. A total of 8 percent of the slopes in the area along this link are identified as steep to excessive. Soil instability, erosion and sedimentation potential are higher for the steeper portions of this link in the area of Caucomgomoc Mountain.

Link No. 9A

This link starts at the junction of Links 9 and 10B, and proceeds in a southwest direction to Long Pond then continues in a westerly direction to the junction of Link 10 at the northwest corner of Long Pond. The relief along this link is generally between 200 and 300 feet. At the north end of Long Pond the relief rises to 400 feet. Glacial tills account for approximately 99% of the surficial materials along this link and 100% of the slopes in the area along this link are identified as low to moderate.
Link No. 4

This short link connecting the links of 8 and 11A with 9A and 12, is entirely of low relief (200 to 300 feet). low slopes and glacial till surficial material. (Note: Those portions of Links 11 and 12 north of the Jackman/Moose River midpoints will be described in Segment C.)

Link No. 10A

This link starts at the junction of Links 9 and 9A and proceeds in a westerly direction to Link 10, (1 mile southwest of Fish Pond) and continues in a westerly direction until the junction of Links 11A and 11 near Upper Churchill Stream. Relief along this route is generally between 200 and 300 feet. All slopes within the right-of-way were mapped as low to moderate. More than 90 percent of the surficial soil material is glacial till.

3. Segment C

This segment runs from the Jackman/Moose River area southwestward through the hilly to mountainous terrain of northwestern Maine and northern New Hampshire to the Moore Substation on the Connecticut River. Due to the rugged terrain, most of the links have some steep to excessive slopes. The mountainous portions of the segment are part of the northern extension of the White Mountains. In general, the summit elevations increase from the Jackman/Moose River area to the Groveton area of New Hampshire. The topography decreases from here to the Moore substation. Summit elevations around Groveton range from 2,000 to 2,600 feet. The predominant surficial material is glacial till with some fine granular and potential aggregate sources located along the stream valleys. Potential soil instability, erosion and sedimentation problems exist along the steeper portions of this segment.

The various links of Segment C are underlain by metamorphosed sedimentary rocks ranging from Ordovician to Devonian in age. In many areas, volcanic rocks are interspersed with, and gradational to, the sequence of slates, shales, phyllites and schists. The volcanic rocks, for the most part, were deposited contemporaneously to the adjacent metasediments and also range in age from Ordovician to Devonian. Both mafic and acidic intrusives were injected into the sedimentary sequence during multiple periods of deformation from Ordovician to Mississippian time. Some syenite and serpentine rocks of unknown age are encountered along the route. In general, the intrusive rocks weather and erode more slowly than the volcanic sequence which in turn weathers and erodes more slowly than the sedimentary rocks giving rise to a complex topography. In many cases, however, local structural and lithological characteristics are the principal determiners of topography.
Segment C has glacial till derived soils along most of its length. Much of these soils are silty and stony. The silty till soils belong to the Chesuncook-Telos-Monson soil association in Maine and the Calais-Buckland-Glover soil association in New Hampshire. All these soils have formed in compact tills and have very firm substrata. The Chesuncook-Telos-Monson association may be more silty and of a colder temperature regime, but basically the soils of these associations have similar characteristics. Chesuncook and Calais soils are well-drained deep soils which are found near the tops of ridges and hills. Telos and Buckland soils are found along the base of slopes and the lower areas of the segment, and are more poorly drained. Monson and Glover soils are shallow to bedrock. Soils of these types are found from Jackman to Wilson Mills, Maine and Columbia, New Hampshire. These soils have medium erodibility. South of Columbia, the till-derived soils are more sandy. Soils in this area belong to the Lyman-Berkshire-Marlow association and the more gravelly, Becket-Skerry-Lyman association. Shallow-to-bedrock soils are common. Because of steep slopes, much of the area is well-drained. The soils of these associations have low erodibility.

The till-derived soils in Vermont are more silty and the erodibility of these soils is higher. They are soils of the Cabot-Peru-Marlow association. Much of this area is well-drained.

South of Attean Pond to Spencer Lake in Maine, the till-derived soils belong to the Peru-Marlow-Lyman Soil Association. These soils are sandy to silty and have compact, very firm substrata. Lyman soils are shallow to bedrock. Erodibility is medium to low.

Along the large streams in Segment C, soils have formed sandy water-deposited terraces. The Masardis-Adams association have sandy and gravelly soils of this type. Peat and muck soils are common with these soils. They are found in Maine along the Dead River and from Parmachenee Lake to Cupsuptic Lake. Other terrace soils belonging to the Windsor and Adams-Colton-Duane associations are found along the Mohawk, Jones and Connecticut Rivers and Akers Pond. Mixed outwash-alluvial soils of the Colton-Ondawa-Podunk association are found along the Swift Diamond, Upper Ammonoosuc and Connecticut Rivers. Terrace soils have low erodibility. Floodplain soils are found only in a small area of the segment. These soils of the Limerick-Winooski association are silty and have a high erodibility. Segment C crosses the Connecticut River floodplain between Northumberland, New Hampshire and Guildhall, Vermont.

**Link No. 11**

Link 11, the western alternative in this area, starts at the junction of Links 10A and 11A northeast of Jackman. The topographic relief gradually increased from approximately 250 feet at the beginning of the route to about 500 feet in the Burnt Jocket Mountain area.
Here the route turns in a more southerly direction. The relief decreases across the Moose River area. The relief, again, increases southward along the route to over 1,000 feet. This link follows the natural gaps of the South Branch of the Moose River, Caribou Bog area, and the Middle Branch of Kibby Stream before ascending the divide between Kibby Stream and Gold Brook. This is the highest point of the proposed transmission route thus far, over 2,800 feet (MSL). Here the route descends to the North Branch of the Dead River, south of Chain of Ponds (approximately 1,300 feet elevation). From here the route crosses a portion of Bag Pond Mountain Ridge (approximately 2,500 feet elevation) and Round Mountain (approximately 2,700 feet). The route ends on the south flank of Round Mountain at the junctions with Links 13 and 14A. In spite of the mountainous terrain, only 13 percent of the route is classified as steep and less than one percent as excessive. More than 1.5 miles of the 46-mile link are over potential aggregate materials. Approximately 90 percent of the route material is glacial till with 35 percent of the route identified as shallow to bedrock glacial till materials. Soil instability, erosion and sedimentation potentials are increased along this route because of the increased slopes as well as the shallow soil conditions.

The link starts in the Seboomook Formation and rapidly encounters a variety of volcanics and intrusive rock formations. One of the most striking changes that can be visibly identified from the aerial photographs is between the Devonian-Silurian sequence of Conglomeratic sandstone, limestone and slates on the east side of the North Branch Stream in Dennistown and the Attean Quartz Monzonite on the west side of the stream. The stream marks the approximate contact line; on the east the topography is low with gently molded hills, while to the west the topography is one of isolated small "haystack" like hills showing clearly the blocky nature of the numerous joints which are characteristic of the Quartz Monzonite. From here the route turns gradually more southward and crossed metasedimentary and metavolcanics. Toward the end of this route, the bedrock conditions become more complex and include granite, diorite and gabbro intrusives.

**Link No. 11A**

This short link starts at the junction of Links 8 and 10 and connects Links 11 and 10A. It is entirely over low relief (100 feet - 150 feet) with low slopes over glacial till soils.

**Link No. 12**

This link starts in Jackman and heads south toward the west side of Catheart Mountain. Approximately 600 to 700 feet of relief is en-
countered in this area. South of Catheart Mountain, the route
crossed the southeastern corner of the Moose River Valley. Noticeable
outwash deposits and linear features are indicative of a major
glacial outwash channel. Here the route turns westward, crossing
the north end of Fish Pond. Passing south of Hardwood Mountain the
route turns southward again, crossing low to moderate topography
with relief in the range of 200 to 400 feet. The link crosses the
North Branch of the Dead River several miles north of Eustis. The
route turns westward again generally paralleling Tim Brook to the
junction with Links 12A and 13A near Sawyer Brook. This link has
less than 3 percent steep to excessive slopes and more than 72 per-
cent glacial till soils.

Link No. 12A

This connector link starts at the junction of Links 12 and 13A near
Sawyer Brook and proceeds in a southwesterly direction, passing
just south of Black Mountain and ends at the junction of Links 13
and 25. Relief along this link ranges from 800-900 feet, however,
the slopes in the area are low to moderate with over 93 percent
glacial till-derived soil material.

Link No. 13

Link 13 is a short connector between Links 12A/25 and 11/14A. The
route trends north-south and generally follows the upper tributary
of Alder Stream. More than 50 percent of the route is classified
as low slope and 25 percent steep. More than 21 percent of the
route is across alluvial and peat and muck soils. Based on the
higher percent of peat and muck soils and the steep slope classif-
ication, soil instability, erosion and sedimentation potentials are
moderately high. The bedrock material varies from metasedimentary
to gabbro and diorite intrusives.

Link No. 13A

This link begins at the junction of Links 12 and 12A and proceeds
in a westerly direction to a junction with Link 13 just west of the
South Branch of Alder Stream, and continues northwesterly to the
junction of Links 14 and 14A. Relief ranges from 800-900 feet with
over 9 percent excessive slopes, 15 percent steep slopes and more
than 94 percent glacial till soils. A potential exists for erosion,
sedimentation and slope and soil instability.

Link No. 14

This link starts on the south of Boil Mountain and runs west-
southwest to the Kennebago River immediately northwest of Cow
Ridge. The relief of this area is over 1,000 feet. Crossing the Kennebago River, the relief gradually decreases to less than 500 feet at the junction of Links 15 and 16 near Brown Dam Camp. The bedrock is similar to Link 13. Approximately one-third of the route is classified as steep to excessive. More than 90 percent of the soils are glacial till while the valleys are typically alluvial soils with peat and much deposits. Due to the steeper slope conditions the potential for soil instability, erosion and sedimentation problems exist.

**Link No. 14A**

This link starts at the junction of Links 11 and 13 and runs in a southwesterly direction across the south ridge of Boil Mountain to the junction of Links 13A and 14 just west of the West Branch of Alder Stream and south of Boil Mountain. The relief of this area is over 900 feet, more than 10 percent of the slopes are excessive and 13 percent steep slopes. Glacial tills account for over 85 percent of the surficial material. Due to the steeper slope conditions the potential for slope and soil instability, erosion and sedimentation exist.

**Link No. 15**

This link arcs northward from the junction with Links 14/16 across low topography for the first half of the route. Relief varies from 200 to 400 feet. After crossing the Magalloway River, the topography increased from 600 to 800 feet. The route ends at the junction with Links 16 and 17 southeast of Second Connecticut Lake (New Hampshire). Again, this link crosses highly variable metasedimentary and metavolcanic bedrock. No steep or excessive slopes were identified as mappable units along this link. Approximately 85 percent of the route is classified as glacial till soils with 7 percent of the link having a potential aggregate source. Most of this potential aggregate material is along the Magalloway River.

**Link No. 16**

This link starts at the junction of Links 14/15 at Brown Dam Camp and arcs southward crossing the Magalloway and Little Magalloway Rivers immediately south of Parmachenee Lake. This portion of the route is of moderately low relief (400-600 feet). After the little Magalloway River the relief rapidly increased to over 1,000 feet as the route crossed the north flank of Bosebuck Mountain. The route ends at the junction of Links 15/17 southeast of Second Connecticut Lake.
Approximately 19 percent of the route has steep to excessive slopes. Slightly less than 90 percent of the soils are glacial till. Potential soil instability, erosion and sedimentation exists along this link. Potential aggregate sources are located mainly along the Little Magalloway River Valley (approximately 9 percent).

**Link No. 17**

The route starts at the junction of Links 15/16 and runs southwest across moderate topography to the junction with Links 17A/17B south of the First Connecticut Lake. The north portion of the route skirts northwest of two major topography highs, Diamond Ridge and Magalloway Mountain. Relief is generally uniform over the entire route varying from 400 to 600 feet. Less than 7 percent of the route is classified as having steep slopes, no excessive slopes were identified as mappable units. More than 90 percent of the route is mapped as glacial till soils.

**Link No. 17A**

This connector link starts at the junction of Links 17 and 17B south of First Connecticut Lake and southwest of Magalloway Mountain and proceeds in a south-southwest direction to the junction of Links 18 and 19 south of Little Diamond Pond. Relief over the entire route varies from 400-600 feet with less than 4 percent slopes classified as steep, no excessive slopes were identified. Over 90 percent of the surficial material along the route is mapped as glacial till soil. A potential for erosion and sedimentation exists.

**Link No. 17B**

This link begins at the junction of Links 17A and 17 south of First Connecticut Lake and southwest of Magalloway Mountain and runs in a southwest direction to Mudget Mountain then proceeds in a southerly direction to the junction of Links 18A and 18 just west of Kidderville. Relief varies along this route from 1,200 to 1,300 feet with general decrease in elevation south of Mudget Mountain. Less than 3 percent steep slopes were identified as mappable units along this route. Over 90 percent of the surficial material was classified as glacial till soil. Some slope and soil instability problems may exist west of Morgan Notch.

**Link No. 18**

Link 18 starts at the junction of Links 17/19 and runs parallel to Link 19. The northern portion of the route parallels the North Branch of Hix Brook to Kidderville. At Kidderville the route
crosses the Mohawk River and continues south-southwestward toward Cranberry Bog Pond at the junction of Links 19/20. The topographic relief varies from 300 to 400 feet for most of the route. Near Cranberry Bog Pond relief increases to 600 to 800 feet. Potential aggregate sources account for the slightly more than 6 percent of the route while slightly more than 90 percent of the route is glacial till. Excessive slopes account for approximately 2.7 percent of the route. Some potential for soil instability, erosion and sedimentation problems may exist for these small areas where steeper slope conditions were identified.

Link No. 18A

This link starts at the junction of Links 17B and 18 and proceeds in a south-southwesterly direction to the junction of Links 19 and 20 west of Morgan Notch. Relief along this route varies from 500-600 feet with 5 percent excessive slopes and 95 percent low to moderate slopes. The excessive slopes are west of Morgan Notch at the junction of Link 18A, 19, and 20. Over 90 percent of surficial material along this route is mapped as glacial till. Erosion and sedimentation potentials, as well as slope and soil instability problems, may exist west of Morgan Notch.

Link No. 19

This route starts at the junction of Links 17/18 and runs south-southwestward along the west facing flank of Keyser and Baldhead Mountains to the junction of Links 18/20 near Cranberry Bog Pond. Relief varies from 600 to 800 feet along most of the route. Most of the route is above the valley floor, thus accounting for less than 2 percent potential aggregate sources and more than 95 percent glacial till soils.

Link No. 20

This link, starting at the junction of Links 18/19 near Cranberry Bog Pond, runs southward through Cranberry Bog Notch, paralleling Nash Stream to the junction of Links 21/23. The route passes to the east of the former Nash Bog Pond. The pond totally disappeared more than 5 years ago when the dam was breached and flooded the downstream valleys of Nash Stream and the Upper Ammonoosuc River. Fresh exposures of aggregate material and glacial till are still well exposed along Nash Stream from the erosion associated with this flood. The topography is moderately high with relief ranging from 400 to 800 feet. Steep slopes account for 23 percent of the route. Slightly less than 90 percent of the soils are glacial till. While no excessive slopes were identified, the high percent of steep slopes indicates a potential for soils instability, erosion and sedimentation problems.
Link No. 21

This short alternate route starts at the junction of Links 20/23, cuts cross-country from Nash Stream toward the south slope of Morse Mountain, where it turns southeastward and crosses the Upper Ammonoosuc River immediately upstream from Groveton, New Hampshire. The route ends at the junction of Link 31/34 on the northeast flank of Cape Horn Ridge. Relief along this link varies from 300 to 500 feet. Nearly 7 percent of the slopes are mapped as steep. No excessive slopes were identified as mappable areas. More than 30 percent of the soils along this link are glacial tills.

Link No. 22

This short alternative link connects Links 23/24 with Links 32/33. The link crosses the Upper Ammonoosuc River Valley where potential aggregate material accounts for 37 percent (0.9 miles) of the route. South of the river the link crosses the west flank of Beech Hill where steep slopes were encountered. Potential soil instability, erosion and sedimentation problems may be encountered due to the slopes and potential flooding on the moderately broad river valley.

Link No. 23

This short alternative link connects Links 20/21 and Links 23/24 along the east side of Nash Stream. Slopes range from moderate to steep with relief over the entire route of 500 feet. The soils are identified as glacial till. Soil instability, erosion and sedimentation potentials exist.

Link No. 24

This short alternative route connects Links 22/23 and 31/32 along the northeast side of the Upper Ammonoosuc River. Total relief along this link is approximately 300 feet. Slopes vary between moderate and steep and a potential for soil instability, erosion and sedimentation problems exist. A small, potentially high-quality aggregate source exists along the valley wall.

Link No. 25

This link connects alternate Links 12/13 and Links 26/27. The route starts southeast of Black Mountain at the junction of Links 12/13 and runs southwest across moderately low topography to the junction with Links 26/27, 1.5 miles northwest of Cupsuptic Lake. The overall relief of this link varies from 500 to 600 feet. Approximately 84 percent of the area is classified as low slope and the rest is of moderate slope. The shallow, moderately broad
valleys of the Kennebago and Cupsuptic Rivers are crossed. A potential exists for aggregate material from the outwash deposits in this area. Soil instability problems, due to the mixture of alluvial and peat and muck material, may also exist in these areas.

Link No. 26

Alternate Link 26 starts at the junction of Links 25/27 where the moderately low relief of 300 to 400 feet rapidly increases to slightly over 1,000 feet at Observatory Mountain. The route terminates at the junction of Links 26/28 southeast of Aziscohos Mountain. More than 35 percent of the route is classified as steep to excessive slope, parallel to the proposed route at Observatory Mountain, a high potential exists for soils instability, and in particular, erosion and sedimentation problems. More than 95 percent of the route is over glacial till materials.

Link No. 27

Link 27 starts at the junction of Links 25/26 northwest of Cupsuptic Lake and runs southward toward the west side of Mooselookmeguntic Lake. Along this section of the link the relief increases rapidly from 200 to 300 to nearly 800 feet, and then begins to decrease gradually. The route makes a sharp turn toward the west along the northwest end of Upper Richardson Lake where the relief continues to decrease to slightly over 100 feet. After crossing Fish Pond Brook and skirting north of Little Beaver Pond, the relief gradually increases to over 500 feet at the junction of Links 26/28. Steep slopes account for only 5 percent of the route, while 78 percent of the route is low. Glacial tills make up over 96 percent of the soil material.

Link No. 28

This link starts southeast of Aziscohos Mountain at the junction of Links 26/27. The entire link is of moderate topography with an overall relief of 400 to 500 feet except for a short stretch along the northwest flank of Diamond Peak, where the relief reaches slightly over 600 feet. The route ends at the junction of Links 29/30 west of Dustan Mountain. The route crosses the Megalloway, Dead Diamond, and Swift Diamond Rivers. Ninety-six percent of the slopes are moderate or less with a single short stretch of excessive slopes located on Diamond Peak. Potential problems of soil instability, erosion and sedimentation may occur if the upper slopes of Diamond Peak are used.

Link No. 29

This short alternative link starts at the junction of Links 28/30 west of Dustan Mountain and runs southwestward between Black
Mountain and Greenbough Pond to the junction with Links 30/31 at the north end of Akers Pond. The link relief varies from 400 to 600 feet. Steep slopes along the Black Mountain ridge account for more than 15 percent of the route. Potential soil instability, erosion and sedimentation problems may exist for sections of the route. Glacial till accounts for more than 90 percent of the surficial materials along the route.

**Link No. 30**

This short alternate route arcs southward from the junction of Links 28/29 west of Dustan Mountain and Greenough Pond. Relief varies between 300 to 400 feet along most of the link and decreases slightly at the junction with Link 29/31 north of Akers Pond. Slopes along the entire route are classified as low to moderate. Glacial tills account for 98 percent of the surficial materials.

**Link No. 31**

This link starts at the junction with Links 29/30 north of Akers Pond. The initial portion of the route skirts along the south end of Black Mountain ridge where it turns westward for several miles along Clear Stream. At the confluence with Mills Pond Brook the route turns southward and follows Millfield Pond Brook, further south the route passed between Signal Mountain and Mount Patience. Continuing further to the southwest the route passes the north end of Drummer Ponds and east of Long and Bald Mountains. At the Upper Ammonoosuc River the route turns west and passes between Christine Lake and Dickey Hill to the junction with Links 24/32. Relief along most of the route ranges between 300 and 400 feet with areas of greater relief near Mount Patience, Bald and Long Mountains. Steep to excessive slopes account for approximately 36 percent of the route. In these steeper areas potential soil instability, erosion and sedimentation problems will exist. Slightly less than 90 percent of the soils are glacial till.

**Link No. 32**

This short alternative route connects Links 24/31 with Links 22/23. The route starts west of Dickey Hill and runs southwest crossing the Upper Ammonoosuc River near Blake School. The route joins Links 22/37 south of Beech Hill. The relief ranges from 200 to 300 feet along this route. More than 25 percent of the route was identified as steep. Some potential for soil instability, erosion and sedimentation problems exist on these steep slopes. Glacial till accounts for slightly more than 77 percent of the route while the remaining soil conditions are outwash and alluvial deposits found along the river valleys. A potential aggregate source exists in the areas.
Link No. 33

This short alternate route connects Links 22/32 south of Beech Hill with Links 21/34 southwest of Moore Mountain along Roaring Brook. The relief varies between 200 and 400 feet with steep slopes encountered along the southeast flank of Moore Mountain. These slope conditions may pose potential soil instability, erosion and sedimentation problems. The entire route is over glacial till soils.

Link No. 34

This short alternate route connects Links 21/33 with Links 35/38 at the northeast end of Cape Horn Mountain. The entire route has low slopes and glacial till soils.

Link No. 35

This alternate route starts at the junction of Links 34/38 at the northeast end of Cape Horn Mountain and runs southwest along the northwest flank of this mountain ridge to Northumberland, where the route turns more westerly crossing Beech Hill and the Connecticut River to the junction with Links 36/37, near Duran Mountain. The steep to excessive slopes of Cape Horn Mountain ridge are due to differential erosion around this extremely resistant syenite rock intrusion. Steep to excessive slopes account for more than 15 percent of the route while only 28 percent of the route crosses over low slopes. Potential aggregate sources are present in the outwash materials that account for 19 percent of the route. Potential soil instability, erosion and sedimentation problems exist for these areas around Cape Horn and Duran Mountains.

Link No. 36

This alternate route at the junction of Links 35/37 south of Duran Mountain starts westward away from the Connecticut River valley passing between the summits of Halibut and Sheridan Mountains before arcing southwestward near Adden Mountain. The route continues past Baldwin Hill through Lunenburg and Concord, Vermont. The topography is a hilly terrain with relief ranging from 500 to 600 feet near Duran, Halibut, Sheridan, and Adden Mountains to 300 to 400 feet over most of the remaining portions of the route. Steep to excessive slopes account for approximately 7.5 percent of the route. Near the above-mentioned mountains, potential soil instability, erosion and sedimentation problems may exist. A large portion of alluvial soils with peat and muck material exists along Catbow Brook. This area may have potential soil instability problems. Slightly over 90 percent of the surficial materials are glacial till.
Lin No. 37

This alternate route starts at the junction with Links 35/37 and proceeds southwestward along the west side of the Connecticut River Valley. Much of this route crosses side slopes facing the river. The route ends at the junction with Links 37/38 south of Gilman, Vermont. The topography is hilly with relief ranging from 200 to 400 feet along the entire route. No steep or excessive slopes were identified as mappable units. More than 75 percent of the route is glacial till material and approximately 17 percent is classified as lacustrine/outwash. This material is composed of highly erodible silts and fine sands and are classified as lake-deposited material which overlies coarser granular material, probably outwash in origin.

Lin No. 38

This alternate route starts at the junction of Links 35/34 northeast of Cape Horn Mountain and proceeds southward across flat to gently rolling topography to Whitefield (New Hampshire) where the route turns west, crossing Dalton Mountain and passing between Beede Mountain and Wallace Hill before crossing the Connecticut River to the junction with Links 37/39. In general, the relief varies from 100 to 200 feet for most of this route with a maximum of 800 to 900 feet in Dalton Mountain. Approximately 4 percent of the route is in the steep to excessive slope category. The highest potential for soil instability erosion and sedimentation also occurs at Dalton Mountain and along the steep slopes adjacent to the Connecticut River. Soil stability problems may also exist with the alluvial/peat and muck soil materials which account for approximately 7.5 percent of the route. The most extensive area of these soils occur along Parks, Dean and the upper tributaries of Burnside Brooks.

Lin No. 39

This route connecting Links 37/38 with Links 36/40 parallels existing transmission lines along the west side of the Connecticut River Valley. Almost the entire route is located on a side slope facing the river. While the relief generally varies between 300 to 600 feet, over 50 percent of the slopes of this route are steep to excessive. Shallow glacial till soils account for over 50 percent of the route. Potential soil instability, erosion and sedimentation problems exist along the steeper portions of this link.

Lin No. 40

This short route connects Links 36/39 on the west side of the Connecticut River with Links 41/42 and the east side of the river.
The route parallels an existing transmission line and the Connecticut River, and crosses the river below the Moore Reservoir Dam to connect with the Moore Substation (Link No. 41). Relief ranges between 300 and 400 feet for the entire route. Steep slopes account for slightly more than 13 percent of the route. No excessive slopes were identified as mappable units. With exception of the river and 1.7 percent outwash material, the rest of the route is composed of glacial till soils. The potential for soil instability, erosion and sedimentation may exist.

**Link No. 41**

This short spur connects Links 40/42 with the Moore Substation. The route is entirely over glacial till soils of low slope. Relief is less than 100 feet.

4. **Segment D**

This segment runs from the Moore Substation on the Connecticut River west and southwestward across the hilly to mountainous terrain of east central Vermont. In general, the topography is moderately hilly with numerous isolated peaks having summit elevations between 2,000 and 3,000 feet.

With the exception of Link 42 on the Connecticut River, glacial till is the predominant surficial material. Along the Connecticut River (Link No. 42) from Moore Substation to Barnet, Vermont, fine lacustrine/outwash deposits are generally exposed along the steeper valley walls.

Steep to excessive slopes were encountered along all but Link 45. In general, where these steeper slopes are crossed, a potential for soil instability, erosion and sedimentation problems may exist.

The bedrock underlying Segment D is comprised of Ordovician to Devonian metamorphosed sediments and volcanics. These metamorphic rocks have been intruded by Ordovician and Devonian granite rocks, and in some cases, early intrusive rocks have been metamorphosed by more recent events. In general, the bedrock structure appears to subordinate lithology as the primary control of topography. However, the large granite complex in the vicinity of Hardwood Mountain shows a strong correlation between topography and lithology.

Almost all of Segment D has soils which have formed in glacial till. There are some areas of floodplain soils belonging to the Limerick-Winooski soil association but these are of minor extent. The most notable of these areas is along the Jail Branch of the Winooski River. The Connecticut River has been dammed where Segment D crosses and the
floodplain normally associated with the river has been flooded. Along many of the streams in this segment, terraces are present. The lower terraces along the larger rivers are mostly sandy and gravelly, and are well-drained. These soils belong to the Adams-Windsor association. Soils of this association are also found on terraces along small streams. The largest areas of these soils are located near the Connecticut River, Wells River, Jail Branch, Stevens River, and Great Brook. Erodibility of the Adams-Windsor association is low.

On the higher terraces along the Connecticut River, soils have developed on old lake plains. These soils are commonly silty and are moderately well-drained. Erodibility is high. Lake plain soils in this segment belong to the Hartland-Belgrade soil association.

There are few significant areas of muck and peat along Segment D. The largest occurs in the town of Peacham. Muck and peat is highly erodible when disturbed.

Soils formed in glacial till make up the largest part of Segment D. They vary in characteristics depending on topography and their location. In the New Hampshire section of the segment, the soils belong to the Lyman-Marlow-Peru soil association. These soils are sandy and silty with a well-developed fragipan. On hills and ridges these soils may be shallow to bedrock. In much of this area, Berkshire soils, which are sandy and have no fragipan, are found. Berkshire soils are also common in the southern parts of the segment. The Lyman-Marlow-Peru soil association has medium to low erodibility, while slopes are generally steep.

The till soils from the Connecticut River to Groton, Vermont are in the Colrain-Woodstock soil association. The soils found here in the rolling uplands of central Caledonia County are sandy to silty and mostly well-drained. The soils of Colrain-Woodstock association are typically found along the ridges and hills of this part of the segment, and are shallow to bedrock in places. In the lower lying areas, soils belonging to the Paxton-Woodbridge association are found. These soils are similar to those of the Colrain-Woodstock association, but have a fragipan at one to two feet depth. Their erodibility is medium. The Colrain-Woodstock association has low erodibility.

In the Groton, Peacham, Marshfield area and in northern Topsham and Orange, the soils again belong to the Lyman-Marlow-Peru soil association. These soils are generally found in the higher elevations in this part of Vermont. Shallow to bedrock soils predominate on the ridges and hilltops of this area.

On the lower sides of the hills in this part of the segment, silty soils with well-developed fragipans are located. These soils of the Cabot-Buckland association have medium erodibility. Most of the soils of this
association are found in the towns of Topsham and Orange, but they are also found, to some extent, in Peacham near Martins Pond. Associated with the Cabot-Buckland soils are the Colrain-Woodstock association. These are sandier soils and are shallow to bedrock. Most of the ridges and hilltops in the lower Orange and Topsham have these soils.

In eastern Washington and western Orange Counties, the till-derived soils become silty and have a very firm compact layer at one to two feet. These soils, of the Glover-Calais-Buckland soil association, are generally found in the lower elevations of central Vermont. Much of the area is well-drained with shallow to bedrock soils along hilltops and steep slopes. Erodibility is medium.

Segment D is primarily composed of glacial till-derived soils. There are minor areas of sandy to gravelly and silty soils found along river terraces and old lake plains. There are few areas of peat and muck. Most of the till soils are silty except in the higher elevations. Soils with well-developed fragipans are common over the entire segment. Overall erodibility is medium.

**Link No. 42**

Link No. 42 starts at the junction of Link 40 and the short Moore Substation spur (Link No. 41) adjacent to and southeast of the Moore Reservoir dam and runs westward along the south and southeast side of the Connecticut River to Monroe where the route crossed the Connecticut River joining Links 43/44 north to Barnet, Vermont. Most of this route parallels both an existing transmission line and the Connecticut River. Relief over most of the route ranges from 200 to 300 feet except at Foster Hill where the relief reaches approximately 500 feet. The predominant surficial material along this route is lacustrine/outwash which accounts for approximately 72 percent of the route. Slightly over 11 percent of the route is classified as steep to excessive slopes. A high potential exists for soil instability and in particular, erosion and sedimentation problems on the steeper slopes of the highly erodible lacustrine/outwash material. The high concentration of silts and fine sand of the lacustrine portions of this material are easily transported by water.

**Link No. 43**

This route starts at the junction of Links 42/44 north of Barnet and runs west along Stevens River and Hollow Brook toward Peacham. The route continues westward between Devils Hill and Morse Mountain, passing south of Peacham Pond. The route arcs southward at Burnt Mountain and skirts along the west flanks of Kettle and Hardwood
Mountains. In Plainfield, the route parallels Great and Orange Brook valleys to East Barre where the route swings slightly westward to the junction of Link 44/45. The topography along the first half of the route is hilly with broad intervening valleys. The last half of the route encounters rolling to moderately hilly topography. Relief over most of the route ranges between 300 and 400 feet, except near the major hills and mountains such as Anderson, Morrison, Burnt, Kettle, and Hardwood. Over 6 percent of the slopes are classified as steep to excessive. Potential soil instability, erosion and sedimentation problems may exist in these steeper areas. In particular, the first 2-3 miles of the route near Anderson and Morrison Hills both have steep to excessive slopes and highly erodible lacustrine/outwash material. This area may have a higher potential for rapid erosion and sedimentation. Although the surficial materials are slightly more diverse along this route, glacial till still accounts for nearly 90 percent.

**Link No. 44**

This alternate starts at the junction with Links 42/43 and runs south paralleling the Connecticut River for a short distance before arcing westward near McIndoe Falls past the southern flank of Blue Mountain. From here the route crosses Wells River between the towns of Groton and South Ryegate and proceeds west, southwest and westward again, passing south of the topographic high of Knox Mountains to the junction with Links 43/45. While the relief generally ranges between 300 and 600 feet, steep to excessive slopes account for almost 20 percent of the route. Most of these steeper slopes are located along the first portion of the route between the junction with Link 42/43 and Blue Mountain. The lacustrine/outwash soils along this steeper area have a high potential for rapid erosion and sedimentation. Potential soil instability problems also exist for the steeper areas. Glacial till account for more than 90 percent of the entire link.

**Link No. 45**

This short east-west trending link connects 43/44 with the Granite Substation. The relief varies from 100 to 200 feet and the slopes range from low to moderate. The entire route has glacial till soils.

5. **Segment E**

This segment runs from the Granite Substation northwestward paralleling the Winooski River Valley through the Green Mountains to the Essex Substation located approximately 5 miles east of Burlington, Vermont. The
Topography ranges from hilly to mountainous along the axis of the Green Mountains. In general, the Winooski River is a mature stream that has become entrenched into the terrain. Extensive lacustrine/outwash deposits, which are transitional to a marine deltaic sequence, occurs throughout this area as a result of numerous lakes formed during the waning glacial period. These deposits are exposed along the valley walls and lower upper surfaces along most major streams. These lake and outwash materials often form the steep slopes along the moderately deep entrenched stream valleys. These sediments, due to their high silt and fine sand fractions, are highly erodible when the surface soils are disturbed.

Relief along the route ranges from several hundred feet to nearly 1,000 feet. The higher percentage of steep to excessive slopes are mainly due to the steep valley walls of the entrenched streams throughout this segment.

The bedrock underlying Segment E is comprised of Cambrian to Devonian metamorphosed sedimentary and volcanic rocks. Due to the long time span over which these rocks were formed and the variety of the tectonic and orogenic events that deformed them subsequent to their disposition, the proposed links cross a great number of various lithologies in Segment E. These varied lithologies range from dolomite and marble to schist and crystalline gneiss. The topography of Segment E appears dependent on a combination of lithology, structure and local factors.

Segment E primarily has soils derived from glacial tills. Most of the till soils found along the segment are stony. Soils of the Buckland-Cabot association and Glover-Calais-Buckland association are found from the Granite Substation to Montpelier. These soils are silty and have a very firm compact layer at one to two feet depth. Many areas are shallow to bedrock and much of this part of the segment is well-drained. The erodibility is generally medium. From Montpelier to Richmond much of the segment is located near the interface where floodplain soils meet till-derived soils. The floodplain soils belong to the Hadley-Winooski-Limerick association. These soils are found in the larger stream valleys along the entire segment. The valleys include the Winooski River, Dog River, and Stevens Branch of the Winooski River. The floodplain soils are generally silty and have a high erodibility.

The till soils in the Montpelier to Richmond section of Segment E belong to the Lyman-Marlow-Peru soil association. The soils are less silty than those of the Buckland-Cabot soil association but a well-developed fragipan is also found in them. Most of this area is in the Green Mountains and is shallow to bedrock. Erodibility of the soils in this association is medium to low while slopes are generally steep.
In the section of Segment E from Richmond to Essex most of the soils have formed in water deposited material. There are some small areas in this section with till-derived soils which belong to the Peru-Cabot-Marlow soil association. These soils are deep and have a fragipan. They have medium erodibility. There are also some minor areas of till-derived soils belonging to the Farmington-Neilis-Stockbridge soil association along this section. The soils of this association are shallow to bedrock for the most part, and are generally more silty than the soils of the Peru-Cabot-Marlow association. They have medium erodibility.

Large areas of floodplain soils of the Hadley-Winooski-Limerick soil association are found in this section of Segment E along the Winooski River. Above the floodplain are extensive areas of terraces and old lake levels. Generally, the soils found on the terraces belong to the Adams-Windsor soil association. These soils are sandy to gravelly and are mostly well drained. The erodibility of this soil association is low. Soils of the Adams-Windsor association are found on other terraces along most of Segment E. The largest of these areas occur along the Winooski River between Crossett Brook in Duxbury and Middlesex. Most of the soils formed on the old lake plains belong to Hartland-Belgrade-Monson soil association. These soils are found on the higher river terraces primarily along the Winooski River, Snipe Island Brook, Crossett Brook and Mad and Dog Rivers. The soils are silty and are sometimes underlain by clay. Erodibility is high. Near the Essex Substation there is another area of soils which have developed in old lake plains. These soils belong the Enosberg-Whately-Vergennes association. They are sandy near the surface and underlain by clay. Some areas have clayey surface soils. The soils of the Enosberg-Whately-Vergennes association have medium to high erodibility.

Most of the soils found along Segment E have been formed in glacial tills. Extensive areas along this segment are shallow to bedrock and the deeper till derived soils have well-developed fragipans. Erodibility is medium. Along major streams and rivers these are large areas of floodplain soils which have high erodibility. On terraces along the streams and rivers there are sandy outwash soils with low erodibility. Along some streams and in the Champlain Valley, soils that have formed on dissected lake plains are found. These soils have high erodibility. Overall erodibility is medium to high.

**Link No. 45A**

This short link runs northwest from the Granite Substation to the junction with Links 45B/45C. Relief ranges from 100 to 200 feet and the slopes are all low to moderate. The surficial material along the entire route is glacial till.
Link No. 45B

This short link triangulates between the junction of Links 45A/45C and Links 45C/46. Relief over the entire route is between 300 and 400 feet. All slopes are low to moderate. While glacial till accounts for more than 60 percent of the route, a small potential aggregate source is located along the Stevens Branch of the Winooski River.

Link No. 45C

This short route "dog-legs" between the junction of Links 45A/45B and Links 45B/46 south of Bolster Reservoir. The route parallels Cold Spring Brook to the crossing of the Stevens Branch and the Winooski River where it turns north and proceeds to the junction with Links 45B/46. The overall relief varies from 250 to 400 feet. Slopes range from low to moderate along the entire route. A small potential aggregate source is located along the Stevens Valley.

Link No. 46

This link starts at the junction of Links 45B/45C and runs northwest past Bolster Reservoir toward Barre, Vermont. At the city boundary, the route turns northwestward and proceeds to the junction with Links 47/50 near Berlin Pond Brook. The topography is low to gently rolling with all slopes low to moderate. More than 95 percent of the surficial materials are glacial till.

Link No. 47

This link starts at the junction of Links 46/50 and runs west-northwest, crossing Dog River and route parallels the south side of the Winooski Valley to the junction of Links 47A/51, slightly west of Jones Brook. The topography is moderately hilly with relief ranging from 400 to 500 feet along the entire route. Steep to excessive slopes along the river account for nearly 30 percent of the route. While glacial till soils make up approximately 65 percent of the surficial material the lacustrine/outwash deposits along the steeper portions of the site adjacent to the Winooski River represent a high potential for erosion and sedimentation. Soil instability problems on these steeper slopes may also exist.

Link No. 47A

This short alternate route parallels the south side of the Winooski River and connects Links 47/51 with Links 48/53. The relief along this route varies from 400 to 500 feet. Nearly 50 percent of the route has steep to excessive slopes and over 45 percent of the
route is lacustrine/outwash surficial material. This setting of steep slopes and highly erodible soils poses a high potential for rapid erosion and sedimentation. Soil instability problems may also exist along the steeper portion of the route.

**Link No. 48**

This alternate link parallels the Winooski River from the junction of Links 47A/53 to the junction of Links 49/54 at Bolton Falls. This link parallels an existing transmission line for the entire route. The relief over the route gradually decreases from approximately 500 feet near the start to 200 to 300 feet near Bolton Falls. Steep and excessive slopes account for 28 percent of the route and more than 50 percent of the route crosses lacustrine/outwash surficial materials. The potential for soil instability, erosion and sedimentation problems are similar to the previous routes that parallel this portion of the Winooski River.

**Link No. 49**

This link starts at the junction of Links 48/54, crossing the Winooski River at Bolton Falls. The route parallels the Winooski River, west-northwest through the Winooski River gap at the axis of the Green Mountains past Richmond, Vermont to the junction with Links 55/56. This line parallels an existing transmission line for the entire route. The relief ranges between 300 to 600 feet along the entire route. Over 45 percent of the route has steep to excessive slopes and 18 percent of the soils are lacustrine/outwash material. A high potential for soil instability, rapid erosion and sedimentation problems exist on this link. Potential aggregate sources exist along the river valley where more than 18 percent of the route consists of outwash and ice contact deposits.

**Link No. 50**

This alternate route starts at the junction of Links 46/47 west of Berlin Pond Brook and runs northwestward crossing Dog Stream and Jones Brook before reaching the junction with Links 51/52. The topography is hilly to gently rolling with relief between 600 and 1,000 feet. Steep to excessive slopes account for more than 33 percent of the route. Limited areas of lacustrine/outwash (5.8 percent) were encountered. While extensive areas of shallow glacial till soils (66 percent) are predominant, the steeper slope conditions, as well as the highly erodible shallow tills and lacustrine/outwash soil, indicate a potential for rapid erosion and sedimentation as well as soil instability problems.
Link No. 51

This short connector runs between the junction of Links 47/47A and Links 50/52. The relief ranges from 500 to 600 feet with more than 42 percent steep slopes mainly located adjacent to Jones Brook. The surficial materials, shallow glacial till and lacustrine/outwash, along the entire route should be considered moderate to highly erodible. These materials coupled with the high percent of steep slopes have a potential for soil instability, erosion and sedimentation problems.

Link No. 52

This alternate link runs from the junction of Links 50/51 northward connecting with Links 53/54. The relief ranges from 400 to 600 feet with more than 50 percent steep slopes. The entire route is over glacial till with more than 84 percent shallow glacial till conditions. While the shallow till materials are not as highly erodible as the finer, more uniform lacustrine/outwash deposits, they do pose a potential for soil instability, erosion and sedimentation problems on the steeper slopes.

Link No. 53

This short connector link runs between Links 47/48 near Middlesex Gorge and Links 52/54 near Mad River. The relief ranges between 200 and 300 feet. No steep or excessive slopes were identified as mappable units. Slightly more than 85 percent of the surficial materials are lacustrine/outwash deposits. While the slopes are not generally above 15 percent (moderate category) local variations within these highly erodible soils material may cause potential erosion and sedimentation problems.

Link No. 54

This link starts at the junction with Links 52/53 and runs northward, arcing slightly toward the north, to the junction with Links 48/49 at Bolton Falls. Relief ranges from 400 to 500 feet along the route. Steep to excessive slopes account for more than 75 percent of the route. More than 24 percent of the route consists of lacustrine/outwash materials. A high potential exists for soil instability, erosion and sedimentation problems.

Link No. 55

The route starts at the junction with Links 49/56 on the east side of the Winooski River. The route proceeds west-northwest across the moderately broad floodplain and river. The route continues
across relatively flat topography to the junction with Link 56 and the substation at Essex. The relief varies from 200 to 300 feet along the Winooski River to less than 200 feet for the rest of the route. Approximately 15 percent of the route encounters steep to excessive slopes and more than 28 percent is lacustrine/outwash surficial material. This moderately erodible material poses potential soil instability, erosion and sedimentation problems along the steeper slope areas.

Link No. 56

This route starts at the junction of Links 49/55 on the east side of the Winooski River and runs northward parallel to the river for approximately 1.5 miles before turning west and crossing the river, and the moderately broad floodplain. The route continues west-northwest across relatively flat topography to the junction with Link 55 and the substation at Essex. Slightly more than 80 percent of the route is over lacustrine/outwash material. Steep to excessive slopes account for nearly 20 percent of this link. Potential soil instability, erosion and sedimentation problems exist for these steeper slopes on the more highly erodible lacustrine/outwash materials.

6. Proposed Microwave Tower Sites

The following are brief descriptions of the eleven proposed microwave tower sites. The approximate location of each of the tower sites is shown on Figure 3 (p. 35).

Pennington Mountain (Proposed)

This site is approximately 8 miles south-southeast of Eagle Lake, east of Route 11 on Pennington Mountain and is located in the northeast portion of Winterville, Maine, Quadrangle Sheet (Figure 4). The summit elevation is approximately 1,540 feet with relief of 600 to 700 feet to the surrounding area. Drainage from the eastern half of Pennington Mountain flows through the tributaries of the West Branch of Beaver Brook. Westward, the area is drained by Pennington Brook.

The soils found on the proposed microwave site are derived from glacial till and are shallow to bedrock. The soils are gravelly and generally silty. They are well-drained. Soils of this type are classified as Thorndike. Depth to bedrock is usually 18 inches or less. In the lower areas along the streams draining the mountain, Howland soils are found. These soils are generally deeper and usually have a perched watertable just above a very firm substratum. Erodibility of these soils are medium.
The proposed site is underlain by Ordovician volcanics. The volcanics form a belt of pronounced topography trending to the northeast. The areas defined by the less pronounced topography to the north and south of the Pennington Mountain station are underlain by metasediments of Devonian age.

Access to the summit area would be either from Route 11 approximately 1.5 miles west of the site or from an unimproved gravel surface road that runs northeast from Route 11 south of Pennington Pond. (General Highway Map, Aroostook County, 1957). Access to the summit on most sides of the mountain will encounter steep to excessive slopes. A limited area on the southeast side of the mountain encounters only moderate to steep slopes.

Ashland (Proposed)

This site is located approximately 2 miles southwest of Ashland on Young Hill in Garfield, Maine (Figure 5). Elevation is approximately 790 feet with relief of 240 to 270 from the Machias and Aroostook Rivers, respectively. Drainage flows radially either directly to or through small tributaries of the Machias and Aroostook Rivers. Springs are found north of the site. These springs flow into the Machias River. A marshy area is found northeast of the site.

The soils found on the site have been formed in glacial tills. Most of the soils are of the Plaisted and Howland soil series. Plaisted soils are well-drained, gravelly and silty to sandy material. Howland soils are moderately well drained and similar in texture to Plaisted soils. Both Plaisted and Howland soils have a very firm substratum but Howland soils are found in the lower areas of the site and have a perched water-table just above the substratum. Bedrock is expected to be greater than three feet. Plaisted and Howland soils have medium erodibility.

The bedrock underlying the proposed microwave station has been mapped as metamorphosed sediments of Devonian age ranging from shales to conglomerates. The calcareous Perham formation of Silurian-Devonian age has been mapped immediately north of the proposed station. Both of these units show, in general, low to moderate topographic relief. Volcanic rocks of the Elm Hill formation are found approximately two miles northeast of the proposed station. The Devonian volcanics show a strong topographic relief indicating that they are less susceptible to erosion than the surrounding sedimentary rocks. It appears that the proposed station, located in an area of moderate relief, is underlain by low grade metamorphosed sediments. Access to the site is over paved secondary roads from Ashland.
Oak Ridge (New Site)

This proposed microwave site is located on Oak Ridge along the eastern town line of Shirley, Maine (Figure 6). The location can be found in the east central portion of the Greenville, Maine, Quadrangle Sheet. The elevation is approximately 1,660 feet. Relief in the immediate area ranges from 250 to 400 feet. Drainage flows radially from the summit to Coffee House Stream (north) and Little Wilson Stream (west and south) and Thompson Brook (northeast) and the West Branch of Thompson Brook (east and southeast).

The soils found in this area are of the Thorndike-Howland-Plaisted soil association. These are soils formed in glacial till. Thorndike soils are shallow to bedrock. Howland and Plaisted soils are deeper and have a very firm substratum. Howland soils have a perched watertable above the substratum. Since most of the knolls and ridgetops found in this area are shallow to bedrock, Thorndike soils are expected to be found on the proposed site. Erodibility of these soils is medium.

The proposed microwave station is located in an area mapped as the Seboomook Formation, a cyclicly bedded slate and metasandstone of Devonian age. Some calcareous Siluro-Devonian sediments have been mapped immediately east of the proposed station. They may trend as far west as the proposed site.

It appears that the most direct access to the summit area is from Upper Shirley Corner located approximately 3 miles to the west-southwest. Based on the 1951 topographic quadrangle sheet, an access trail from Upper Shirley Corner comes within one quarter mile of the summit. Slopes vary from low to moderate on the west flank and moderate to steep on the south and east flanks of the mountain.

Parlin (Proposed)

This site is on a 2,600 foot unnamed mountain at the boundary intersections of Jackman, Long Pond and Misery Gore (Figure 7). The summit area is located in the south central portion of Long Pond, Quadrangle Sheet, approximately one mile east-northeast of Jackman Field on U.S. Route 201 and 7.5 miles southeast of Jackman Station. The topography is slightly mountainous with relief in the immediate area of 700 to 900 feet. Drainage flows radially from the summit to tributaries of Bean Brook and Parlin Stream on the east, south and west and to tributaries of Mountain Brook on the north.

The soils found in the area belong to the Peru-Marlow-Lyman soil association. These are sandy to silty soils which are generally well-drained. Peru and Marlow soils have a very firm layer. Peru soils have a seasonal perched watertable above the firm stratum. Lyman soils are
Figure 6
shallow to bedrock soils. Shallow to bedrock soils are usually found along hilltops in this area and are expected to be found on the site. Marlow soils may also be encountered. Erodibility of the soils at the site are medium.

The proposed Parlin microwave station is underlain by undifferentiated intrusive and extrusive rocks of Devonian age. The less pronounced topography to the east and north of the proposed station appears to be related to the fine grained metasandstones of the Devonian Tarratine Formation.

Slopes around the mountain are mainly steep with few areas of moderate or excessive slopes. It appears that access would be from U.S. Route 201 near Jackman Field. Based on the 1922 topographic map, it appears that a natural approach would start diagonally up the west face toward a small moderately flat bench on the south flank 250 feet (relief) below the summit.

McLean Mountain (Proposed)

This site is located approximately 4 miles south-southeast of St. Francis at the southern end of the McLean Mountain ridge line (Figure 8). The summit is 1,824 feet elevation with relief of approximately 800 feet above the surrounding area. Drainage from the summit area flows northward into the Petite Brook and southward into McLean Brook, both of which are tributary to the St. John River. The entire summit area is heavily wooded. No rock outcrops were visible on the aerial photographs. The soils are shallow to bedrock, however, with depths 18 inches or less. The soils have formed in glacial till and are well-drained. Many boulders and stones are found in these soils. Slopes are very steep and erodibility is medium to high.

The proposed site is underlain by gray slate containing minor amounts of graywacke and is part of the Seboomook formation. The topographic expression of McLean Mountain is, in part, due to the more resistant graywacke bedrock materials.

Access to the summit will encounter steep to excessive slopes. Logging roads, as viewed from the photos (June 20, 1973), are limited. Access to the site can either be made from the Back Settlement or the McKinley School areas of St. Francis. Access from the south appears to be the most advantageous route in terms of slope.

Lincoln School (Proposed)

This site is located on the northwest side of the St. John River opposite the Lincoln School area (Figure 8). The summit is approximately 1,120 feet elevation with a relief of 400 feet above the river. Drainage from
Figure 12
the site is either directly to the St. John River or by way of several small tributaries to the river. The site is heavily wooded with strong indications of shallow to bedrock conditions.

The proposed site is underlain by gray cyclically bedded slates and sandstones of the Seboomook formation.

Access to the site is limited by both the St. John and St. Francis Rivers. Several logging roads enter the area from the southwest. This network of logging roads is from the St. John bridge at Dickey, approximately eight miles southwest of the site.

Oakfield Hill (Proposed)

This site is located in Oakfield, approximately 4 miles south of the town center, on the north side of South Road (Figure 9). The proposed site is approximately 1,200 feet elevation with relief of 600 to 700 feet above the surrounding area. Drainage from the site is through Downing and Bear Brooks, both are tributary streams to the Mattawamkeag River. The site is heavily wooded. Rock outcrops appear along the east side of the summit area. The soils found on the site are shallow to bedrock, usually 18 inches or less. They have formed in glacial tills and are well-drained gravelly silts. Slopes are steep. On the more level areas, the soils are mapped as Plaisted. These soils are deeper and have a very firm subsubstratum. Plaisted soils are well-drained. Erodibility of the soils at the site are medium.

The site is underlain by a strongly metamorphosed sequence of gray to green fine to coarse clastic sedimentary rock units. Igneous intrusions may be common in this rock sequence.

Access to the site appears to be most feasible from South Road, approximately 3,000 to 4,000 feet northwest of the summit.

Hot Brook (Proposed Alternate Site)

This site is located approximately three miles southwest of Danforth Center on the northwest side of Route 169 (Figure 10). The site is approximately 850 feet elevation and with a relief of between 350 to 400 feet above the surrounding area. Drainage from the proposed site flows northwestward toward Lower Hot Brook Lake and southeastward through Harding Brook to Crooked Brook flowage. Both waterbodies are part of the Baskahegan Stream drainage. The site, based on 1955 aerial photographs appears to be a partly wooded pasture.
Figure 9
The soils found on the site are classified Plaisted and Thorndike. Plaisted are well-drained glacial till soils with a very firm substratum. Bedrock is usually at greater than 3 feet depth. Thorndike soils are shallow to bedrock, usually 18 inches of less. Both soils are gravelly silts to sands with stones and boulders. Immediately west of the site, the soils have a high watertable. Erodibility of the soils found on the site are medium.

The site is underlain by metamorphosed dark gray to black shale, chert, sandstone and minor occurrences of volcanic material.

Access from Route 169 is less than one-half mile. This approach appears to be moderately direct with no significant topographical restrictions.

**Ferry (Proposed)**

This site is located 5 miles east of Milo, south of the Piscataquis River (Figure 11). The site is approximately 450 feet in elevation and with a relief of 250 feet above the surrounding area. The area is cleared and has an existing lookout tower. The soils found on the site are Plaisted and Howland soils. These soils have formed in glacial tills and have a very firm substratum. Plaisted soils are well-drained and are found in the higher areas. Howland soils are moderately well-drained with a perched watertable just above the substratum. Howland soils are found in swales and depressional areas on the site. Depth to bedrock is generally 3 feet or greater but may be shallow in places. Howland and Plaisted soils have gravelly silty and sandy textures and erodibility is medium. The area is underlain with a variable meta-sedimentary rock sequence. An access road exists for the lookout tower and adjacent farm.

**Bagley Mountain (Proposed)**

This site is located approximately 5.5 miles northeast from the center of Lincoln immediately south of and parallel to Bagley Road (Figure 12). The elevation of Bagley Mountain is approximately 850 feet with a relief of 400 to 450 feet above the surrounding area. Drainage from the site flows northward into Smith Brook and southward toward Long Pond, and Cambolasse Stream. Both waterbodies are tributary to the Penobscot River. An existing structure is located at this site. The area is moderately wooded.

The soils found on the site have been found in glacial till. These are gravelly silty soils which are classified as Plaisted. Plaisted soils are well-drained and have a very firm substratum. Many stones and boulders are present. Bedrock is found at 3 feet depth or greater. Slopes on the site are generally steep. Erodibility is medium. Bagley Mountain is underlain by granitic rocks.

An access road and utility lines are at the site.
Figure 11
**Black Cap (Existing)**

This site is located 3 miles south-southeast from East Eddington Center (Figure 13). The summit ridge ranged from 950 to 1,022 feet elevation and has a relief of 600 to 700 feet above the immediate area. The area has several existing tower structures. The bedrock material underlying the site is part of a large granitic rock mass. The site has access from East Eddington by way of Black Cap Road.

There is almost no soil found on Black Cap. Bedrock outcrops and rock land predominate the higher elevations. The areas where soils are found are shallow to bedrock. These soils are well-drained, gravelly sands for the most part and have been formed in glacial tills. Depth to bedrock is generally less than 12 inches. Erodibility of the soil is high.

7. **Substations**

The following are short descriptions of the eight proposed and existing substation sites. The approximate location of each of the substation sites is shown in Figure 3 (p. 35).

**Fish River (Existing)** - This substation is located on the east side of the Fish River, approximately two miles up-stream from the confluence with the St. John River. The site is situated on a mixture of deep glacial till and outwash deposits. The slopes are low and the soil has a slight erosion potential. Sedimentation potential to the Fish River is low.

**Lincoln School (Proposed)** - This site is located on the southeast side of the St. John River at Lincoln School. Slopes at the proposed substation are low. The soils are all deep, well-drained, outwash materials. Both the erosion potential at the site and sedimentation potential to the St. John River are low.

**Dickey (Proposed)** - This site is located on the northwest side of the Allagash River approximately two miles up-stream from the confluence with the St. John River. The proposed substation will be on deep glacial till material with low to moderate slope. Both the erosion potential at the site and potential sedimentation to the Allagash River are low.

**Jackman (Proposed)** - This site is located on the south side of the Moose River approximately three miles east of Jackman. Slopes are low at the proposed substation and the erosion potential is slight. Direct sedimentation potential to the river is low.

**Moose River (Proposed)** - This proposed substation is located adjacent to Route 201 near the Moose River-Dennistown Town line. Both the ground slope and erosion potential are moderate. The soils are shallow glacial till. Direct sedimentation potential to the nearest waterbody, East Branch of the Sandy Stream, is low.
Figure 13
Moore (Existing) – This site is located on the south side of the Connecticut River at the Moore Reservoir Power Station. The proposed addition to the existing substation is on glacial till soils. The ground slopes, erosion potential and resulting sedimentation potential are all low.

Granite (Existing) – The proposed addition and existing facilities are located approximately six miles south of Barre. The moderate ground slopes and deep glacial till soil conditions result in a moderate potential for erosion. The sedimentation potential to waterbodies from this site is low.

Essex (Existing) – The proposed addition and existing facilities are located less than two miles south of Essex Junction. This site is situated on a mixture of lacustrine/outwash soils. Slopes at the site range from low to moderate and the erosion potential ranges from slight to moderate.
III. IMPACT ASSESSMENT, EVALUATION AND DEFINITIONS

A. METHODOLOGY OF EVALUATION

1. Slope Evaluation

The slope categories were selected in order that both pedologic and engineering variables could be used for the impact assessment. As shown on Table I, the units are as follows: Low - 0 to 10 percent; Moderate - 10 to 15 percent; Steep - 15 to 35 percent; and Excessive - greater than 35 percent. The slopes were measured with pre-made transparent acetate templates for the two different mapped contour intervals. A slope category was assigned to each measured surficial unit. Where variations of the slope occurred within a single mapped unit, a single weighted value was determined for that unit. The determination of the weighted value was made by visual estimate. Where significant variation by area was encountered within a single unit, a hyphenated range was used (i.e., Moderate-Steep or Moderate-Excessive). When the hyphenated ranges were used for calculation or tabulation, the mileage was split equally into each unit.

Table I is an inventory of all slope categories. Table III is a tabulation of miles per link and percentage per link for each slope category. While no direct impact evaluation was made for the slope categories as shown in Tables I and III, slope values were incorporated into the assessment of erosion potential, sedimentation potential, and the combined slope and soil instability potentials.

2. Erosion Potential

Soil erosion is a function of the precipitation, slope, soil properties and ground cover as illustrated in Figure 14. Of these parameters, the interaction of the slope conditions with the internal properties of soil determines, to a great extent, the erosion potential of a particular area. The method used in identifying the slope conditions for the proposed transmission corridor has been outlined above.

The characterization of the internal properties of soil, as they relate to the erosion potential, are depicted by the use of a K value. This is a quantitative measure of the rate at which a given soil will erode when other factors affecting erosion are constant. The U.S. Department of Agriculture, Soil Conservation Service (SCS) have developed K values for many soil series in the project area. These values range from .17 to .49. In those portions of the project area where the SCS have mapped the soils, the K values for the identified soils series have been used in obtaining a weighted average K value for a given segment. For those
FACTORS OF SOIL EROSION

- EROSION
  - DUE TO
    - DISPERITIVE ACTION AND TRANSPORTING POWER OF WATER
      - AFFECTED BY
        - DISPERSIVE AFFECTS OF RAINDROPS AND AMOUNT AND VELOCITY OF RUNOFF
          - DETERMINED BY
            - RAINFALL CHARACTERISTICS
            - SLOPE CHARACTERISTICS
        - RESISTANCE OF SOIL TO DISPERSION AND MOVEMENT
          - DETERMINED BY
            - ABILITY OF SOIL TO ABSORB AND TRANSPORT WATER
              - DETERMINED BY
                - SOIL PROPERTIES
                - VEGETATION AFFECTS

Figure 14
areas where the specific soils series have not been identified and mapped, a general soils map has been used and the K values estimated through correlation of the geologic material present to those of established values.

By grouping the K values into erodibility classes, as shown in Figure 1, and interrelating these with the slope classes, an erosion potential has been developed. This potential is a qualitative value; i.e., slight, moderate, high, and very high; and are shown for each link segment on Table 1. As noted above, this value is only an indication of the potential for the soil to erode if it is disturbed by some means, either naturally or by man's activities. It does not indicate how much soil will be moved nor over what time period this will occur. Furthermore, the erosion potential of a soil in no way reflects what will happen to the soil particles once they are eroded from a given point.

3. Sedimentation Potential

Soil erosion cannot occur without the corresponding process of sedimentation. As noted above, erosion entails the detachment and movement of particles whereas, sedimentation is the deposition of these eroded particles. From a geologic designation, the term sediment collectively refers to any solid material that is deposited by wind, water, or ice. The particles being transported and deposited generally consist of gravel, sand, silt, and clay size particles which may be moved varying distances depending on the velocity of the transporting agent, water or wind.

Several methods have been developed for estimating the amount of sediment that is moved from a given area over a given period of time. The method that seems most appropriate for evaluating the sedimentation potential from a construction project, such as the one being proposed, is the Universal Soil Loss Equation (USLE). The values obtained from this method are quasi-quantitative and can be used as a comparative tool in evaluating the various alternate routes. It must be stressed, however, that the USLE was originally developed for use on agricultural lands. Thus, since most of the proposed transmission corridor is through forested areas, the products derived from this equation are accurate only for purposes of comparison and without detailed field investigations, which were not part of this project, it is not possible to precisely project how much soil is going to be eroded from any specific area. The values obtained should present an order of magnitude approximation of what can be expected to be moved under the assumed conditions.

The Universal Soil Loss Equation is composed of several factors:
\[ Y = A \cdot R \cdot K \cdot S \cdot L \cdot C \cdot P \cdot Sd \]

Where:

\( Y \) = Sediment yield/year (in tons/year)

\( A \) = Area in acres (per water feature)

\( R \) = Erosion potential of rainfall for a given locality (summation of the individual storms kinetic energy of rainfall within a given period)

\( K \) = Soil erodibility (in tons of soil loss/acre/unit of \( R \))

\( SL \) = Slope x slope length (Dimensionless)

\( C \) = Ground cover (Dimensionless)

\( P \) = Erosion control practice (Dimensionless)

\( Sd \) = Sediment delivery ratio; how much sediment actually reaches a waterbody. (As a percent of the total sediment moved)

The rainfall factor, \( R \), values were interpolated for the various portions of the proposed corridor from average annual rainfall - erosivity indices published by the U.S. Department of Agriculture, Agricultural Research Service. A source document for the \( R \) factor is included in Appendix F. The values range from 65 to 100 within the project area as compared to the conterminous U.S. Range of 10 to 350. The \( K \) values were derived as indicated above under the section on erosion potential. The \( SL \) factor is an average from the various slopes within the slope category using a 300 foot slope length. The \( C \) and \( P \) factors are dimensionless factors interpolated from published tables for various ground covers and erosion control practices. These tables, along with those for the \( R \) and \( SL \), were taken from the Maine SCS Technical Release No. 51 (REV), August 1976, entitled "Procedure for Computing Sheet and Rill Erosion on Project Areas."

Projected sediment yields for the transmission corridor have been calculated for only those areas within 300 feet of the identified waterbodies. (Table II) The rationale behind this is that even though there is a potential for erosion to occur wherever the transmission lines are constructed, the resulting sediment will usually be filtered out before it travels 300 feet overland. This is especially true if some of the vegetative cover has been left undisturbed. Even within the 300 foot strip adjacent to waterbodies, all of the eroded soil does not end up in the water. Most of these suspended soil particles will only be moved from one point to another on the site. The amount that reaches the waterbody may vary from site to site depending on many variables. The MITRE Corp., has developed the following empirical formula for estimating the sediment delivery ratio: \( SD = D^{-0.22} \) where \( D \) = the overland distance between the construction site and the waterbody. Solving the equation shows that at a 50 foot separation, 40 percent of the sediment actually reaches the water, whereas at 300 feet separation only 28 percent of the sediment will get into the waterbody.

Each stream identified by the Center of Natural Areas was located on the topographic maps. A clear template was constructed to show five angle
categories. The template was placed on the transmission line at the point of intersection between the stream and the right-of-way centerline. The approximate angle at which the stream intercepts the corridor was determined. Five angles were used, each angle was identified by the following number.

1 = Stream crossing at right angle (90°)
2 = Stream crossing at 67.5°
3 = Stream crossing at 45°
4 = Stream crossing at 22.5°, and
5 = Stream parallel to line within corridor.

This number was entered in the left hand column under comments in Table 2.

In this way, the trapezoidal or rectangular area (150 x 600) within each corridor was calculated. For each number except 5 (parallel) the areas would be constant. Parallel stream (5) areas were calculated by measuring their distance within the corridor and multiplying by the 150 feet estimated affected distance.

The central column under comments contains the number representing the estimated average slope of the land on both sides of the identified streams. The slope categories are: 1) 0-5% slopes; 2) 5-10%; 3) 10-15%; 4) 15-35%; and 5) greater than 35%.

In some cases, the stream has two slope categories within the corridor. This was entered in the center column (comments) as two slope category numbers. Using these slope categories, an SL factor was determined for each.

The USLE was applied to the existing land use segments identified under the Land Use Study to estimate sediment delivery to the surface waterbodies for the individual links along the proposed corridor. The estimated quantities are listed, along with the various values for the USLE parameters, on Table II under the heading C. These represent the existing condition or "status quo" option. A sediment delivery ratio of .2 was used for this condition since it was assumed that very little of the area is completely stripped or worked at any one time. Again, it must be stressed that due to the very limited detail of this data, the estimated yields presented are for comparison purposes only and are not to be inferred as a precise quantitative evaluation of the erosion-sedimentation potential for a given site.

Sediment yields that are listed in Table II as 0.00 tons/year should not be inferred to mean that no erosion or sedimentation is occurring. It only indicates that the sediment yield is insignificant and its quantification is far beyond the accuracy of the assessment techniques being used.
## SLOPE AND SOIL INSTABILITY POTENTIALS

Cu yds/mile

<table>
<thead>
<tr>
<th></th>
<th>LOW</th>
<th>MODERATE</th>
<th>STEEP</th>
<th>EXCESSIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLACIAL TILL (DEEP)</td>
<td>NONE</td>
<td>NONE</td>
<td>3520</td>
<td>14080</td>
</tr>
<tr>
<td>GLACIAL TILL SHALLOW TO BEDROCK</td>
<td>&quot;</td>
<td>&quot;</td>
<td>1760</td>
<td>7040</td>
</tr>
<tr>
<td>GLACIAL TILL WITH HIGH GROUND WATER</td>
<td>&quot;</td>
<td>&quot;</td>
<td>17600</td>
<td>70400</td>
</tr>
<tr>
<td>GLACIAL TILL SHALLOW TO BEDROCK WITH HIGH GROUND WATER</td>
<td>&quot;</td>
<td>&quot;</td>
<td>8900</td>
<td>35200</td>
</tr>
<tr>
<td>ICE CONTACT</td>
<td>&quot;</td>
<td>&quot;</td>
<td>NONE</td>
<td>5800</td>
</tr>
<tr>
<td>OUTWASH</td>
<td>&quot;</td>
<td>&quot;</td>
<td>NONE</td>
<td>NONE UNLESS &gt;100% SLOPE</td>
</tr>
<tr>
<td>OUTWASH WITH HIGH GROUND WATER</td>
<td>&quot;</td>
<td>&quot;</td>
<td>1760</td>
<td>8800</td>
</tr>
<tr>
<td>OUTWASH AND ALLUVIAL</td>
<td>&quot;</td>
<td>&quot;</td>
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<td>8800</td>
</tr>
<tr>
<td>ALLUVIAL</td>
<td>&quot;</td>
<td>&quot;</td>
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<td>29300</td>
</tr>
<tr>
<td>ALLUVIAL WITH PEAT AND MUCK</td>
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<td>&quot;</td>
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<tr>
<td>BEDROCK</td>
<td>&quot;</td>
<td>&quot;</td>
<td>NONE</td>
<td>7040</td>
</tr>
</tbody>
</table>

Figure 15
4. **Slope and Soil Instability**

The evaluation of slope instability was based on the slope data and soil descriptions established for general use in the impact study. Soil type and groundwater conditions have a direct bearing on slope stability, therefore, the soil type descriptions are major parameters. Generally, only the "steep" and "excessive" slopes will have stability problems since slopes flatter than 15 percent should be stable for all soil types investigated. The most severe problems occur only when slopes exceed 50 percent (2 horizontal and 1 vertical).

The evaluation of steep and excessive slopes was based on our field experience and research of published slope stability information (Terzaghi and Peck, 1948).

The evaluation included a qualitative review of the characteristics peculiar to each soil type, i.e., stratification, groundwater table, effect of vegetation mat, permeability, density and susceptibility. A determination of a failure based on the soil characteristics resulted in (1) the type of failure; i.e. deep seated or surficial sloughing, (2) surface area or lateral extent of failure, (3) width of influence across the transmission line route, and (4) the frequency of individual failures/mile was made based on the following equations:

(1) Number Failures/Mile = \( \frac{\text{Frequency of Failures} \times \text{Area of Influence}}{\text{Area/Failure}} \)

(2) Cubic Yards/Mile = \( \frac{\text{Number of Failures} \times \text{Volume Failure}}{\text{Mile}} \)

**Frequency of Failure** is based on an estimate of the total surface area of a uniform slope involved in failure/mile of route.

**Area of Influence** is a mile length of width 150 feet or 300 feet depending on slope type and vegetation mat.

**Area/Failure** is an estimate of the surface area of an individual failure.

**Volume/Failure** is based on an estimated geometric shape of the failure.

The volumes computed for each soil type and slope are presented on Figure 15.

5. **Mineral and Aggregate Potentials**

**Minerals**

Impact evaluation of the mineral resource potential along the various links and segments is incomplete. The major reason for this is that
while extensive private reconnaissance and preliminary mineral exploration has been carried out for various areas along the proposed transmission lines, very little of this information is available to the public. It has been noted by us that in some cases the limited information collected is conflicting. The available potential mineral resource data is summarized by corridor segments.

**Segment A (Fort Kent to Dickey)**

No data is available for this segment. The state geologist, Robert G. Doyle, is presently submitting to the Corps of Engineers a reconnaissance strategy for the impoundment and adjacent areas.

**Segment B (Dickey to the proposed Jackman/Moose River Substation)**

No published data about the potential mineral resources is available for this area. Robert G. Doyle, Maine State Geologist, (personal communication) identified Caucomgomoc Mountain, Mile 24 to 28 along Link 9, as a target area for copper and zinc. Work in this area was done by the mineral exploration division of the Exxon Corp. No other areas in Segment B were identified as having potential mineral resources.

**Segment C (Jackman/Moose River area to Moore)**

No published mineral information is available for the Maine portion of Segment C. Doyle (personal communication has indicated the following areas of potential mineral interest:

**Link 10** - The Catheart Mountain area (Mile 7 and 8) has a known copper resource of 22 million tons. This resource, due to its relatively low quality (approximately .2 percent copper) is not at this time considered economically feasible to extract. It is difficult to assess the future economic feasibility of the Catheart Mountain resource. Molybdenum was also identified as a potential resource at this site.

**Link 11** - Sulfide mineralization including a "show" of copper has been identified on Burnt Jacket Mountain south of this link between Miles 3 and 5. No assessment of this potential mineral resource can be made.

**Links 15 and 16** - Three areas were identified by Doyle, in this area. None were identified within the route rights-of-way. One potential copper area, located between Miles 10 on both Link 15 and 16. Both Rump Mountain and Thrasher Peaks north of Link 15 were also identified as having some copper potential.
Links 20 and 23 - The Conway granite is located near Percy Peak and Long Mountain adjacent to and east of these links. The Conway granite, in general, has been identified by Glenn W. Stewart, New Hampshire State Geologist, (personal communication) as potential areas for Uranium exploration and consideration.

Link 22 - This link crosses the Conway granite (see above Link 20 and 23) at Beech Hill.

Link 31 - A copper mine is located 3 to 4 miles southeast of Mile 17. The mine was opened in the early part of the century and produced small amounts of copper and associated gold and silver, however, "The ores quickly ran out and the operation was abandoned" (Chapman, 1949)

Link 36 - Near the start of this link several small mines have been identified. Magnetite was mined at Burnside Mountain, 3 to 4 miles northwest of the junction of Links 35, 36 and 37. These deposits were mined for a short time prior to 1886. Lead in the form of Galena, was identified one mile north of Mile 0. A very small copper mine was opened at Bolles Hill on the east flank of Sheridan Mountain between Mile 1 and 2 during the period of 1860-1880. But, due to the "insufficient size and concentration" (Johansson, 1963) the mine was eventually closed. Near the end of this link, southeast of Concord Center, Essex Mining Company of New York in the 1860's looked for ore associated with the sulfide minerals of pyrite, bornite and chalcopyrite.

Segment D (Moore to Granite)

In general, economic interest along this segment is low. Building materials of granite and slate have been utilized from locations near several links. Current interests are concentrated within a single intrusive granitic mass in and around Barre.

Link 42 - The old Waterford Slate mines are located 5 to 6 miles north of Mile 5 of this link.

Link 44 - Abandoned granite mines are located immediately adjacent to this link at Blue and Burnham Mountains at Miles 6 and 11, respectively. South of Topsham at Mile 20, in an area known as Pike Hill, three copper mines operated intermittently from about 1860 until 1919 "when the mines were closed due to the slump in copper prices..." It should be noted that "the closing of the mines was not due to a pinching out of the mineralized zone or fall in the tenor of the ore.. " (Murthy, 1957).
In the area near the end of Segment D and beginning of Segment E the proposed transmission line routes swing southward toward the substation at Granite. This southern arc in the route avoids crossing the granite complex that has been a major economic resource of the Barre area.

Segment E (Granite to Essex)

It appears from the available published data and personal communication with Charles Ratte, Vermont State Geologist, that the major resource in this area is aggregates found along the Winooski River. Several general statements can be made for the mineral potentials along the transmission routes. First, there are undoubtedly many areas for potential extraction of small quantities of material. Some of the large economically feasible sites have been identified. Secondly, potential non-metallic materials, such as those associated with pegmatite intrusions are possible along portions of the route. In particular, northeastern New Hampshire and northwestern Maine. Based on available information, no pegmatite mines or prospects have been identified in northwestern Maine north of the Rangeley-Mooselookmeguntic Lakes area. (Rank, 1957 and Rand, 1959)

The northern New Hampshire area is dominantly metasedimentary and White Mountain plutonic-volcanic series of rocks. Pegmatites are very rare in this rock series (Billings, 1956). And thirdly, the potential copper resources are poorly identified. Prophyry copper has been identified near Catheart Mountain south of Jackman. This type of deposit, due to its low grade and large size, appears to be uneconomical at present. These types of deposits would probably be open mined at the surface. The massive sulfide deposits are the major target ore resource for copper, lead, and zine. These types of deposits, due to smaller size and high grade would probably be mined underground. The volcanic series that extends from the Dickey area to northern New Hampshire is considered a potential area in which these massive sulfides are found. Due to the relatively small size of these potential ore sites and extensive surficial cover and dense vegetation, exploration success is moderately slow in identifying these deposits. A recent discovery (November, 1977) was made somewhere west of Ashland on land owned by Great Northern Paper Co. Other discoveries will undoubtedly be made with time, and no assurance can be made as to the impact of the proposed transmission line on this potential future resource.

Aggregate Potentials

Aggregate potentials have been assessed in terms of total cubic yards/link and cubic yards/mile/link (Table IV). Impact evaluation is based on the potential loss of this material because of the physical location
of the transmission line. The volume has been estimated by assuming an area 150 feet wide and 15 feet deep by the length in miles, as shown on Table III.

Outwash materials are rated as "fair" while the ice contact material was considered "good". The total impact value was weighted as to potential quality (fair and good). The total weighted aggregate potential values (Table IV) were calculated as the sum of one half the volume of "fair" quality and all of the volume of "good" quality material.

B. ENVIRONMENTAL IMPACT OF GEOTECHNICAL VARIABLES

1. Geologic Impacts

Geotechnical variables of the existing environment may cause environmental impacts due to both natural processes and changes in man's activities. The natural environment can, in most cases, be thought of as being at or near a state of equilibrium in terms of the ongoing processes in a given area. Any changes to the natural setting may produce changes in the natural processes. These process changes may be accelerated or diminished by the activities of man. The natural processes or changes in the physical setting produce the existing environment for any specific point in time. That is to say that the processes and physical settings are evolving.

Bedrock - The uniformity and variation of the underlying rock material is the single most important factor controlling the topographic setting. The topography is the resultant product of erosional processes, both present and past.

In general, slopes within the study area are more severe where the erodibility of the rock material is more variable. The orientation and structure of the rock units, coupled with the erodibility characteristic, may in turn, accentuate the topography (i.e., local relief).

This relationship between the steeper slopes and greater variation in rock resistance is characteristic of many links along Segment C (see Table III, Links 14, 16, 31, 35 and 36). In general, the variable rock resistance in this area is due to the interbedded sequence of intrusive, volcanic and metasedimentary rocks.

Not all of the steeper sloped areas are the result of variations of rock resistance to erosion. Along Segment E many steep slopes have been identified along Links 47, 48, 49 and 50. These steeper areas are mainly due to the relatively rapid downcutting of the Winooski River in the deep unconsolidated lake and outwash sediments associated with the waning glacial period.
**Surficial** - The proposed transmission line routes are located completely within glaciated terrain. The surficial materials are discussed in Appendix A. Generally, these materials consist of glacial till, coarse granular (outwash and ice contact), fine granular (lacustrine and fine outwash), and alluvial (alluvial and peat and muck) deposits. The texture, grain size distribution, and cohesiveness of the soil materials are important variables in terms of potential impacts to the environment. These variables are discussed under the erosion potential, sediment potential, and slope and soil instability sections of this study.

The environmental impact of the proposed action on the aggregate resource amounts to: (1) material becoming potentially irretrievable due to the tower placement and restriction of gravel mining within the right-of-way; and (2) material being used for some phase of construction (irreversible).

2. **Pedologic Impacts**

An erosion potential classification has been developed (Figure 1) based on the slopes and K values. In general, most line segments making up the proposed transmission corridor have only a slight to moderate erosion potential. However, if during the construction of this project, an area is stripped and the soil left barren, it is likely that erosion will occur. This is especially true for the till derived soils. Even soils rated as having only a slight erosion potential will be subject to erosion if disturbed and left exposed for long period of time. The construction practices will determine to a large part how much erosion can be anticipated. Thus, the erosion potential classification provides only an indication of the soil's susceptibility to erosion.

In Table II, under the C2 condition, the sediment yields are based on constructing the proposed transmission line utilizing no special erosion and sediment control practices. These estimates are for comparative purposes only and are based on several assumptions. These assumptions are:

1. A 150-foot wide strip will be cleared the entire length of the transmission corridor.
2. Conventional forestry operations will be used.
3. An access road will be constructed the entire length of the corridor.
4. "Typical" construction techniques will be used.
5. Construction activities would be conducted regardless of the time of the year.
It can be noted by comparing the values for $C_1$ and $C_2$ that there could be a substantial increase in sediment yield due to the construction activities if no special precautions were taken. It should also be recognized that the sediment delivery ratio was increased from .2 to .4 to reflect the impact of clearing and construction activities near the stream banks. This factor may be high for some conditions, but if skidder trails or road construction runs up and down the hillside, a channeling effect is produced which has the capacity of directing large quantities of sediment into the streams. Obviously, since only secondary sources of information were used rather than having direct field measurements, it is impossible to accurately predict how much sediment will reach a given point. Even so, the data presented offers the opportunity and basis for comparisons between link segments. Although the actual sediment yields may vary from those shown, they should be in the same order of magnitude and therefore, the comparisons should be relevant.

3. **Slope and Soil Instability Impacts**

Occasionally, slope failures do occur in nature without influence of construction. However, site clearing and reshaping of slopes undoubtedly effect the stability of natural slopes.

The impact of slope instability appears as (1) increased erosion, (2) damage to structures and (3) delays of construction. All slope failures will result in increased erosion and sedimentation from the raw scarps left by the failures. Large deep seated failures and rock failures can potentially damage transmission line structures resulting in interruption of service. During construction, slope failures will increase costs and may delay completion of the project.

The data presently available is of insufficient detail to quantitatively assess the slope instability problems which may be encountered at any particular location along the route. Such detail should be developed during final route selection and design. Our assessment has been developed only for the purpose of comparing different links during preliminary route selection.

**C. DISTURBANCES**

1. **Temporary**

The maximum impact to the environment will occur during the construction of the proposed facility. All geotechnical variables undergo maximum change at this time. The stability of the existing environment is most vulnerable at this time. The degree of impact will vary to a large degree in direct proportion to the activities needed to construct the proposed facilities along each segment of the right-of-way. For example,
maximum impact would occur where construction of tower or substations facilities take place on excessive slopes where highly erodible soils and natural forest cover is present. A minimum impact situation might occur over cleared farm land of low erodibility where no structures are placed. In this situation essentially no change would occur other than a possible access road through the right-of-way. The temporary impacts that might arise during this phase would result from high slope and soil instability potentials (i.e., mass soil movement), increased erosion and the resulting sedimentation.

2. Permanent

Some permanent changes along the proposed right-of-way, at tower, microwave, substations, and roadway sites will take place. These changes will vary in intensity as a direct result of the proposed action. Compaction or removal of the upper soil horizons will occur. Where new structures are placed, the changes will be permanent. It is anticipated that the total area affected will be very small. Compaction of the soil may, depending on the topographic location, affect shallow groundwater flow patterns. Under some conditions, groundwater flow may be restricted sufficiently to cause ponding and increased seepage at the surface. Increased runoff may occur from compaction of the soil as well as from the construction of microwave and substation structures. For example, where high groundwater and glacial tills are encountered on steep or excessive side slopes potential compaction of the upper soil horizons along roadways may contribute to surface seepage, runoff and ultimate increased erosion and resulting sedimentation. In addition, this situation might also lead to slope and soil instability problems.

D. IMPACT OF CONSTRUCTION, OPERATION AND MAINTENANCE

The major impacts on the geotechnical variables from the proposed project would occur during the construction phase. In general, if the proposed mitigation measures are adhered to, these impacts should be short term. However, if no consideration is given to erosion control and slope and soil instability, the impacts may become cumulative; i.e., once they start they become progressively worse and may even trigger other events. As an example, once erosion begins, it becomes more difficult to stop as time progresses and due to the accumulation of sediment in a stream it may cause flooding or channel cutting. Overall there should be very little impact from the geotechnical variables. There should also be very little, if any, impact as a result of the operation and maintenance activities.
# IV. ALTERNATE ROUTE SELECTION

## A. METHODOLOGY

Alternate routes, as designated by the DOI have been evaluated in terms of their overall environmental impacts. The evaluation is based on those impacts for erosion, sedimentation, slope and soil instability and aggregate source usurption. Each of these variables have been independently evaluated in terms of impacts units/link and impact units/mile/link and are summarized on Table 4. The total combined weighted impact values for each individual link is shown on the last column on Table 4.

The alternate route selection was made based on the impact evaluation of each link and route segment as identified by the DOI staff. The following is a synopsis of the impact evaluation procedure for each variable, for the total combined variables and for the alternate route selection.

### 1. Erosion Potential

Erosion potential has been evaluated in terms of slope and erodibility class (see Matrix, Figure 1). This matrix is a mechanism to evaluate various erodibility classes with slope classes in terms of an overall qualitative erosion potential. The erodibility class is a quasi-quantitative value based on actual, assumed or weighted K value numbers. The slope categories are approximate quantitative values based on measured slope units. The output from the matrix evaluation of erosion potential is a qualitative rating. We have arbitrarily assigned the ratings of slight, moderate, high and very high.

Experience indicates that increasing erodibility classes produce logarithmic-like increases of erosion problems. Based on this concept the increasing erodibility classes were assigned numeric values of 1, 2.5, 5 and 10 for the units/link and units/mile/link. In order to make a total impact assessment of this variable in combination with the other variables, an assigned numerical scale value of one through 10, based on the range of units/mile/link was used.

### 2. Sedimentation Potential

The sedimentation potential for all water features as designated by the ecological contractor, has been calculated (see Methodology Section, Sedimentation Potential). Table 4 lists the total sediment potential (C3) in tons/water feature/year and in terms of tons/mile/link. In order to make a total impact assessment of this variable in combination with the other variables an assigned numerical value of one through 10 based on the range of tons/mile/year was used.
3. Slope and Soil Instability

The slope and soil instability impact was made in terms of potential tons/mile for each slope and soil type. (Note: For a complete description of the calculation of these values see Methodology Section, Slope and Soil Instability Potential). Table 4 lists the total potential volume of soil material that may be affected in terms of cubic yards/link and cubic yards/mile/link. In order to make a total impact assessment of this variable in combination with the other variables an assigned numeric scaled value of one through 10 based on the range of tons/mile/year was used.

4. Aggregate Potential

 Aggregate potential has been identified in terms of total cubic yards/link and cubic yards/mile/link on Table 4. These values were determined from the total miles of each material as inventoried on Table I and modified as to quality (see Methodology Section). The units in cubic yards/mile/link has been assigned a numerical scaled value of one through 10.

In order to place all impacts on an equivalent basis, a weighted adjustment of the anticipated environmental impact was made for each assessed geotechnical variable. The weighted adjustments were based on our assessment of the relative significance of the impacts on the environment. The adjustment values are as follows: erosion potential, assigned value times 2; sedimentation potential, assigned value times 5; slope and soil instability, assigned value times 2; and aggregate potential, assigned value times 1.

5. Alternate Route Assessment

a. Segment A. This segment runs from Dickey to Fort Kent and has two alternate routes. Route A-2 was selected as the best alternate based on the fact that substantial aggregate potential exists along the St. John River Valley (Route A-1). It should be noted that Route A-2 did have a higher sedimentation potential than Route A-1. If the aggregate potential of A-1 along the right-of-way is compared to the potential of the entire area the impact is small. Based on these two conditions, the choice of a best route will be dependent on the other variables.

b. Segment B. This segment runs from Dickey to Jackman/Moose River Substations. The Route B-1 and B2-1 were selected as being equally good. The amount of impact variation between the four alternate choices was small. The inclusion of Link 9, with its slightly higher erosion and slope and soil instability potentials in Routes B-2 and B2-2, made these routes slightly less desirable from a geotechnical standpoint.
c. Segment C. This segment runs from the Jackman/Moose River Substation to the Moore Substation on the Connecticut River. Route Cl-1 indicates slightly less potential impacts from both erosion and sedimentation.

d. Segment D. These routes run from the Moore Substation to the Granite Substation in Vermont. These two routes D-1 and D-2 vary with the alternate choices of Links 44 and 43. Due to the substantially higher impact for potential sedimentation along Link 43, Route D-1 is the best choice.

e. Segment E. This segment, between the Granite and Essex Substations, runs along the Winooski River Valley. Of the eight alternate routes, four of them (designated "B") are based on the alternate choice of Link 55 and 56 on the basis of potential sedimentation and slope and soil instability impacts. Of the four "A" routes, E-3A was the best choice, based on the overall lowest impact as well as having the least number of total impacts.

B. IMPACT DESCRIPTION BY LINK

Link 1

An overall weighted impact of 28 was assessed for this link. The largest single impact for this link is the sedimentation potential. This is due to steep slopes immediately adjacent to several of the small tributary streams to the St. John River. A large portion of this link traverses potential aggregate sources.

Link 1A

This short connector link has a low impact due to low slopes over all granular materials. The entire link has a moderate potential as an aggregate source.

Link 1B

This short connector link, similar to 1A, is entirely of low slope over granular soils. Potential aggregate sources are found along this link.

Link 1C

A low impact of 12 was assessed for this link due to slightly elevated erosion and sedimentation potentials.

Link 2

An impact value of 25 was assigned to this link. A potential for sedimentation to waterbodies is the major impact. Steep to excessive slopes account for 22 percent of the route. These steeper slopes coupled with a moderate to high erosion potential for portions of the route account for the higher than average sedimentation potential.
Link 3

The overall impact for this route is 16. While the erosion potential is moderately high due to some steep to excessive slopes and moderate to high erosion potential, the sedimentation potential is moderately low, due to the topographic relationship of the waterbodies to the right-of-way.

Link 4

This link has a moderately low weighted impact total of 12. The relatively low topography and low erosion potential of the soils along this link indicate a minimal impact to the environment.

Link 5

The overall terrain considerations, such as slope and erosion potential, are relatively low for this entire route. An impact value of 8 was assigned to the link.

Link 6

A moderate impact value of 19 was assigned to this link. Sedimentation potential is the major impact. In particular, the area along Rattle Brook between Mile 8.7 and 9.3 appear to have a significantly high potential for sedimentation to that water body. Potential slope and soil instability problems may exist on the south bank of the Penobscot River at Mile 2. An old landslide feature appears to be present in this area.

Links 7 & 8

Both of these routes are similar in their overall impact to the environment. A value of 8 was assigned to each of these links. The lower slopes and moderate erosion potential are indicative of the minimal impact for the proposed action. An old landslide feature was tentatively identified from the aerial photographs at Mile 1, Link 8, on the south side of the South Branch of the Penobscot River. This could not be confirmed from the single overflight of the proposed routes.

Link 9

This route has an impact level of 19. Due to slightly higher slopes along this route, erosion potential factors are slightly elevated. A potential impact to mineral resources (copper and zinc) exists near miles 24 to 28 of this link.

Links 9A & 10

An overall impact level of 8 and 5, respectively, were assigned to these links. The extremely low slope conditions along these links indicate minimal impact for the proposed action.
Links 10A & 11 (to the midpoint)

The low slope conditions found along both of these links, indicate minimal impact of 10 and 7 respectively. A potential impact to mineral resources (copper and molybdenum) exists near miles 7 and 8 of Link 10.

Link 11 (from the midpoint)

A moderately high impact assessment of 31 was assigned to this link. The major impact being from sedimentation potential to waterbodies. This potential is high for Twin Island Ponds, South Branch of the Moose River, Caribou flowage, Middle Branch of Kibby Stream, Gold Brook and a small tributary to the lower pond of the Chain of Lakes. An area was identified at Mile 34, as having possible old landslide debris. A "show" of copper south of Miles 13 and 14 at Burnt Jacket Mountain indicates a slight potential mineral resource for this area.

Link 11A

A minimal impact level of 7 was assigned to this link. Low slopes and low erosion potential result in a minimal impact for the proposed action.

Link 12

A moderate impact of 24 for the entire link is due to sedimentation potentials along Halfway Brook, Baker Pond, Spencer Stream, Jim Pond, and Tim Brook.

Link 12A

A low impact of 13 was assigned to this link. The major impact point is at Alden Inlet where a slightly elevated sedimentation potential exists.

Link 13

This link has a moderately high impact of 32. The major impact is the potential for sedimentation to the Middle and North Branches of Alden Stream.

Link 13A

A moderate impact assessment of 19 was assigned to this link. Higher erosion potentials in the steeper areas account for this moderate impact.
Link 14

A high impact level of 38 was assigned to this link. The high erosion potential and sedimentation potential to a small tributary stream to the Cupsuptic River accounts for the higher impact along this link.

Link 14A

The moderate impact of 23 assigned to this link is due to the steeper slopes and the high erosion potential of the soils.

Link 15

The moderately low impact total of 16 is due principally to the sedimentation potential at Tressel Brook.

Link 16

A weighted impact total of 26 was assigned to this link. Sedimentation potential to the Little Megalloway River and the West Branch of the Little Megalloway River account for the moderately high overall impact.

Note: Three areas that have been identified near links 15 and 16 indicate potential copper mineral resources for the area.

Link 17

This link has a moderately low overall impact value of 15. Both erosion potential and sedimentation potential are slightly elevated, along this route.

Link 17A

A moderate impact value of 22 was assigned to this link. Both the erosion and sedimentation potential are slightly elevated in this area.

Link 17B

A moderately low overall impact of 15 was assessed to this link due to sedimentation potentials along several small streams.

Link 18 & 18A

A total impact of 16 and 12 respectively were assigned to these links. In general, slightly elevated erosion potential and sedimentation potential values account for this impact.
Link 19

An impact value of 21 is the result of the slightly elevated erosion and sedimentation potentials for portions of this link.

Link 20

A very high impact value of 60 was assigned to this link. High erosion potential and very high sedimentation potential account for this value. A very high sedimentation potential was assigned to the Nash Stream area. A very slight potential for mineral resources (uranium) may exist in the Conway granite near this link.

Link 21

A low impact value of 10 was assigned to this link.

Link 22

An impact value of 22 was assigned to this link because of slightly elevated sedimentation potentials and a high aggregate potential. A very slight potential for mineral resources (uranium) may exist in the Conway granite at Beech Hill.

Link 23

A high impact of 54 on this link is due to the high impact of sedimentation potential of Nash Stream. A very slight potential for mineral resources (uranium) may exist in the Conway granite near this area.

Link 24

A moderate to low impact value of 17 was assigned to this link. Slightly elevated sedimentation potential and an aggregate potential exist for this area.

Link 25

A minimal impact of 9 was assessed for this route.

Link 26

A moderate impact value of 22 is due to slightly elevated erosion and sedimentation potentials.
Link 27

A low impact value of 11 was assigned to this link.

Link 28

A moderate impact value of 27 was assigned to this link due to sedimentation potentials on a small tributary to the Megalloway River at Mile 4.3 to 4.8.

Link 29

A moderately high impact value of 32 was assigned to this link. Moderate sedimentation potential at Green Oak Brook and slope and soil instability problems between Miles 2.4 and 3.8 account for the impact on this route.

Link 30

This link has a low impact of 10. A slightly elevated sedimentation potential accounts for the entire impact of this link.

Link 31

This link has a moderate impact of 24. The major impact of the link is due to sedimentation potential along Mills Field Pond Brook. Copper was mined for a short time near Mile 17 of this link. The future potential for an economically mineable copper deposit in the area are small.

Link 32

An impact value of 10 was assigned to this link.

Link 33

The moderately low impact value of 15 is due primarily to slightly elevated slope and soil instability potential along the initial portions of the route.

Link 34

The overall impact weight of 17 for this link is due in part to erosion potential problems associated with the wet glacial till soils.

Link 35

This link has a moderately high impact value of 38. The major portion of the impact is due to sedimentation potential along the Upper Ammonoosuc River and wetland associated with the Connecticut River.
Link 36

A moderately low impact value of 14 was assigned to this link. A very small copper mine was opened around the 1860-1880's very near the right-of-way between Miles 1 and 2. The future potential for additional copper extraction in this area is small.

Links 37 & 38

A moderately low impact value of 11 and 15, respectively, for these links is due mainly to slightly elevated erosion and sedimentation potentials.

Link 39

A very high impact value of 75 was assigned to this link. A high erosion potential and very high sedimentation potential is due to the steep and excessive slopes found along the west bank of the Connecticut River.

Link 40

A moderate impact value of 26 was assigned to this link. The impact in this area is due to sedimentation potential to Moore Reservoir.

Link 41

This short connector link over flat ground has a very low impact of 5.

Link 42

A moderately low impact of 20 for this link is the result of a slightly elevated sedimentation potential to the Connecticut River and a moderate potential for aggregate sources.

Link 43

A moderately high impact value of 39 was assigned to this link because of sedimentation potential problems at Stephens River.

Link 44

This link has a total impact of 24. Sedimentation potential to the Connecticut River and Coburn Pond and associated outlet area account for the majority of this impact. Granite mines were operated very close to the right-of-way near Blue and Burnham Mountains. Three copper mines south of this link at Mile 20 were closed in 1919 due to a drop in copper prices. The future potential resource value of these areas is unknown.
Link 45

The impact value of 24 for this link is the result of sedimentation potential at the unnamed stream at Mile 0.

Link 45A

This short link over relatively flat topography has a low impact of 5.

Link 45B

This link has a total impact of 33. The impact is due in part to sedimentation potential to Cold Stream and Stevens Brooks and the potential aggregate sources adjacent to Stevens Brook.

Link 45C

The high impact value of 58 is due exclusively to the sedimentation potential to Cold Stream Brook.

Link 46

The moderately high value of 46 assigned to this link is due to elevated erosion and sedimentation potentials at Pond Brook and other tributaries to the Winooski River.

Link 47

The overall impact of this link is 20. This moderately low impact is due to slightly elevated erosion and sedimentation potentials.

Link 47A

The impact value of 91 for this link is the highest for the entire proposed transmission line facility. High potential for erosion and slope and soil instability problems as well as the very high sedimentation potentials is due to steep to excessive slopes on the highly erodible lacustrine/outwash deposit is along Jones Brook and the Winooski River.

Link 48

A moderately high impact value of 47 is assigned to this link as a result of elevated values for erosion and sedimentation potentials. The high sedimentation potential areas are along the Mad and Winooski Rivers.
Link 49

The moderate impact value of 38 assigned to this link is due, in part, to both erosion and sedimentation potentials along the steeper slopes over the lacustrine/outwash materials.

Link 50

The moderately high impact value of 44 assigned to this link is the result of elevated erosion potential and high sedimentation potentials associated with Dog River, Herring and Jones Brooks.

Link 51

This link has a low impact value of 9.

Link 52

The moderately low impact of 20 is the result of slightly elevated erosion and sedimentation potentials along this route.

Link 53

The impact value of 32 for this link is due mainly to the sedimentation potentials along the Winooski River.

Link 54

This link has a moderately high impact value of 42. These impacts include slightly elevated erosion and sedimentation potentials, slope and soil instability, and aggregate potentials along the Winooski River and several small tributaries to the Winooski River.

Link 55

Moderately low impact value of 24 for this link is in part due to the slightly elevated erosion and sedimentation potentials.

Link 56

The impact value of 36 for this link is in part due to the slightly elevated erosion potential and moderately elevated sedimentation potentials along the Winooski River.
V. MITIGATION MEASURES FOR PROPOSED ACTION

A. MITIGATION OF SLOPE HAZARDS

Mitigation of the hazards from steep to excessive slope conditions are discussed in the following three sections: erosion, sedimentation and slope and soil instability. In general, steep slopes which pose a potential hazard to the environment can be mitigated by either avoidance, or mechanical modifications or stabilization of the slope area. As the conditions become more severe, the cost of mitigation increases. Avoidance of an area should be considered if the cost of mitigation is excessive or if the potential hazards cannot be controlled. Based on the large scale of the available data maps, no specific avoidance recommendations have been made. During the detailed design of the specific tower, substation, and microwave sites potentially hazardous slope conditions may be identified and addressed. These potential hazards may require avoidance recommendations.

B. MITIGATION OF EROSION

The erosion and sedimentation process is a naturally occurring phenomenon that is going on continuously. However, because of man's activities the erosion process can be accelerated. It is the accelerated erosion that is of major concern inasmuch as it is usually not practical nor economically feasible to try to prevent all erosion. Thus, the mitigation measures presented here are designed to reduce the erosion potential from the proposed project rather than to stop all erosion.

The most effective actions in erosion and sedimentation control are those that reduce the kinetic energy of the rain prior to its reaching the soil and the reduction of the velocity of the surface runoff so that it loses its abrading and transporting power. The former can be best accomplished by keeping the ground covered rather than having large exposed areas. Cover may either be natural vegetation or artificial such as mulches, gravels, pavement, rocks, etc. The kind of cover is not as important as is the completeness of cover. Preventing the raindrop from directly striking the soil will reduce the impact energy of the raindrop and thus reduce its loosening or eroding power.

In general, when the velocity of running water is reduced by half the abrading power is cut four times and the transporting power is reduced 32 times. Probably the most efficient means of reducing the velocity of the surface runoff is by the flattening of slopes or the shortening of the slope over which the water travels. The only means of flattening the slope would be through some process of cut and/or fill operation. These operations often are very costly and may produce more erosion than
could be prevented by the slope reduction. Therefore, the most practical means of reducing the velocity is to shorten the actual slope length between mitigating measures or techniques.

Examples of techniques or mitigation measures which may be employed on the proposed project to diminish the erosion potential are: (1) cutting only that vegetation that is required to install the transmission line; (2) refrain from disturbing the organic mat on the soil (e.g., forest duff or grass); (3) revegetation of disturbed areas immediately following construction in that area; (4) use of mulches such as wood chips; (5) cross slope skidding, and (6) timing of the construction activities (e.g., wintertime operations in wetland areas and avoiding spring freshets). The Department of the Interior (DOI) has published a listing of mitigation measures that will be used during the construction of the proposed transmission line. If these measures are adhered to, the erosion potential should be lessened substantially.

C. MITIGATION OF SEDIMENTATION

As noted above, if erosion is reduced, the subsequent sedimentation will also be reduced. An effort has been made to assess the reduction in sedimentation if the mitigation measures are followed. A comparison can be made between the sediment yields that could be anticipated by constructing the line with no consideration to erosion and sediment control and those yields obtained when mitigating measures are used. In Table 2 the $C_3$ values are the result of mitigation. The only difference between the $C_2$ (construction without mitigation) and $C_3$ measures were that no erosion control practices ($P$) were considered in the $C_2$ values. It must be stressed again, however, that these values are to be used only for comparative purposes and not as precise quantitative values.

In order to arrive at the $C_3$ values, certain assumptions had to be made. These assumptions all influence, and are the basis for, the $P$ values that are listed under the $C_3$ conditions. The assumptions made are:

1. In forested areas it will be necessary to cut a large number of trees within the transmission line right-of-way.
2. Some access and maintenance roads will need to be constructed.
3. Skid trails will go across slopes rather than up and down them.
4. Some cutting of trees will be required adjacent to water courses or drainage ways.
5. Disturbed areas will be revegetated or otherwise stabilized immediately following construction in a given area.
The P values for the C3 conditions are based on our best estimates rather than on field research data. We are not aware of any published values for the type of erosion control practices that are being proposed for this project. There are published values, however, for revegetation, mulching, etc. and these were considered in arriving at the estimated values listed for P under the C3 conditions. Without detailed field data, it is not possible to do more than estimate the sediment yield for the proposed project. If the actual field conditions require less cutting of timber and minimal road construction, the actual sediment yields should be lower than those projected in Table II.

To summarize Table II, it can be anticipated that the erosion and its subsequent yields can be controlled to a major extent if the mitigation measures outlined by DOI are followed. As noted above, in Section III-B-2 there is only a small percentage of the proposed corridor that has a high erosion potential and these areas can be effectively treated by the prescribed mitigation measures.

D. MITIGATION OF SLOPE INSTABILITY

Slope failures occur naturally but may be seriously influenced by construction operations and general land clearing. Slope failures along the transmission line route may occur during or many years after construction. Mitigation measures include (1) avoidance of steep and excessive slopes, (2) the construction of drainage and groundwater control facilities, (Cedergren, 1967, Chapter 8 - Slope Stabilization with Drainage) (3) the construction of retaining structures, such as gabions and rip rap and (4) the seasonal timing of construction.

Mitigation measures, other than avoidance of steep and excessive slopes, will necessarily take different forms depending on specific soil and slope conditions. Due to the preliminary nature of this study, no detail has been developed with respect to mitigation of slope stability problems.

E. POTENTIAL MINERAL AND AGGREGATE SOURCES

Mitigation of impacts to mineral sources cannot be addressed in any detail because of the lack of specific identification of potential mineral resource areas. The potential impact to mineral resource production can be related to the potential extraction process. If the mineral is to be mined by an underground operation, the potential impact from the transmission line is negligible. If the mineral would be extracted through an open pit operation, the impact would be total and would result in either moving the line or making the resource irretrievable.
Mitigation of impacts to aggregate sources would require avoidance of the area by the right-of-way, avoidance by placing the tower locations outside of the aggregate area and by placing the conductors at a sufficient height to allow access and extraction of aggregate within the right-of-way. In general, most identified aggregate sources are narrow and located on the valley floor adjacent to water features. It would appear that in most cases tower locations will not be established on these materials.
VI. ADVERSE EFFECTS THAT CANNOT BE AVOIDED

By virtue of the nature of the proposed action some adverse effects will take place. To mitigate completely all effects is not feasible nor practical from the standpoint of accomplishing the proposed project in a reasonable time frame. Mitigating measures can effectively reduce the impacts and control from where they might occur. For example, some erosion and ultimate sedimentation will take place during the initial phase of the project. But the amount of erosion can be reduced and the resulting sedimentation can be controlled as to where deposition will take place. This means that while some erosion and sedimentation may result, the impact to the more critical areas (water features) can be controlled within acceptable limits.

In some extremely critical areas where steep to excessive slopes are immediately adjacent to water features, the implementation of mitigating measures may, in themselves, create greater impacts to the environment. In these situations avoidance would be the only mitigating alternative. Based on the scales used for this study, many of these conditions cannot be identified.
VII. RELATIONSHIPS BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE OF LONG-TERM PRODUCTIVITY

The short-term uses, in part, have been discussed in Section III-C, Disturbances. In addition to the short-term maximum impact during the construction phase, some additional environmental impacts will continue during the maintenance and operation of the transmission facility. These will include access to and along the right-of-way for repair to towers and conductors, microwave towers and substations. These impacts will include disturbance of the vegetation and soil surface which may increase erosion and result in soil loss. Periodic cutting and removal of the taller vegetation species would result in continued minimal impacts much less than those associated with the initial phases of construction. These impacts should not exceed the impact of the existing wood harvesting activities that would normally be carried out for this resource area.

The long-term effects that could result from implementation of the proposal, include soil loss from erosion, and vegetative disruption in the more sensitive areas. The vegetative disruption and soil loss impacts, while important, cover a proportionately small part of the total resource area. The visual long-term impact of the line itself would only continue if the towers were left in place after, termination of the transmission lines service.
The placement of structures, such as transmission towers, microwave sites and substations would render irreversible such resources as agriculturally productive soil or aggregates which are removed as part of that construction. The erosion or removal of topsoil is considered an irretrievable resource loss. In humid climates, such as the study area, natural production requires 500-700 years to redevelop one inch of topsoil. Similarly, the use of aggregate materials for road, microwave and substation site essentially renders that portion of the resource irretrievable.
The methodology employed to identify, describe and analyze the pertinent geotechnical elements were selected to provide both a comparative and a quasi-quantitative assessment of the potential environmental impacts of the proposed action. Identification of surficial geologic materials through the interpretation of aerial photographs was moderately well controlled by the limited, but strategically located, available soil and surficial geologic data. Slope categories, as measured from the USGS 15-minute quadrangle maps do not reflect the potentially critical site specific variations that may exist. The erosion potential values are only an indication of the potential for soil to erode if disturbed. The resulting estimates of potential sedimentation were derived from the Universal Soil Loss Equation. Because this equation was developed for use on agricultural land and may not be as applicable to forest land, the quantity estimates developed should be viewed only in a comparative sense. Slope and soil instability problems were evaluated in volume units for potential slope failures for the various qualitative soil characteristics and slope combinations. Impacts to potential aggregate sources were identified and compared as a function of volume and quality.

The four tables that accompany this study are included as a data source, for clarification of methodology and for evaluation and comparative assessment.

Based on our experience with the soil characteristics, terrain variables and environmental settings of northern New England, we have selected the scales and weighed the parameters for the final impact assessment of the individual links and route combinations. It would be possible, from the tables, to rework the raw data by changing both the scaled and weighed values.

While no severe geotechnical impacts that would require avoidance as the only mitigating approach, were identified, the steeper slopes should always be avoided if the choice is available. Table 2 (Appendix III) gives the comparative results of the impact assessments of sedimentation potentials for no action ($C_1$), construction with no mitigation ($C_2$) and construction with mitigation ($C_3$). The steeper slopes increase the impacts of all the assessed variables except for the impacts on potential mineral and aggregate sources. In general, the impacts on the mineral and aggregate resources are site specific and must be made when actual tower site locations and conductor heights are known. The steep to excessive slope areas on the highly erodible lacustrine/outwash deposits create the most severe single impacts for the proposed action.

While the impact of the slope variable was not assessed by itself, it would appear from the observed data and assessment procedures that it is the single most important geotechnical variable for the proposed action.
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