


1978

Dickey-Lincoln School Lakes Transmission Project : Draft Environmental Impact Statement

Transmission EIS Study Team

United States. Department of Energy

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ENVIRONMENTAL IMPACT STATEMENT

TRANSMISSION PLANNING SUMMARY

DICKEY-LINCOLN SCHOOL LAKES PROJECT

TRANSMISSION STUDIES



U. S. Department of Energy
Federal Building
Bangor, Maine 04401
February 1978

APPENDIX

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Transmission EIS Study Team
Federal Building, Room 209
Bangor, Maine 04401

TRANSMISSION PLANNING SUMMARY

PREFACE

On October 1, 1977, the responsibility for marketing federally generated power 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, first published in November 1976, is included as an appendix to that statement.

Appendix C, Transmission Planning Summary, documents in summary form the early phases of the study leading to the selection of System Plan E and its associated corridors for further detailed route location and environmental studies. This important decision was based on the results of the System Planning Study, the Alternative Power Transmission Corridor Study by VTN, and field reconnaissance at a regional level.

This document was distributed in the region in December 1976. The information and decisions presented in it were the subject of a series of seven public response meetings held in the region in December 1976.

A handwritten signature in cursive script that reads "Harry D. Hurless".

Harry D. Hurless
Project Team Manager

TRANSMISSION PLANNING SUMMARY

DICKEY-LINCOLN SCHOOL LAKES PROJECT
TRANSMISSION STUDIES



U.S. Department of the Interior
November 1976

Bangor, Maine

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TRANSMISSION PLANNING SUMMARY

Dickey-Lincoln School Lakes Project Transmission Studies

ABSTRACT

This report summarizes the results of system planning, environmental, and location studies for transmission facilities associated with the proposed Dickey-Lincoln School Lakes Project in northern Maine. The studies recommend the construction of two 345-kV transmission circuits from a substation near the project along a route through western Maine into northern New Hampshire and Vermont. The plan will integrate the power produced by the project into the New England Power Pool Transmission System. Five alternate integration plans were identified and studied. Of the five plans, the recommended plan, which calls for the lines to be suspended from a single row of steel towers, has the least environmental impact and is the least costly.

INTRODUCTION

The site of Dickey Dam is on the upper St. John River just above its confluence with the Allagash River, some 28 miles from Fort Kent, Aroostook County, Maine. As authorized, the dam would be an earthfill structure impounding a reservoir with a storage capacity of 7.7 million acre-feet for power, flood control, and recreation.

Lincoln School Dam is to be located on the St. John River, 11 miles downstream from Dickey. It is to be an earthfill structure impounding 24,000 acre-feet of water. A reregulating dam, Lincoln School will smooth out the fluctuation of flows created by peaking operations at Dickey.

Private and public utility engineers had been studying the feasibility of developing a tidal power plant at Passamaquoddy, a system of tidal bays, since 1919. Later they included the upper St. John River in their studies. In April 1961 after 3 years of study and an expenditure of some \$3 million, the International Joint Commission completed a comprehensive report on the project. The Commission concluded that under conditions existing then the project was not economically feasible.

Shortly thereafter, President John F. Kennedy asked that the Commission report be reviewed in light of advanced engineering techniques and prevailing economic conditions. A review report was submitted to the President in July 1963. It concluded that a different use concept for the power, coupled with advanced engineering techniques, favored project feasibility.

On July 16, 1963, President Kennedy directed the Departments of Army and the Interior to make additional studies to supplement the 1963 report. An Army-Interior Advisory Board on Passamaquoddy and Upper St. John River was formed. The Army Corps of Engineers launched studies leading to the design of the dams and other physical components of the project. Interior conducted studies on transmission, marketing, and other economic aspects.

The studies resulted in a report to the Secretary of the Interior in August 1964. Its recommendations included early authorization of the Passamaquoddy Tidal Project and Upper St. John River Developments and early construction of the project to develop low cost firm power for Maine and peaking power for the remainder of New England.

The Secretary submitted a report to President Johnson July 9, 1965, summarizing the studies. Subsequent reviews updated the power benefits. The benefit-to-cost ratio for the Dickey-Lincoln School Lakes project was then found to be 1.81 to 1.

The U. S. Congress authorized the Dickey-Lincoln School Lakes Project in Public Law 89-298, the 1965 Flood Control Act. President Lyndon B. Johnson signed the Act into law. It became effective October 27, 1965.

Planning and design for the Dickey-Lincoln School project began after the project was authorized--but ceased in late 1967 due to lack of funds. These activities resumed in the fall of 1974 when additional funding was provided to the Corps of Engineers.

The Flood Control Act of 1944 assigns the authority and responsibility for marketing and transmission of electric power generated at Federal hydroelectric projects to the Department of the Interior (DOI). This authority covers the power not used at the projects themselves. The act also sets forth certain broad criteria for the marketing of this power.

Thus, the Corps in 1974 asked the Department of the Interior to conduct a marketing study and do the transmission system planning, environmental, and location studies. The DOI established separate study teams, one for the marketing and another for the transmission planning, environmental, and location efforts.

The DOI will prepare a draft environmental impact statement on transmission aspects of the project as required by the 1969 National Environmental Policy Act (NEPA). The Corps is preparing a draft environmental impact statement on the project itself.

The two draft statements will be filed separately with the Council on Environmental Quality (CEQ). The Corps draft is to be submitted to the CEQ in June 1977, and the DOI draft in November 1977. The availability of the draft statements will be announced in the Federal Register and in the media.

The draft statements will then be combined into a single, final joint Environmental Impact Statement (EIS) for the project and associated transmission facilities. This EIS is scheduled to be filed with the CEQ in June 1978.

The DOI has established an office and small staff at Bangor, Maine, to manage and perform planning, reconnaissance, location, and environmental activities. The staff at Bangor has written this report.

APPROACH

Hence, the DOI has undertaken studies in four general areas--marketing, system planning, environmental impacts, and reconnaissance and location. The four studies, which are briefly described below, are:

- Dickey-Lincoln School Project Financial Feasibility Study for Electric Power
- Transmission System Planning Study
- Alternative Power Transmission Corridor and Environmental Study
- Transmission Reconnaissance and Location Study

Dickey-Lincoln School Project Financial Feasibility Study for Electric Power

The marketing study considers alternative ways of allocating Dickey-Lincoln School power to potential markets in the Northeast region, possible rate schedules for the power, and the establishment of rate levels. These rate levels would assure repayment of the investment in the project, including the cost of: (a) that part of the capital cost of the project allocated to power, and (b) the capital cost of the transmission facilities. All capital costs are repaid with interest.

The marketing study will consider alternatives and recommend a plan for marketing the power. Results of the marketing study will be presented in a separate report. Further discussion of the marketing study, therefore, is not included in this report.

Transmission System Planning Study

These studies will determine the electrical facilities needed to integrate Dickey-Lincoln School generation into the New England transmission system. Engineering and economic considerations are used to identify alternative electrical solutions referred to as "Plans of Service". Each such plan includes the physical transmission circuits and associated facilities required.

The system planning studies are based on projected loads, generation, and transmission facilities that, when this study was begun, were assumed to exist by 1986. That is the year this proposed project is tentatively scheduled to be completed if it is built. Load projections have since been adjusted. The current load estimate used in the study is now more representative of the estimated 1990-91 load level.

Current system studies were made in cooperation with NEPLAN, the planning organization, for the New England Power Pool (NEPOOL). They supplement earlier studies completed by NEPOOL which were discussed in a report dated November 1974.

Results and recommendations of the present study, based on load flow, stability, and cost studies, are presented in a report titled the Dickey-Lincoln School Lakes Project Transmission System Planning Study report. It is dated November 1976.

The system planning studies addressed two levels of development for the project--an authorized level and an ultimate level of generation as shown below:

TABLE 1

	<u>LEVEL OF DEVELOPMENT</u>			
	<u>AUTHORIZED</u>		<u>ULTIMATE</u>	
	<u>Peak</u> <u>(MW)</u>	<u>Energy</u> <u>(GWH)</u>	<u>Peak</u> <u>(MW)</u>	<u>Energy</u> <u>(GWH)</u>
Dickey	874	894	1311	894
Lincoln School	<u>80</u>	<u>262</u>	<u>80</u>	<u>262</u>
TOTAL	954	1156	1391	1156

The transmission planning study has identified five alternative transmission plans. All extend through Maine into New Hampshire and Vermont. Two of the alternatives follow an eastern route through Maine, and three a western route.

System studies indicate that each of the five transmission plans is capable of integrating the ultimate output of Dickey into the New England transmission system. The plans are:

Plan A

Plan A would require the construction of several new 345-kV alternating current (a-c) transmission lines. (See figure 1.) They follow an eastern route through Maine.

Plan B

Plan B would require the construction of a slightly different set of 345-kV a-c lines over portions through the same eastern areas traversed by for Plan A. (See figure 2.)

Plan C

Plan C would require the construction of a + 400-kV direct current (d-c) transmission line from a point near Dickey Dam to Comerford Substation near Littleton, New Hampshire, via western Maine. (See figure 3.)

Plan D

Plan D calls for the construction of two single-circuit, wood pole, 345-kV a-c lines between Dickey and Comerford Substation over the same general route through western Maine identified for Plan C. (See figure 4.)

Plan E

Plan E calls for the construction of two 345-kV a-c circuits from the project site to Comerford Substation over the same general route of Plans C and D. Plan E differs from Plan D in that two 345-kV circuits would be suspended from a single row of double-circuit, lattice-steel towers. (See figure 5.)

Dimensioned sketches of typical structures being considered for the five plans are shown in figures A-1 and A-2 in appendix A.

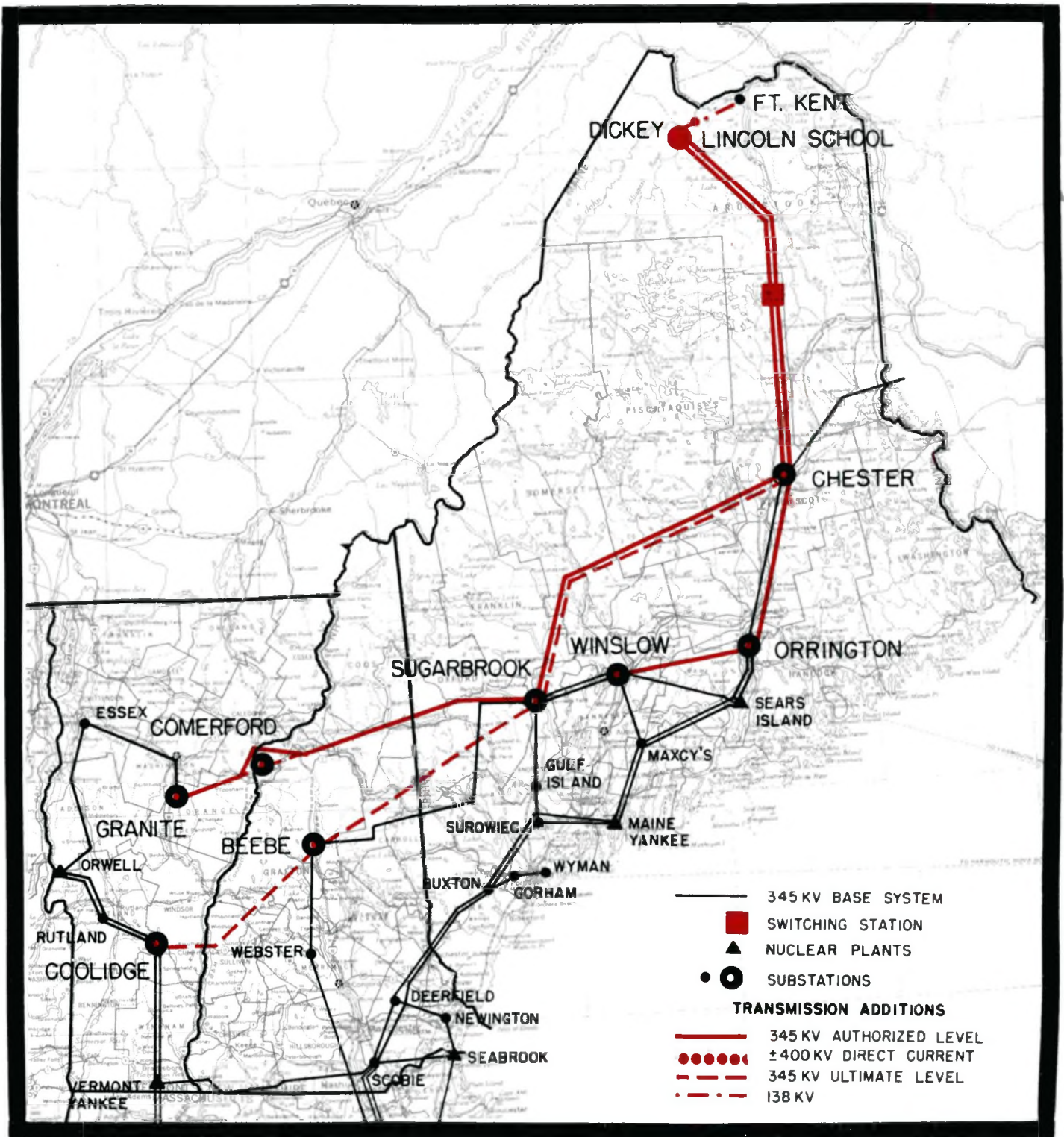
The construction of a 345-kV wood pole line from Comerford Substation to Granite Substation near Barre, Vermont, is common to all five alternative plans at the authorized level. An additional 345-kV wood pole line from Comerford to Beebe Substation near Plymouth, New Hampshire, is required at the ultimate level for Plans C, D, and E.

The construction of a 138-kV a-c transmission line from Dickey Dam to Lincoln School Dam and on to Fort Kent, Maine, is common to all of the five plans.

Each of the five alternative plans will require the construction of new substations and additions to existing substations. A preliminary list of substation facilities that would be required for each plan appears in appendix B, table B-1. The substations are discussed in the transmission system planning study report.

Microwave facilities also will be required to monitor and control transmission facilities associated with the project. Preliminary plans call for the use of both new and existing microwave installations. Control facilities are discussed in more detail in appendix C and also in the transmission system planning study report.

The transmission system planning study identifies Plan E as the best plan from engineering and economic standpoints. (For further details, please refer to the General Discussion section of this report or the separate transmission system planning study report.)



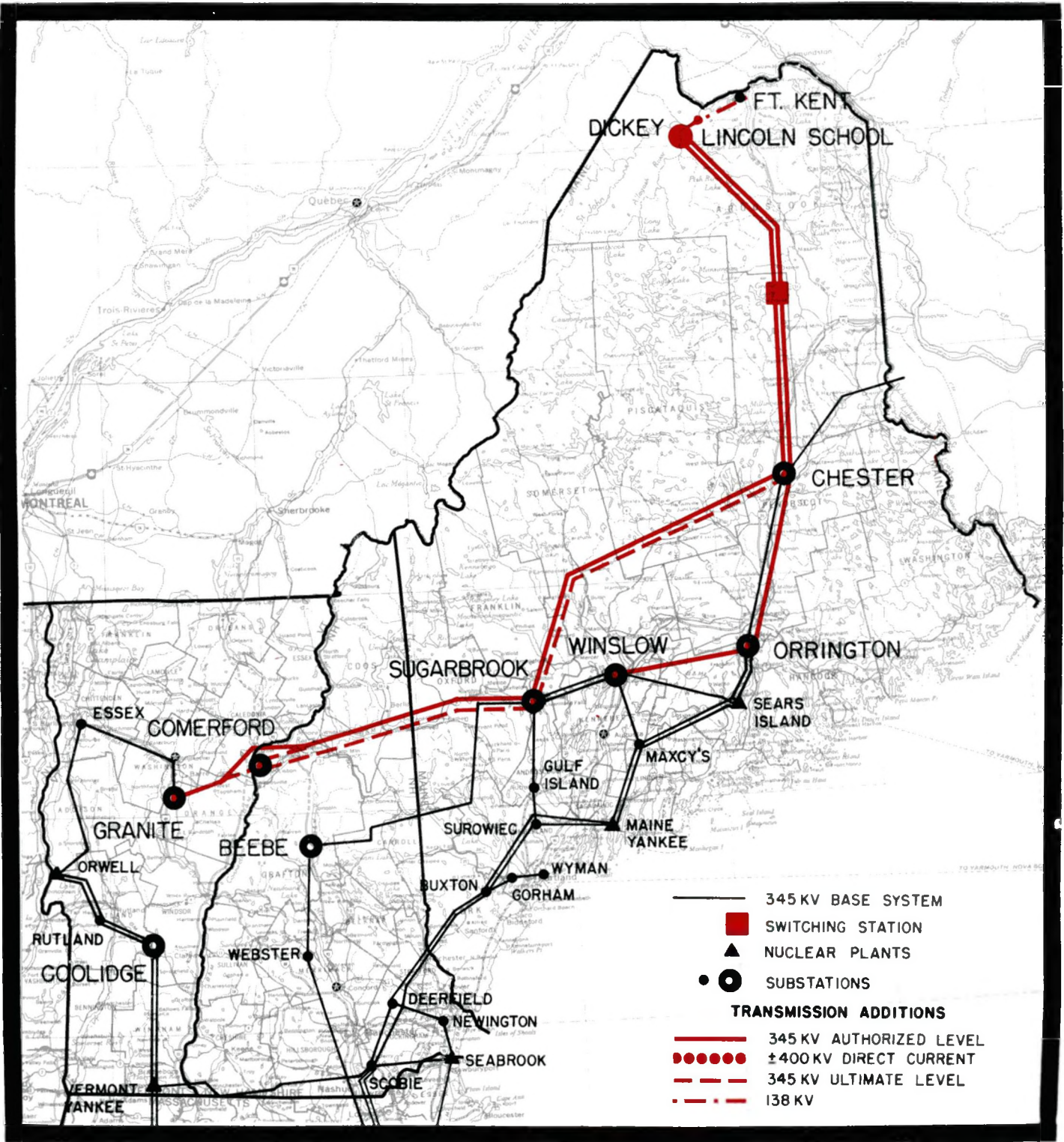
SYSTEM PLAN A

Eastern AC Plan

DICKEY / LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November, 1976



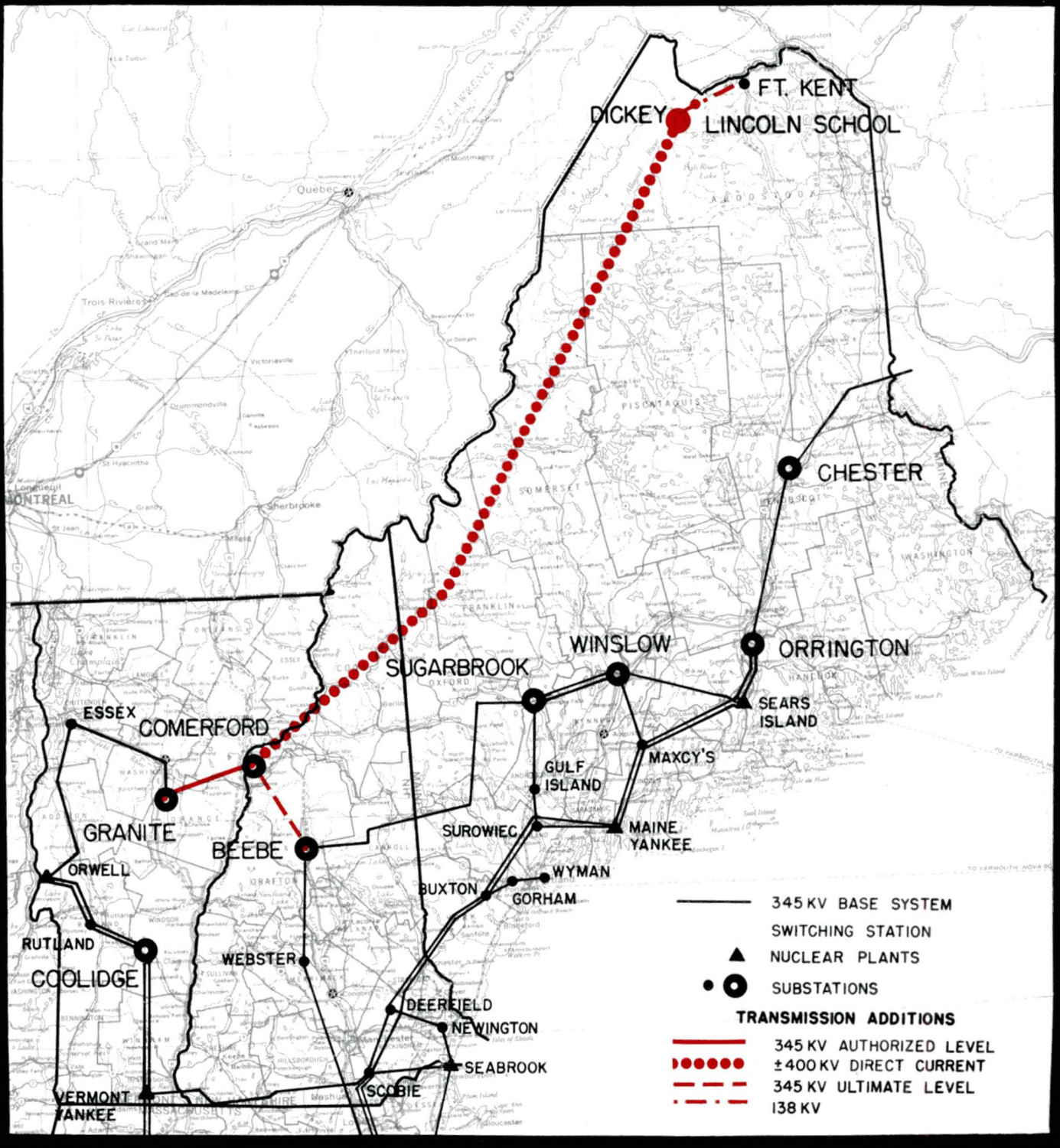
SYSTEM PLAN B

Eastern AC Plan

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U.S. Department of the Interior

November, 1976



SYSTEM PLAN C

Western DC Plan - Direct Current

DICKEY / LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November, 1976

FIGURE 3

Table 6 shows preliminary mileage figures for each of the five plans at both the authorized and ultimate levels of development for purposes of the system planning studies.

TABLE 6
Dickey-Lincoln School Transmission System Planning Study
 Transmission Line Additions

Authorized Level (874 MW at Dickey)

Plan	A	B	C	D	E
Circuit Miles	670	670	322	582	582
Corridor Miles	520	520	322	322	322
WHF (Single line) ^{1/}	370	370	62	62	62
WHF (Two lines in parallel)	150	150	--	260	--
WHF dc	--	--	260	--	--
SDC	--	--	--	--	260

Ultimate Level (1311 MW at Dickey)

Plan	A	B	C	D	E
Circuit Miles	989	895	371	631	631
Corridor Miles	714	520	371	371	371
WHF (Single line) ^{1/}	439	145	111	111	111
WHF (Two lines in parallel)	275	375	--	260	--
WHF dc	--	--	260	--	--
SDC	--	--	--	--	260

^{1/} Includes 30 miles of 138-kV line.

Alternative Power Transmission Corridor and Environmental Study

The Alternative Power Transmission Corridor and Environmental Study was a complex, technical effort, as stated above, to: (1) identify a study area; (2) inventory, analyze, and map physical, biological, and social data; (3) identify alternative corridors; (4) rank the identified corridors based on least environmental impact; and (5) use this information to evaluate alternative system plans.

The corridors referred to are from 1 to 10 miles wide and identify linear areas of the landscape where least impact can be expected from construction, maintenance, and operation of transmission facilities.

The first of the current environmental assessment studies undertaken for the DOI was an Environmental Data Reconnaissance Report prepared by Comitta Frederick Associates (CFA), West Chester, Pennsylvania, in March 1976. The purpose of this study was to identify and document what type of environmental data is available in Maine, New Hampshire, and Vermont.

The environmental consultant hired by the DOI to conduct the "Alternative Power Transmission Corridor and Environmental Study" was VTN Consolidated, Inc. (VTN), of Cambridge, Massachusetts. CFA served as a subcontractor to VTN. The DOI has actively followed the progress of this corridor study and has furnished input related to transmission engineering.

The corridor study addresses three general location alternatives: two through eastern Maine (Plans A and B) and a third through western Maine (Plans C, D and E).

Corridor study phases leading up to issuance of this transmission planning summary report are shown in figure 6.

PROJECT PHASES

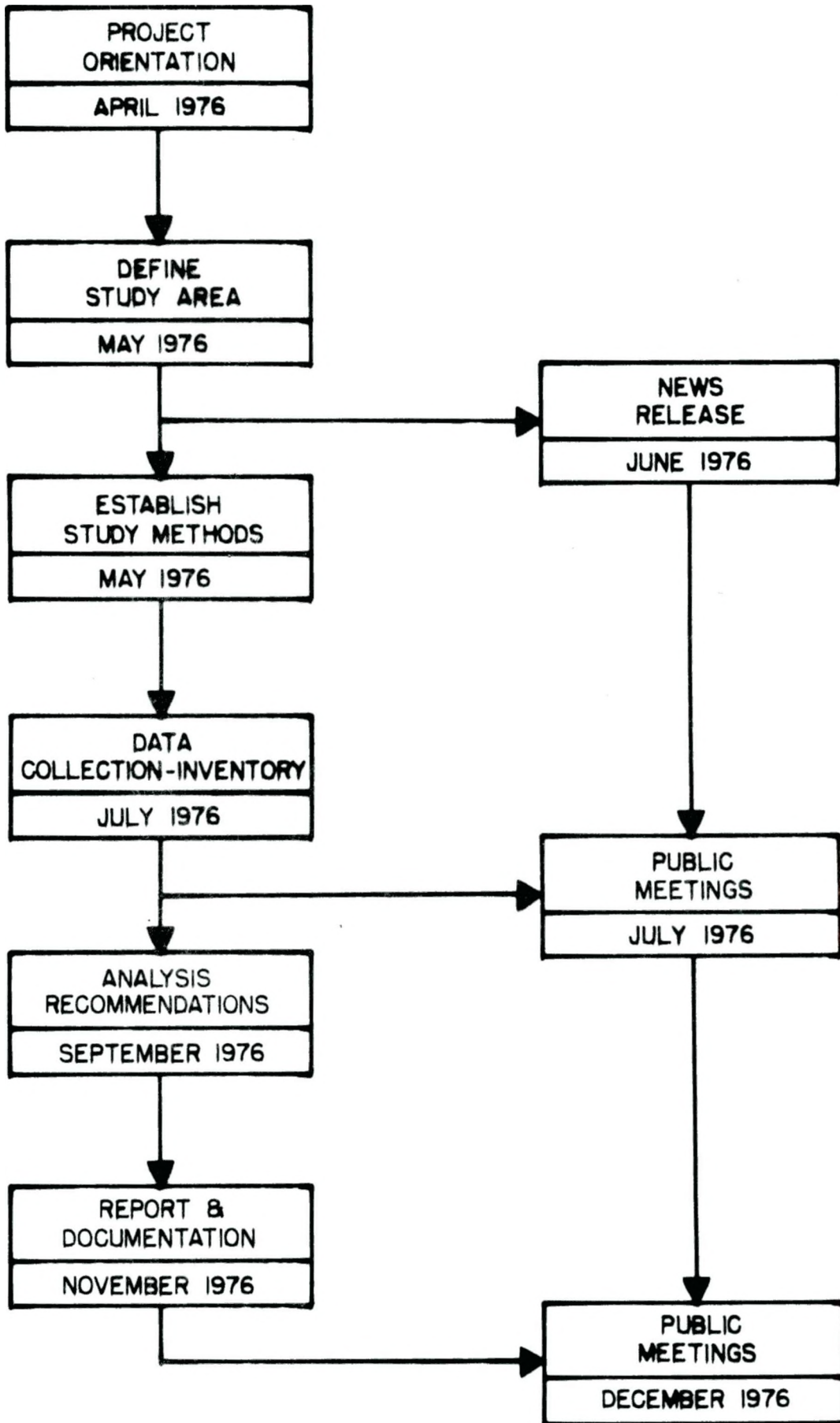


FIGURE 6

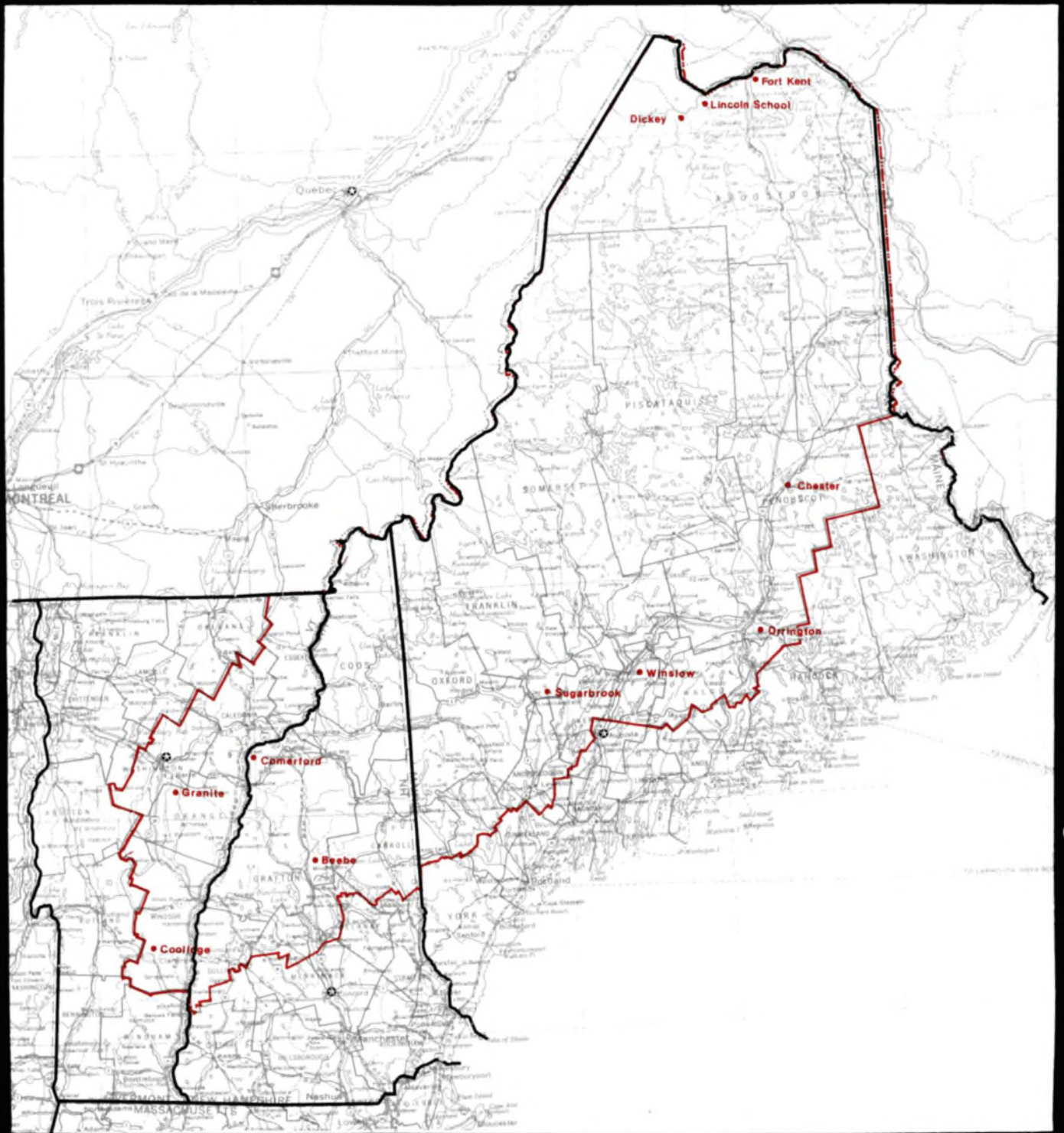
Study area boundaries were drawn to include all areas that could be considered as locations for any of the system plans under study. Figure 7 shows the study area. Its outline follows jurisdiction boundaries, including the International Boundary between the United States and Canada, as well as county and town boundaries. The area includes the northern parts of Maine and New Hampshire and north-eastern Vermont. It encompasses about 32,000 square miles.

The consultant established a study methodology which would focus on environmental concerns and resources most threatened by the construction, maintenance, and operation of transmission facilities. The methods would provide for consideration of and reaction to the concerns of a multidisciplinary team working on the project for the contractor as well as those of the many people and organizations who have been contacted by contractor's representatives and by members of the DOI team at Bangor.

Two reports - the March 1976 CFA report entitled "Environmental Data Reconnaissance Report - Dickey-Lincoln School Transmission Project" and a September 1975 META System, Inc., report entitled "Scope of Work-Environmental Impact Statement for the Dickey-Lincoln School Lakes Project," - provided much useful information about the availability of data and the environmental concerns in the region.

Information obtained in the public meetings, held by the DOI in July 1976 at Presque Isle, Bangor, and Augusta, Maine; Concord and Berlin, New Hampshire; and Montpelier, Vermont, was also very useful.

Major concerns, already identified above and repeated here for the convenience of the reader, were: Social, economic, natural system, esthetic/cultural, legal, and site development costs. (See data/analysis matrix, figure 8.)



STUDY AREA

DICKEY / LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November, 1976

TRANSMISSION CORRIDOR ASSESSMENT

DATA/ANALYSIS MATRIX

CONCERNS

LOCATION FACTORS

A-LEVEL

B-LEVEL

C-LEVEL

A-1 SOCIAL

A-2 ECONOMIC

A-3 NATURAL SYSTEMS

B-1 WILDLIFE

A-4 AESTHETIC/CULTURAL

A-5 LEGAL

A-6 SITE DEVELOPMENT COST

B-3 ACQUISITION

B-4 MAINTENANCE AND CONSTRUCTION

- C-1 LAND OWNERSHIP
- C-2 HUMAN POPULATION
- C-3 RECREATION LAND USE
- C-4 RECREATION LAND USE
- C-5 OPEN/AGRICULTURAL LAND
- C-6 EXISTING FOREST/INDUSTRY
- C-7 VEGETATIVE COVER
- C-8 SURFACE WATER SYSTEMS
- C-9 GROUNDWATER SYSTEMS
- C-10 WET HABITAT
- C-11 WETLAND AREAS
- C-12 FISH HABITATS
- C-13 SIGNIFICANT WILDLIFE AREAS
- C-14 SOILS - INCREASED EROSION
- C-15 HISTORIC RESOURCES
- C-16 ARCHAEOLOGICAL RESOURCES
- C-17 UNIQUE RESOURCES
- C-18 EXISTING VISUAL QUALITY
- C-19 VISUAL QUALITY DUE TO VISIBILITY/ABSORPTION PARAMETERS
- C-20 VISUAL QUALITY DUE TO EXPOSURE TO LAND USES
- C-21 COST DUE TO VALUE OF DEVELOPER LANDS
- C-22 COST DUE TO VALUE OF RECREATION LANDS
- C-23 COST DUE TO VALUE OF FOREST LANDS
- C-24 COST DUE TO DECREASED ACCESSIBILITY
- C-25 COST DUE TO AREAS OF UNSTABLE SOILS
- C-26 COST DUE TO AREAS OF STEEP SLOPES
- C-27 COST DUE TO AREAS OF ENDANGERED, THREATENED, OR UNIQUE SPECIES
- C-28 COST DUE TO EXPOSURE TO SEVERE MICROCLIMATIC CONDITIONS

CONCERN	1.0 LAND USE	2.0 TOPOGRAPHY/SLOPE	3.0 RECREATION LAND USE	4.0 TRANSPORTATION	5.0 LAND OWNERSHIP	6.0 DEMOGRAPHY	7.0 SURFACE HYDROLOGY	8.0 ARCHAEOLOGY	9.0 HISTORIC	10.0 ENVIRONMENTAL QUALITY	11.0 GROUNDWATER	12.0 UNIQUE RESOURCES	13.0 EXISTING UTILITIES AND HABITAT OF WILDLIFE	14.0 WILDLIFE	15.0 FISH	16.0 VISUAL QUALITY	17.0 ACQUISITION	18.0 MAINTENANCE AND CONSTRUCTION
A-1 SOCIAL																		
A-2 ECONOMIC																		
A-3 NATURAL SYSTEMS																		
B-1 WILDLIFE																		
A-4 AESTHETIC/CULTURAL																		
A-5 LEGAL																		
A-6 SITE DEVELOPMENT COST																		
B-3 ACQUISITION																		
B-4 MAINTENANCE AND CONSTRUCTION																		

DATA ELEMENTS

- 1.0 LAND USE
 - 1.1 Urban Centers/Communities
 - 1.2 Rural Centers
 - 1.3 Farm Country
 - 1.4 Forest Land
 - 1.5 Pastureland
 - 1.6 Indian Lands/Reservations
- 2.0 TOPOGRAPHY/SLOPE
 - 2.1 Slope up to 10%
 - 2.2 Slope 10 to 20%
 - 2.3 Slope greater than 20%
- 3.0 RECREATION LAND USE
 - 3.1 Public Parks
 - 3.2 Private Parks
 - 3.3 State Park Lands
 - 3.4 National Park Lands
 - 3.5 National Recreation Areas
 - 3.6 National Historic Sites
 - 3.7 National Historic Trails (Special-Use Areas)
 - 3.8 National Historic Trails
- 4.0 TRANSPORTATION
 - 4.1 Interstates, A.S.T., A.S.T. and Freeway
 - 4.2 Major Highways
 - 4.3 Other Major Highways
 - 4.4 Existing Access Routes
 - 4.5 Existing Access Routes
 - 4.6 Existing Access Routes
- 5.0 LAND OWNERSHIP
 - 5.1 State Land
 - 5.2 Federal Land
 - 5.3 Large Institutional/Non-Federal Land
 - 5.4 Small Institutional/Non-Federal Land
 - 5.5 Private Land/Other - High
 - 5.6 Private Land/Other - Low
 - 5.7 Parcel Size 10/1/100 - Low
 - 5.8 Parcel Size 10/1/100 - High
- 6.0 DEMOGRAPHY
 - 6.1 U.S.
 - 6.2 S.E.
 - 6.3 S.W.
 - 6.4 S.E. - S.W.
- 7.0 SURFACE HYDROLOGY
 - 7.1 Lakes, Ponds, Great Ponds, Reservoirs, Large Rivers
 - 7.2 Rivers and Streams
 - 7.3 Wetlands
 - 7.4 Aquatic Wetland
 - 7.5 Non-aquatic Wetland
- 8.0 ARCHAEOLOGY
 - 8.1 Existing Archeological Sites
 - 8.2 Archeological Sensitivity Zones
- 9.0 HISTORIC
 - 9.1 National Register Historic Sites
 - 9.2 National Historic Landmarks
 - 9.3 National Historic Sites and National Historic Sites
- 10.0 ENVIRONMENTAL QUALITY
 - 10.1 Air Quality
 - 10.2 Noise
 - 10.3 Seismicity
 - 10.4 Soils
 - 10.5 Wetlands
 - 10.6 Wetlands
 - 10.7 Wetlands
 - 10.8 Wetlands
 - 10.9 Wetlands
 - 10.10 Wetlands
 - 10.11 Wetlands
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 - 10.16 Wetlands
 - 10.17 Wetlands
 - 10.18 Wetlands
 - 10.19 Wetlands
 - 10.20 Wetlands
- 11.0 GROUNDWATER
 - 11.1 Surface and Subsurface Water
- 12.0 UNIQUE RESOURCES
 - 12.1 Cultural Resources
 - 12.2 Cultural Resources
 - 12.3 Cultural Resources
 - 12.4 Cultural Resources
 - 12.5 Cultural Resources
 - 12.6 Cultural Resources
 - 12.7 Cultural Resources
 - 12.8 Cultural Resources
 - 12.9 Cultural Resources
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 - 12.17 Cultural Resources
 - 12.18 Cultural Resources
 - 12.19 Cultural Resources
 - 12.20 Cultural Resources
- 13.0 EXISTING UTILITIES AND HABITAT OF WILDLIFE
 - 13.1 Existing Electric Transmission Lines
 - 13.2 Existing Electric Transmission Lines
 - 13.3 Existing Electric Transmission Lines
 - 13.4 Existing Electric Transmission Lines
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 - 13.18 Existing Electric Transmission Lines
 - 13.19 Existing Electric Transmission Lines
 - 13.20 Existing Electric Transmission Lines
- 14.0 WILDLIFE
 - 14.1 Endangered and Threatened Species
 - 14.2 Endangered and Threatened Species
 - 14.3 Endangered and Threatened Species
 - 14.4 Endangered and Threatened Species
 - 14.5 Endangered and Threatened Species
 - 14.6 Endangered and Threatened Species
 - 14.7 Endangered and Threatened Species
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 - 14.19 Endangered and Threatened Species
 - 14.20 Endangered and Threatened Species
- 15.0 FISH
 - 15.1 Fish
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 - 15.19 Fish
 - 15.20 Fish
- 16.0 VISUAL QUALITY
 - 16.1 Landmark and Thematic Sites
 - 16.2 Landmark and Thematic Sites
 - 16.3 Landmark and Thematic Sites
 - 16.4 Landmark and Thematic Sites
 - 16.5 Landmark and Thematic Sites
 - 16.6 Landmark and Thematic Sites
 - 16.7 Landmark and Thematic Sites
 - 16.8 Landmark and Thematic Sites
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 - 16.10 Landmark and Thematic Sites
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 - 16.12 Landmark and Thematic Sites
 - 16.13 Landmark and Thematic Sites
 - 16.14 Landmark and Thematic Sites
 - 16.15 Landmark and Thematic Sites
 - 16.16 Landmark and Thematic Sites
 - 16.17 Landmark and Thematic Sites
 - 16.18 Landmark and Thematic Sites
 - 16.19 Landmark and Thematic Sites
 - 16.20 Landmark and Thematic Sites

FIGURE 8

The methodology developed and used in the environmental study can possibly best be understood by referring to figure 8. Seventy-three data elements are listed across the top of this matrix. These items are the kinds of things that exist in the study area for which data was collected and mapped and which would be impacted by the construction, maintenance, and operation of transmission facilities. Seventy-three separate data map overlays were made, one for each data element.

A list of the six major concerns that would affect the location acceptability of transmission circuits was developed. They are designated as A-level, major - concerns in figure 8. The A-level, major concerns were then separated into subsets - C-level concerns called "Location Factors". Twenty-eight location factors are listed on figure 8.

The matrix shows the relationship between the location factors (C-1 through C-28), and the 73 data elements. For example, location factor C-1, Land Ownership includes data items: Indian Lands/Reservations (1.6); Parcel Density/Town - high (5.5); Parcel Density/Town - medium (5.6); and Parcel Density/Town - low (5.7). A map was then made in the form of a shaded overlay based upon the relationships established in the matrix. That is, the location factor, Land Ownership is related to or dependent upon data elements 1.6, 5.5, 5.6, and 5.7. Similar overlays were made for each of the 28, C-level location factors.

A location factor, impact number was then assigned to each of the 28 location factors (see table 7). This number indicates the relative impact the transmission facilities could have on the environment. The degree of impact is either severe, moderate, or slight.

Six composite maps corresponding to each of the major concerns (A-level) were then produced by overlaying appropriate location factor (C-level) maps.

Two things remained to be done to accomplish the desired results of this effort. They were:

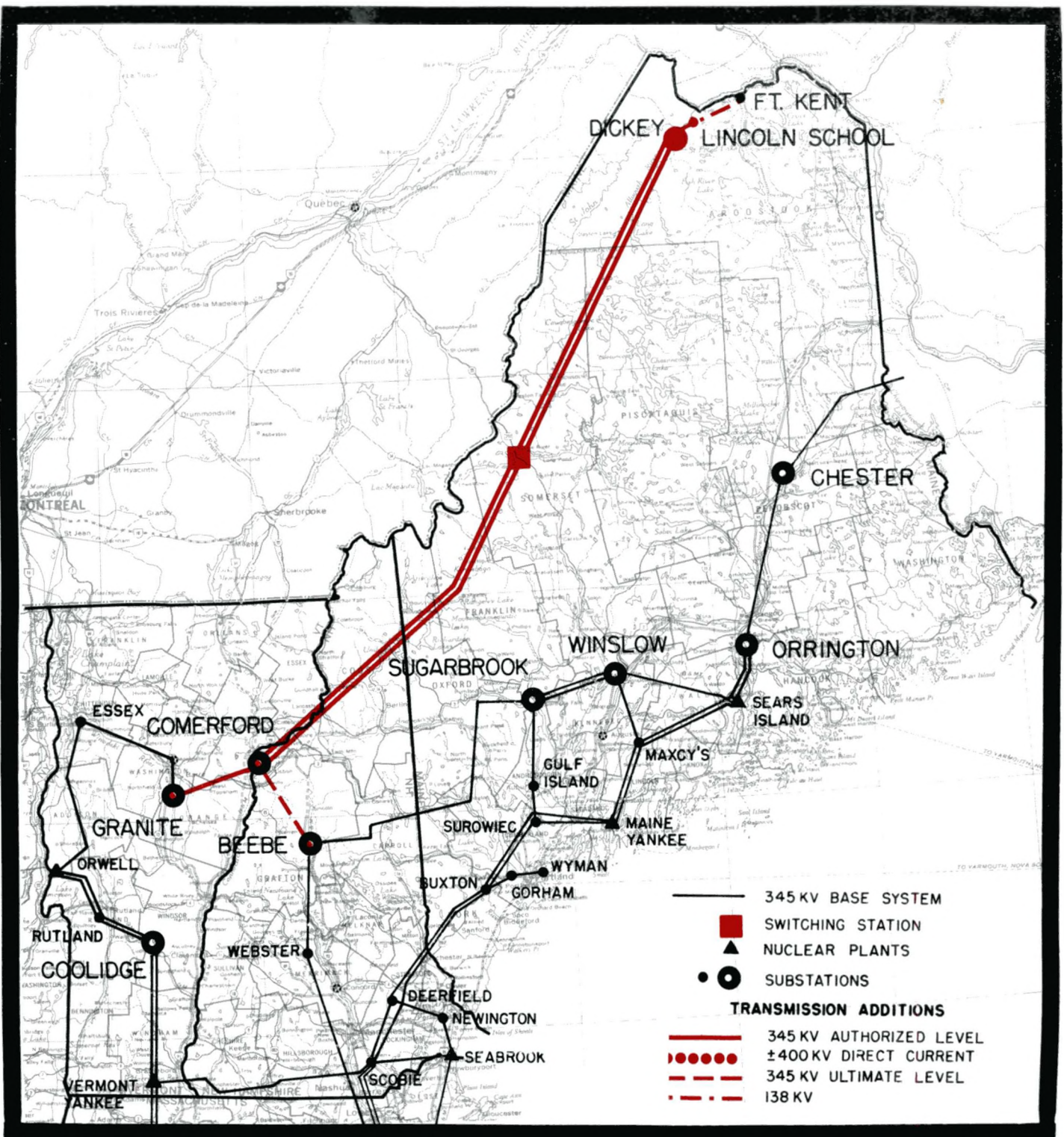
TABLE 7

LOCATION FACTOR IMPACT NUMBERS

<u>LOCATION FACTORS:</u>	<u>IMPACT NUMBER:</u>
1. SOCIAL	
Land Ownership	two (2)
Human Populations.	three (3)
Recreation Land Use.	two (2)
2. ECONOMIC	
Recreation Land Value.	one (1)
Open/Agricultural Land	one (1)
Existing Forest Industry	three (3)
3. NATURAL SYSTEMS	
Vegetative Cover	three (3)
Surface Water Systems.	two (2)
Groundwater Systems.	one (1)
Deer Habitat	three (3)
Waterfowl Areas.	two (2)
Fish Habitat	three (3)
Significant Wildlife Areas	three (3)
Soils; Increased Erosion.	two (2)
4. ESTHETIC/CULTURAL	
Historic Resources	three (3)
Archaeological Resources	two (2)
Unique Resources	three (3)
Existing Visual Quality.	three (3)
Visual Quality Due to Visibility/Absorption Parameters	three (3)
Visual Quality Due to Exposure to Land Uses.	three (3)
5. LEGAL	
6. SITE DEVELOPMENT COSTS	
Value of Developed Lands	three (3)
Value of Recreation Lands.	two (2)
Value of Forest Industry Lands	one (1)
Cost Due to Decreased Accessibility.	two (2)
Cost Due to Unstable Soils	three (3)
Cost Due to Steep Slopes	one (1)
Cost Due to Severe Microclimatic Conditions.	one (1)
Cost Due to Presence of Unique Rare and/or Endangered Plant Species	two (2)

DEGREES OF IMPACT POSSIBLE

- 1 = slight
- 2 = moderate
- 3 = severe



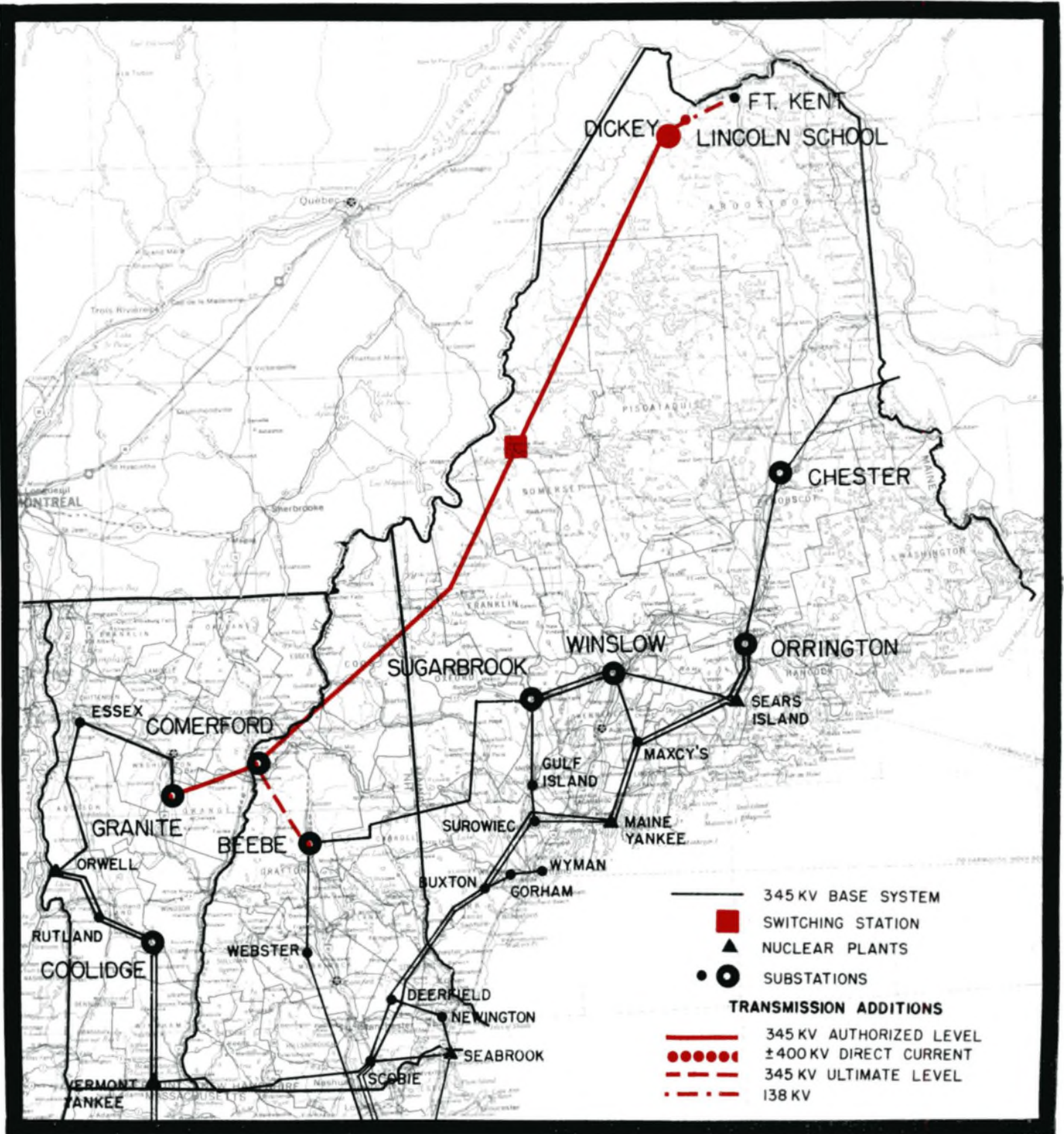
SYSTEM PLAN D

Western AC Plan - Two Single Circuits

DICKEY / LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November, 1976



SYSTEM PLAN E

Western AC Plan - Double Circuit

DICKEY / LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November, 1976

The transmission system planning study has identified five alternative plans of service for integrating the Dickey-Lincoln School generation into the New England power system. In the system planning study, the new transmission facilities required are identified only as lines that go from point to point, for example, from Dickey to Comerford Substation. The steps that follow in the total study process are to locate broad corridors and routes for the facilities. Specific routes and exact lengths of the transmission lines will then be determined through further studies.

Alternative Power Transmission Corridor and Environmental Study

The Alternative Power Transmission Corridor and Environmental Study and the Reconnaissance and Location studies, address the problems of: (a) identifying areas suitable for the locations of the new facilities (corridors); and (b) ranking the corridors in order of desirability.

The objectives of the Alternative Power Transmission Corridor and Environmental Study were to:

1. Identify a study area that would include all possible project transmission line locations;
2. Inventory, analyze, and map the area's physical, biological, and social resources;
3. Identify alternative electrical transmission corridors within the study area;
4. Rank the identified corridors based on least impact to the environmental resources of the area; and
5. Use the corridor impact information to evaluate and rank the alternative system plans.

Corridors are from 1 to 10 miles wide and identify areas in the landscape where least impact can be expected from construction, maintenance, and operation of transmission facilities.

The DOI is utilizing consultants, most of whom are situated in the northeastern part of the United States, for environmental studies. This will help assure that New England environmental concerns are being adequately addressed.

The environmental studies focus on six major areas of concern: Social, economic; natural system; esthetic/cultural; legal; and site development costs.

The consultant for this study (VTN Consolidated, Inc., Cambridge, Massachusetts) established a study methodology which would focus on environmental concerns and resources most threatened by the construction, maintenance, and operation of transmission facilities. The methodology provides a structured way to figure into the decision-making process the concerns of: (a) the contractor's multidisciplinary team; (b) the many persons and organizations contacted in the region; and (c) members of the DOI staff. The DOI reconnaissance engineers worked with the consultants during the corridor identification process.

Prior to VTN's final ranking of the corridors and plans of service and making a recommendation to the DOI, the consultant reviewed the results of their evaluation in the field with DOI reconnaissance engineers. This was done with fixed-wing aircraft and helicopters. Field observations and review generally confirmed findings.

VTN study recommended Plan E. This study's recommendation agreed with the recommendation of the transmission system planning study. Of the alternatives studied, the western plan was found to result in the least environmental impacts.

Reconnaissance and Location Studies

Specially trained, experienced engineers from the DOI Bangor team performed the reconnaissance and location studies. They are familiar with the problems of design and construction of high-voltage transmission facilities and can relate these problems to such factors as topography, geography, geology, vegetation, etc. Their work helps to identify the most satisfactory locations for facilities in view of these factors. It is performed in part by using topographic maps, ERTS satellite photographs, and aerial photographs. The engineers also look over the landscape from the air, from vehicles, and walk over it. They make a

large number of contacts with persons and organizations in the study area. The results of this work have contributed to the proposals and recommendations in this report.

Either the eastern or western route would accommodate overhead transmission lines within the proposed corridors. However, based on reconnaissance and location studies conducted thus far, the western route would seem to impose fewer overall engineering and environmental problems. Many of the impacts that would threaten natural and cultural resources would be mitigated.

FINDINGS

The transmission system planning studies, the environmental studies, and the reconnaissance and location studies have each led individually to the same conclusion, that is:

Plan E, which calls for two 345-kV circuits supported by double-circuit steel towers that follow the western route through Maine, is the best of the five alternatives.

The system planning studies indicate that Plan E is the lowest cost alternative that would meet technical requirements. The environmental studies and the reconnaissance and location studies also indicate that Plan E is best. Therefore, if the Dickey-Lincoln School Lakes Project is shown to be feasible and a decision is made to proceed with construction, this report recommends that the transmission facilities be designed and constructed in accordance with Plan E.

Future Direction

Additional, more detailed environmental studies will be made of the western route associated with Plan E. The draft and final EIS will contain information about the various alternative plans of service and routes as well as more detailed information on the recommended plan.

GENERAL DISCUSSION

The preceding discussion constitutes a "management summary" of the Dickey-Lincoln School transmission studies carried out to date by the DOI. As a result of these studies, and as stated above, Plan E, the double-circuit transmission line supported by steel towers that follows the western route through Maine, is the plan of service recommended.

This section of the report will provide additional detail and information about the three study efforts.

Appendices which follow this section present general information about the transmission circuit design parameters, the substation facilities which must be added, and the microwave radio system facilities required for proper control of the additional transmission facilities.

The technology and processes used in these studies are sophisticated. The reader who wishes to become familiar with the detailed considerations of these study efforts should contact the DOI office at Bangor, Maine.

Transmission System Planning Study

The transmission system planning study is made by creating a computerized mathematical model of the existing New England transmission system with its generation and loads.

The proposed new facility, in this case a hydroelectric resource, is added to the system represented by the model. Alternate ways of integrating the output of the resource into the system are studied to identify those plans which best satisfy engineering and economic considerations.

The system configurations that are developed must permit the power system to operate electrically under a wide assortment of conditions. The total connected load on the system must be served with a high level of reliability. Thus, studies are made to determine adequacy of the system to serve the loads when outages of major circuits and different generation patterns occur. Any component on the system can be expected to be out of service several times during its lifetime for either emergency or routine maintenance.

The studies examine the capability of the electric system to withstand transient conditions on the system when faults occur and generators, especially those near the fault, tend to accelerate and rapidly go out-of-step with the rest of the system. These situations place special stress on the transmission facilities.

This study was made in cooperation with NEPLAN, the planning organization for NEPOOL.

The 1985-86 period load level was chosen for the transmission system planning study covered by this report for two reasons:

- (1) The 1985-86 period represented the earliest time that the Dickey-Lincoln School project could come "on-line" if the project was found to be feasible.
- (2) NEPLAN had made a study in 1974 using the load level projected then for the 1985-86 period. That study considered the desirability of the project from the standpoint of how it could be integrated with other projected regional resources in meeting estimated loads. The 1974 study also considered transmission requirements for the project. The availability of findings and system data from the 1974 study expedited the completion of the additional studies required. A copy of the NEPLAN report, dated November 21, 1974, has been attached to and made a part of this document.

It is important to note that the 1974 NEPLAN report considered only the 830-MW level authorized for the project. The current system planning study was directed primarily at the project's ultimate level of development.

Should the project be constructed at the authorized level, additional studies would be required to determine the feasibility of installing generating units called for at the ultimate level.

The load-resource projections for the region have changed substantially from those used in the study. Load levels which were considered accurate represent loads projected for 1990-91. Delays also have been encountered in schedules for completion of new nuclear plants in Maine and Vermont. This illustrates how rapidly the scheduling, magnitude, and location of new loads and resources can change in today's world. This susceptibility to change necessitates a periodic review of basic assumptions used in the planning studies and a determination as to whether those assumptions are:

- (1) Sufficiently valid to allow proper conclusion to be developed; or
- (2) An updating of the study is essential.

A review of this study's parameters and assumptions has indicated that valid conclusions can be drawn from the study results even though the load and resource data reflect a load level that will be reached several years later than was originally assumed.

Furthermore, continuing load and resource changes should be monitored and judgments made as to their possible effect upon conclusions of the current study.

This study has assumed that the new nuclear plants and their associated transmission facilities would be in service before the Dickey-Lincoln School project is energized. Should the Dickey-Lincoln School project come on-line before these nuclear plants,

some of the transmission planned for the plants probably would have to be built ahead of schedule to integrate power from Dickey-Lincoln School. In this event, additional system planning studies must be made to determine the transmission system required and the costs to be borne by the project.

It is noteworthy that the western plans will not depend on nuclear plant transmission facilities as much as the eastern plans, nor will they be influenced as much if the nuclear plants and associated transmission facilities are delayed beyond the energization date for Dickey-Lincoln School.

As mentioned above under the heading "Approach" and the discussion of the transmission system planning study, five alternative integration plans (See figures 1 through 5) have been identified and studied. Plans A and B are 345-kV a-c plans that follow a route through eastern Maine. Plan C is a \pm 400-kV d-c plan routed through western Maine. Plans D and E are 345-kV a-c plans that follow the same western route.

Engineering Considerations - The following discussion covers load flow and stability studies made by the DOI in cooperation with NEPLAN.

The base New England 345-kV transmission system to which Dickey-Lincoln School transmission additions would be connected is one that is assumed to be available when Dickey-Lincoln School is energized. The project transmission facilities are superimposed on the base system. The base system includes the transmission required for the three nuclear plants -- two 1150-MW nuclear units at Sears Island in Maine and one 1150-MW nuclear unit in Vermont. It also includes transmission required to serve expected load growth in Maine, northern New Hampshire, and northern Vermont.

Each of the five alternative plans of service is designed to integrate the output from Dickey-Lincoln School at both the authorized and ultimate levels of generation. The transfer capability out of Maine is 3000 MW for the 874-MW level and 3450 MW for the 1311-MW level.

Three different load levels were used to test the alternative systems at the ultimate level: (1) 90 percent of winter peak, (2) 60 percent of winter peak, and (3) 45 percent of winter peak. The heavy and intermediate load levels were used to test each alternate system with Dickey peaking. In the tests, the system had to withstand a single contingency outage while accommodating scheduled transfer of 3450 MW out of Maine. Table 2 shows transfer limits. (See following page.)

With the loss of one of the two a-c circuits out of Dickey, the remaining circuit should be able to carry the full output of the Dickey plant. With the d-c plan, however, the loss of either the plus or minus conductor of the line would reduce the line's capacity by half. However, loads could still be served with reserve generation.

Power flow studies were made for each load level. Stability tests were made for the heavy and intermediate load levels but not for the light load level.

The light load level was used to test the alternate systems with Dickey-Lincoln School in the pumping mode to determine whether some transmission limitation existed. None was found.

The transmission system planning study contains detailed information on power flow studies and stability tests.

Future System Studies - Future studies will be undertaken if Dickey-Lincoln School is approved for construction. Cognizance will be taken of any major changes or developments, should they occur and affect the basic assumptions of this study.

Economic Considerations - The economic studies considered three possible approaches to financing construction of the transmission facilities required. These were: all Federal financing, a combination of Federal and non-Federal, or all non-Federal.

TABLE 2
Dickey-Lincoln School Transmission System Planning Study
Maine-New Hampshire Transfer Limits-MW

<u>PLAN</u>	<u>REINFORCEMENT</u>	<u>90%</u>	<u>60%*</u>	<u>60%**</u>
A	Sugarbrook-Beebe-Coolidge 345-kV	3500 <u>1/ 3/</u>	3050 <u>2/</u>	3350 <u>3/</u>
B	Sugarbrook-Comerford No. 2 345-kV	3450 <u>1/ 3/</u>	3000 <u>2/</u>	3325 <u>3/</u>
C	Dickey-Comerford dc Comerford-Beebe 345-kV	3575 <u>1/</u>	3475 <u>3/</u>	--
D	Dickey-Comerford 345-kV No. 1 & No. 2-Comerford-Beebe 345-kV	3575 <u>1/</u>	3475 <u>3/</u>	--
E	Dickey-Comerford 345-kV Double- Circuit-Comerford-Beebe 345-kV	3575 <u>1/</u>	3475 <u>3/</u>	--

<u>LIMITING ELEMENT</u>	<u>RATING (MW)</u>	<u>LIMITING OUTAGE</u>
<u>1/</u> Buxton-Scobie	1260	Buxton-Deerfield
<u>2/</u> Surowiec-Buxton	1260	Maine Yankee-Buxton
<u>3/</u> Buxton-Deerfield	1260	Buxton-Scobie

* Yarmouth No. 4 @ 210 MW, Yarmouth No. 3 @ 120 MW

** Yarmouth No. 4 @ 600 MW, Yarmouth No. 3 @ 0 MW

NOTES: 1. Generation scheduled at Dickey: 1311 MW
2. 90% - Heavy load level; 60% - Intermediate load level

Information on the estimated costs for the five alternative plans is shown in detail in the transmission system planning study report. DOI representatives consulted with NEPLAN member organizations to develop unit costs for the estimates. The purpose: to reflect NEPOOL experience in designing and constructing transmission facilities in New England similar to the facilities proposed for this project.

Based on these unit costs, the cost of transmission facilities for the project were estimated to range from \$157 to \$191 million at the 374-MW level. They ranged from \$181 to \$255 million at the 1311-MW level.

The figures include interest during construction. Again, detailed cost information on interest during construction appears in the transmission system planning study report. The estimates are based on 1976 dollars. The value of wheeling charges and electrical losses are not included with the costs shown in tables 3 and 4.

Tabulations for the total capital investment costs (including interest during construction) for the transmission system facilities are shown in tables 3 and 4 on the following pages.

These capital costs are converted into total annual cost figures for transmission using two appropriate annual cost ratios (ACR). One assumes federal construction at an ACR of 10 percent; the other assumes private utility construction at an ACR of 20 percent.*

The cost of peaking and the energy as they relate to the annual cost of just the transmission was then calculated. In each set of calculations, it is assumed that the total transmission annual cost will be repaid by using a peaking charge or an energy charge. Tables 3 and 4 provide this information for all five alternative transmission plans and for both the authorized and ultimate levels.

*See footnotes 2 and 3 of tables 3 and 4.

TABLE 3
 DICKEY/LINCOLN SCHOOL PROJECT
Authorized Level of Plant Capacity

Transmission Cost Comparison
 (Without Loss Evaluations & Wheeling Charges)

	<u>Plan A</u>	<u>Plan B</u>	<u>Plan C</u>	<u>Plan D</u>	<u>Plan E</u>
Total Investment (000)	\$177,900	\$177,900	\$191,100	\$157,200	\$157,200
<u>ALL FEDERAL CONSTRUCTION</u>					
Total Annual Cost (\$000/yr)	19,800	19,800	18,900	17,600	15,000
\$/KW-yr (Peak=954MW)	20.8	20.8	19.8	18.4	15.7
Mills/KWH (Energy=1,156 x 10 ⁶ KWH)	17.1	17.1	16.3	15.2	13.0
<u>COMBINED FEDERAL/NON-FEDERAL CONSTRUCTION</u>					
Total Annual Cost (\$000/yr)	27,800	27,800	20,000	18,800	16,200
\$/KW-yr (Peak=954MW)	29.1	29.1	21.0	19.7	17.0
Mills/KWH (Energy=1,156 x 10 ⁶ KWH)	24.0	24.0	17.3	16.3	14.0
<u>ALL NON-FEDERAL CONSTRUCTION</u>					
Total Annual Cost (\$000/yr)	35,600	35,600	38,200	31,400	29,200
\$/KW-yr (Peak=954MW)	37.3	37.3	40.0	32.9	30.6
Mills/KWH (Energy=1,156 x 10 ⁶ KWH)	30.8	30.8	33.0	27.2	25.3

- NOTES:
- 1) All costs are in 1976 dollars.
 - 2) Federal costs of money - 7%; Non-Federal Bond costs calculated at 10%.
 - 3) Approximately 27% of the Non-Federal annual costs are in taxes.
 - 4) \$/KW-yr. and Mills/KWH figures are each based on total annual costs:
 that is, \$/KW-yr. = $\frac{\text{Total Annual Cost}}{954,000 \text{ KW}}$; and Mills/KWH = $\frac{\text{Total Annual Cost}}{1,156 \times 10^6 \text{ KWH}}$
 the figures are not additive.
 - 5) Total investment includes interest during construction.
 - 6) The value of transmission losses is not reflected in this table.
 - 7) NEPOOL wheeling charges and losses are not included.
 - 8) The energy figures do not reflect added energy from downstream benefits and pumped-storage operations.
 - 9) For total costs that include values for estimated losses and wheeling charges see DOI Marketing Study.

TABLE 4
 DICKEY/LINCOLN SCHOOL PROJECT
Ultimate Level of Plant Capacity

Transmission Cost Comparison
 (Without Loss Evaluations & Wheeling Charges)

	Plan A	Plan B	Plan C	Plan D	Plan E
Total Investment (000)	\$254,600	\$237,800	\$253,400	\$180,600	\$180,600
<u>ALL FEDERAL CONSTRUCTION</u>					
Total Annual Cost (\$000/yr)	28,200	26,500	24,900	20,400	17,800
\$/KW-yr (Peak=1,391MW)	20.3	19.1	17.9	14.7	12.8
Mills/KWH (Energy = 1,156 x 10 ⁶ KWH)	24.4	22.9	21.5	17.6	15.4
<u>COMBINED FEDERAL/NON-FEDERAL CONSTRUCTION</u>					
Total Annual Cost (\$000/yr)	43,100	39,800	27,100	22,700	20,100
\$/KW-yr (Peak=1,391MW)	31.0	28.6	19.5	16.3	14.5
Mills/KWH (Energy = 1,156 x 10 ⁶ KWH)	37.3	34.4	23.4	19.6	17.4
<u>ALL NON-FEDERAL CONSTRUCTION</u>					
Total Annual Cost (\$000/yr)	50,900	47,600	50,700	36,100	33,900
\$/KW-yr (Peak=1,391MW)	36.6	34.2	36.4	26.0	24.4
Mills/KWH (Energy=1,156 x 10 ⁶ KWH)	44.0	41.2	43.9	31.2	29.3

- NOTES: 1) All costs are in 1976 dollars.
 2) Federal costs of money - 7%; Non-Federal Bond costs calculated at 10%.
 3) Approximately 27% of Non-Federal costs are in taxes.
 4) \$/KW-yr and mills/KWH figures are each based on total annual costs:
 that is: $\$/KW\text{-yr} = \frac{\text{Total Annual Cost}}{1,391,000 \text{ KW}}$; and $\text{Mills/KWH} = \frac{\text{Total Annual Cost}}{1,156 \times 10^6 \text{ KWH}}$
 the figures are not additive.
 5) Total investment includes interest during construction.
 6) The value of transmission losses is not reflected in this table.
 7) NEPOOL wheeling charges and losses are not included.
 8) The energy figures do not reflect added energy from downstream benefits and pumped-storage operations.
 9) For total costs that include values for estimated losses and wheeling charges see DOI Marketing Study.

To arrive at a possible "cost of power" from the Dickey-Lincoln School Lakes Project, additional calculations must be made. The annual cost of the transmission facilities (tables 3 and 4) must be added to: the annual cost required for repayment of the dams and appurtenant facilities; the system losses in the new facilities and the increase in system losses in the existing New England utility system; wheeling costs; etc.

A judgment must then be made as to what percentage of the total annual cost requirement should be borne by the peaking power benefit derived from the project and from the energy derived. These assumptions and calculations are included in the "Financial Feasibility Study for Electric Power" for the project. One condition assumed in that study would require a \$50 per kilowatt-year charge for capacity, plus an energy rate of 15 mills per kilowatt-hour.

Energy costs shown in the second table for the ultimate level can be misleading in that the last two generating units that may be added at Dickey are peaking units. Hence, the cost evaluation based on peaking capability (\$/KW-yr.) is more meaningful than one based on energy (mills/kwh) for these two units.

The value of transmission losses as well as wheeling charges must be added to the transmission cost figures in both tables to arrive at the total cost of Dickey-Lincoln School power and energy delivered to the ultimate consumer. Electrical losses will occur on facilities associated with Dickey-Lincoln School as well as on the New England system. Table 5 shows the losses and gives a dollar value for losses for the different alternatives. A figure of \$55 per kilowatt-year was used to estimate dollar values in the source of this information, the transmission system planning study report.

TABLE 5

Dickey-Lincoln School Transmission System Planning Study

Losses on Project-associated Transmission Facilities

<u>Plan</u>	<u>Description</u>	<u>Authorized (874 MW @ Dickey)</u>			<u>Ultimate (1311 MW @ Dickey)</u>		
		<u>MW</u>	<u>%</u>	<u>Value of Losses ^{1/}</u> <u>(\$10⁶)</u>	<u>MW</u>	<u>%</u>	<u>Value of Losses ^{1/}</u> <u>(\$10⁶)</u>
A	Eastern AC Plan #1	60	6.9	3.3	110	8.4	6.1
B	Eastern AC Plan #2	60	6.9	3.3	100	7.6	5.5
C	Western DC Plan	55	6.3	3.0	105	8.0	5.8
D	Western AC Plan #1	40	4.6	2.2	90	6.9	5.0
E	Western AC Plan #2	40	4.6	2.2	90	6.9	5.0

^{1/} Estimated annual value of losses evaluated
at \$55/kw-yr.

1. Corridors of least impact needed to be located for each plan of service.
2. The different corridors for each plan needed to be ranked to identify the best location for the facilities.

The first requirement was achieved by overlaying the six A-level, shaded maps. The corridors of least impact were identified via the lighter shaded areas on the resulting composite.

The DOI Bangor staff shared knowledge of study area conditions and transmission construction and location requirements with VTN's multi-disciplinary team. This collaboration helped assure that feasible routes could be located within the designated corridors.

Corridors identified through these procedures are shown on the corridor map (See figure 9 on the following page).^{1/}

The second requirement - the ranking of the corridors - was accomplished using two methods. A numerical system was developed. A qualitative method was also developed to double check the results of the numerical system.

The numerical system for ranking corridors was developed by first developing an "Impact-Index" number for each of the major A-level concerns. The impact-index number was determined by calculating the average of the "Location Factor Impact Numbers" for each of the A-level concerns. For example, in table 7 the location factor impact

^{1/}The corridor maps also show "Evaluation Lines" within each corridor segment. An evaluation line is an assumed centerline used solely to measure comparative impacts, and is not viewed as being a transmission route. These lines are used for assessing the relative impacts of a transmission line within each corridor. The evaluation lines were located utilizing the "A" level (concern maps) and represent paths with the least environmental impacts.

numbers for the three location factors under A-1 Social are 2,3, and 2. The average of this (the A-Level, impact-index) is 2.3. The resultant A-level, impact-index numbers for the six major concerns are tabulated in table 8 following. A formula was then used to calculate the total impact score. Inputs to this calculation were: the impact index, miles of transmission line, and a factor that represented the level of shading on the overlays for the A-Level concerns map.

TABLE 8

"A" Level Concerns

Social	2.3
Economic	1.7
Natural Systems	2.4
Esthetic/Cultural	2.8
Legal	*
Site Development Costs	1.9

*Items identified as legal concerns tend to be site specific and not particularly difficult to avoid through corridor location. Airports, historic sites, and areas known to be inhabited by endangered or threatened wildlife or plant species are examples of what are termed legal concerns. Impacts on these areas by transmission facilities are not anticipated.

The qualitative evaluation was made by overlaying the corridor map over selected data maps and recording the number and/or proximity of resources.

Some corridors represent opportunities for sharing existing transmission line rights-of-way. The impact of paralleling an existing right-of-way is often considerably less than a new one. A formula for calculating the decreased impact of sharing right-of-way was developed, based on the additional right-of-way width required (100 feet as compared with 150 feet for new right-of-way). When a shared right-of-way was used, the impact score was reduced by 33 percent to reflect a lower environmental impact.

These evaluation procedures were used to rank corridors as to environmental impacts. (See table 9.) Best corridors for each system plan were then compared and used to select the system plan which would have the least environmental impact. Rankings were made at both the authorized and ultimate level of generation, as well as for plans calling for wood pole or steel towers. (See table 10.)

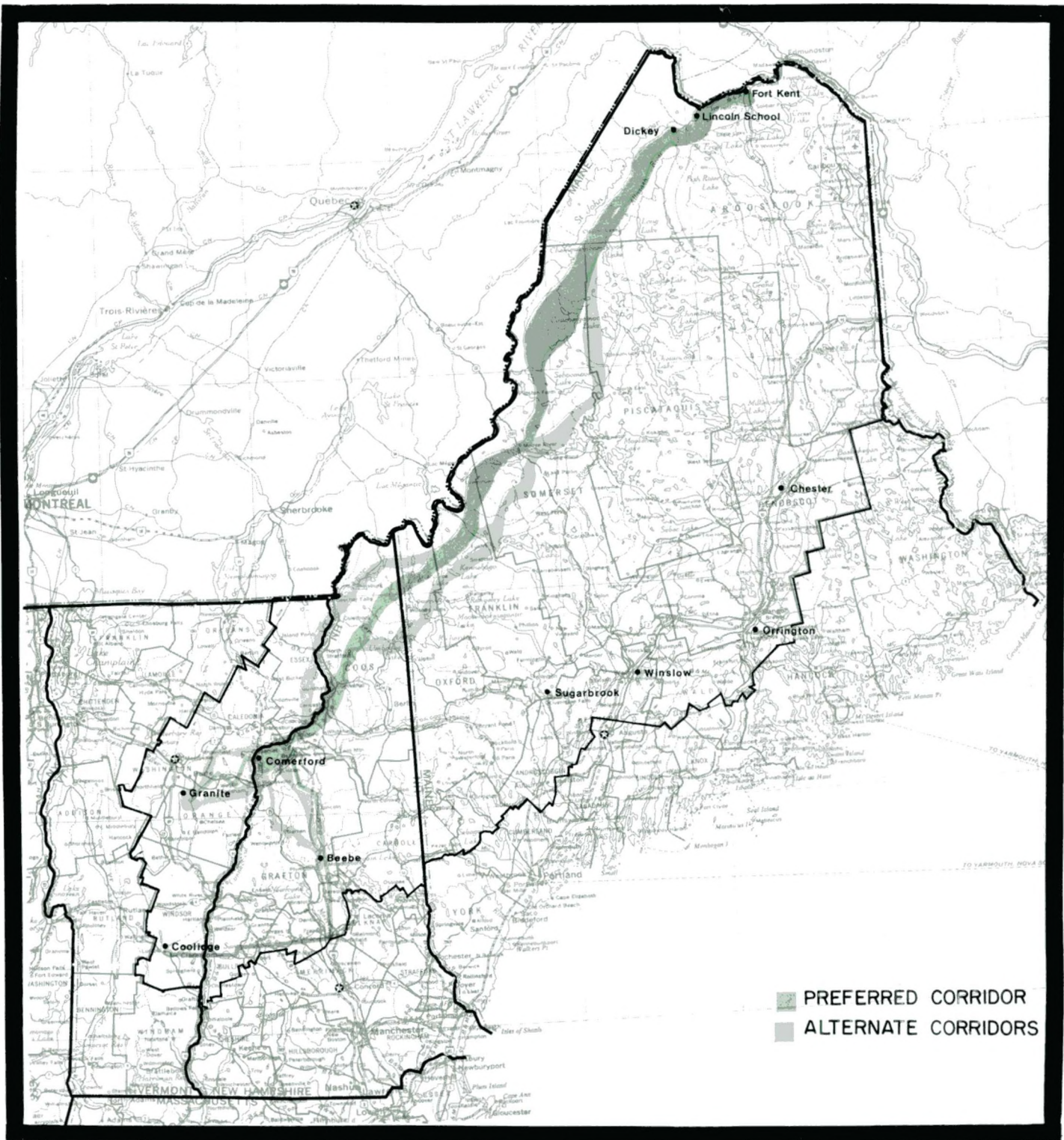
The environmental consultant, VTN Consolidated, has determined that Plan E will have the least impact on the environment. Figure 10 shows the recommended and alternate corridors for this plan. Figure 11 shows the recommended and alternate corridors for the eastern plans.

Prior to making final corridor and plan of service rankings and recommendations to the DOI, the consultant reviewed the results of his evaluation in the field. This was done using aircraft. VTN found that their field observations and ground review generally confirmed the findings. Final rankings and recommendations were then made to the DOI.

The Western Plans (C, D, and E) - Routes for the western plans, C, D, and E, are shorter by about 170 miles than those for the eastern plans, A and B, at the authorized level of generation -- and by 170 to 315 miles at the ultimate level.

The western plans have the lowest, most desirable total impact score at both the authorized and ultimate levels of development. This score is a composite representing total environmental impact. The difference between the total score on the eastern and the western plans is substantial. (See figure 10.)

Plans C, D, and E cross significantly fewer streams than the eastern plans at both the authorized and ultimate levels. Road crossings are considerably fewer with plans C, D, or E. There are also fewer points where the public could see the line.



CORRIDOR RECOMMENDATIONS

Plans C, D & E

DICKEY / LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November, 1976



CORRIDOR RECOMMENDATIONS

Plans A & B

DICKEY / LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November, 1976

The western corridors cross a potential wild and scenic river, the South Branch of the Penobscot River, west of Canada Falls Lake in Somerset County, Maine. This river is currently under study by the DOI.

The western plans also cross roadways designated as scenic highways. These include Maine State Highway 27, the alignment of which corresponds to the Arnold Trail. The western plans do not cross the Appalachian Trail.

The western plans have significantly less impact on people and cultural resources. Table 10 shows data on the proximity of many resources and areas of intensive use. The western plans are generally farther from most of these areas -- the town centers, state parks, scenic waysides, and existing historic sites. The western plans generally avoid areas of special concern.

The Eastern Plans (A and B) - The eastern plans at both the authorized and ultimate levels, as indicated above, require more miles of transmission line. Impacts are greater, as reflected in the data in table 10. The environmental problems associated with these plans are greatest south and west of the site of Chester Substation, north of Lincoln, Maine.

Impacts are more often associated with concerns related to people and land uses. The eastern plans pass close by town centers, state and national forests, waysides, historic sites, and wildlife restoration areas. They also cross a number of streams used by anadromous fish.

Reconnaissance and Location Studies

At the same time the corridor environmental study was under way, a separate DOI team went into the field to perform reconnaissance studies that will lead to the selection of routes 1/4-to-1/2 mile wide within the top ranked corridors. These engineers were in an excellent

position to review the validity of the corridors from the perspective of background and training in transmission line location, design, and construction.

Critical to the overall effort, this field review examined detail beyond that of the overlay mapping technique used by the consultant. The team identified constraints and location opportunities not apparent on data maps.

The following summary was provided by the DOI reconnaissance and location staff. The study area for this study was the same as that shown in figure 7.

Topography--Mountains which are part of the Appalachian Cordillera dominate the topography. The White Mountains, the highest mountains in New England, lie in the western portion of the study area. The Boundary Mountains extend northeast from New Hampshire along Maine's west boundary. The Longfellow Mountains extend from the White Mountains through north-central Maine; Mount Katahdin is their tallest peak. In these mountains, the side hills and ridges are steep to rolling. A long trough between the International Boundary and Longfellow Mountains, extends from northeast to southwest across most of Maine into New Hampshire. Hundreds of lakes and ponds, ranging in size from a few acres to several thousand, are scattered across the trough. They drain to all points of the compass through a pattern of brooks and streams that flow into several major rivers--the St. John, Allagash, Aroostook, Penobscot, Kennebec, and Androscoggin. All find their way to the Atlantic Ocean.

Soils--Soils on the mountain slopes are generally thin, rocky, sandy loams of varying depth. Soils in the lakes region are basically lacustrine silt and clay over glacial till. All support dense forests.

Geology--Bedrock varies throughout the area but is mostly composed of sedimentary and igneous associations. Sedimentary bedrock deposits

have changed through time to slates, shists, quartzites, and geneisses. Granite has pushed through these deposits, altering their formation and forming broken, mountainous terrain.

Semi-precious minerals are found in the study area. Prospecting is conducted for commercial deposits of metal ores. Quarries produce high quality granite for building and decorative stone. Sand and gravel suitable for roads and concrete aggregate is abundant.

Agriculture--East and south of the mountains and lakes, the rolling and flat terrain is dissected by many streams and rivers. Lowland soils are generally deep enough to support farms which produce potatoes, vegetables, fruits, milk, and poultry. However, less than 10 percent of the land in the total study area is devoted to agriculture. The remainder is forested.

Forest Resources--Forests covering most of the study area contain species suitable for commercial use. Generally, higher elevations and lowlands support softwoods. Hardwoods cover the intermediate elevations. The manufacture of forest products supports a large number of persons and is important to New England's economy.

Transportation--Several major highways, including Interstate 95, traverse the study area. The Bangor & Aroostook Railroad serves the eastern portion as far north as St. Francis. The Canadian Pacific Railroad crosses the central part. A network of private roads, some are open to public use by permission, cover the northern part.

Climate--The study area's climate is diverse and more continental than marine. Summers are warm and humid; falls are brisk and cold. Winters are often severe and among the coldest in the nation. Spring thaws begin in April.

The average annual temperature is about 45 degrees. Precipitation averages 40 inches a year and is evenly distributed over all 12 months. On occasion, severe storms sweep the area, bringing winds of hurricane force and heavy rainfall. Annual snow depths range from about 30 inches in some places to 90 inches in others. The snows fall mostly from November through April.

Population--Most of Maine's population is in the eastern and southern parts of the State. Except for isolated communities, the northern and western portions of the study area in Maine are sparsely populated. Population density increases through northern New Hampshire and Vermont.

Recreation--Recreation makes a major contribution to the economy of the study area. Hunting, fishing, and seasonal tourism attract vacationers. Growing winter sport centers are found throughout the area. Lodges and slopes for ski runs are common.

Eastern Plans - Corridors identified for the eastern plans cross a variety of surface features, posing diverse engineering problems--problems that can best be evaluated by considering important features within each segment of each plan. Segments are discussed in detail below. These corridors are identified in figure 11.

Dickey-Chester--Corridors linking Dickey and Chester cross densely forested rolling hills. An extensive pattern of brooks, streams, and rivers drain into the St. John and Penobscot rivers. Slopes are generally less than 15 percent, although steeper slopes are sometimes found at the edges of valleys and near high points. Flat to rolling farm land is found in southern and eastern portions of this area.

The area contains numerous logging roads and major highways, including State Route 11, State Route 116, State Route 157, and U. S. Interstate Route 95. State Route 11 from Ft. Kent to Ashland is

designated a scenic highway. The roadways would be useful for the construction and maintenance of a transmission line.

Soil erosion could occur along steeper slopes next to streams. The location and construction of new facilities near existing roads would help to minimize erosion. Some necessary crossings of wetlands could create environmental impacts and increase costs.

A substation would be constructed midway between Dickey and Chester under the eastern plan. Its exact location has not been determined.

Chester-Sugarbrook--One line is required here for the project's authorized level of development. Two are required for the ultimate level.

Potential corridors linking Chester and Sugarbrook substations pass through forests and open farm lands. The population is scattered.

The topography is flat to rolling. No major mountain ranges would have to be crossed. Potential problems related to soils and geological conditions could be important in choosing routes.

Access for construction and maintenance should not be a big problem, for there are many roads in the area. The road system reflects the population distribution. Some areas are accessible by paved roads open the year round. Others are not. Where there are now no roads, construction should not be unduly hampered.

The second line required here could parallel the first line--if that requirement is considered during the location of the first line.

Chester-Orrington--The corridor of least impact that connects Chester and Orrington parallels an existing 345-kV line and offers many of the advantages of parallel routing. Some improvements are present, adjacent to the existing right-of-way. The existing line crosses flat land. Access is good so permanent access is not maintained. This area is flat and not well drained, but most of the wetlands could be avoided during the line location process.

Orrington-Winslow--Rolling topography and scattered agricultural lands characterize the area between Orrington and Winslow. Any transmission line in this area would impact some farm land. Construction in such an area, although not difficult, should be limited to periods when conditions are suitable for the use of heavy equipment.

An existing 345-kV line could be paralleled part of the way between Orrington and Winslow. A Penobscot River crossing on this route would span more than 2,000 feet.

Existing access to this segment is good, for there are also many roads in this area. Many could be used for construction and maintenance.

Sugarbrook-Comerford--At the authorized level, one line is required in this segment. Under Plan B, at the ultimate level, two lines would be needed.

The most mountainous part in the study area is in western Maine and northern New Hampshire. Corridors in this area generally follow the valleys or cross the lower elevations, as between Sugarbrook and Comerford. The eastern portions of the identified corridors between Sugarbrook and Comerford cross open farm lands and a populated area of moderate density. The central part of these segments is more mountainous.

Two different corridors have been identified which would link Sugarbrook and Comerford. At their western ends both corridors could parallel existing lines. In the eastern section both routes pass close to populated areas and over agricultural lands. In both the extreme eastern and western portions of this segment, access is good for construction and maintenance.

The central parts of these two corridors are different. The southern corridor follows the Androscoggin Valley and parallels U.S. Highway 2. In places the Androscoggin Valley is broad and offers many routing alternatives.

In other more mountainous places, the valley is narrow. Such areas pose the greatest number of engineering problems. They will cause the line to be located on steeper slopes where access is difficult. Line and road construction could trigger erosion and stream siltation. The biggest problems would occur between Bethel, Maine, and Gorham, New Hampshire. Locating a line along the Androscoggin River Valley would add yet another facility in an area where several transportation and utility rights-of-way already exist.

The other corridor in the central part of this segment goes through moderately rolling land where there are few improvements. New access roads would be constructed where needed, and steep slopes avoided where possible. The line would be built through a relatively unspoiled area.

Unlike many of the other segments being studied, wetlands in this area do not pose a significant problem to construction. The biggest problem is probably the shallow soils above bedrock. This condition could increase construction costs.

Sugarbrook-Comerford (Plan B)--Under Plan B, a second line could be built along either of the corridors, although the construction of an additional line parallel to the Androscoggin River in the reach between Bethel, Maine, and Gorham, New Hampshire, would further increase congestion. Serious consideration will be given to selecting the northern corridor between Sugarbrook and Comerford if Plan B is pursued.

Sugarbrook-Beebe--Between Sugarbrook and Beebe part of the White Mountains and many lakes are heavily used for recreation. New transmission lines could be built parallel to existing lines for a considerable part of this segment. However, the intensive recreation use dictates that extra care be taken in locating and constructing a transmission line in this area. Mitigating measures related to right-of-way clearing and management would be necessary.

There are a number of populated areas within this corridor. It is used for permanent and summer residences. How many residences would be affected by a line in this area is not yet known.

Beebe-Coolidge--A line connecting Beebe and Coolidge would either parallel existing lines by way of Webster Substation near Franklin, New Hampshire, or be located within the corridor shown in figure 11. From an engineering standpoint the parallel routing poses fewer problems, but would cost more due to length.

Comerford-Granite--This is the only segment common to both the eastern and western plans. The proposed corridor for this segment parallels an existing line from Comerford to Granite, and is notably superior to other alternatives.

Western Plans - Corridors for the western plans are shown in figure 10.

Dickey-Baker Lake--The transmission lines in this subsegment would be located in one of the more remote areas in the northeastern United States. Access to the area is by private road and is sometimes restricted by the seasons. Winter weather could interfere with construction. Heavy snows fall in the area.

The corridor between Dickey and Baker Lake passes over moderate elevations and rolling topography. The area forms a divide between the St. John and Allagash rivers. Although moderately steep slopes do occur here, the steeper slopes should not be difficult to cross.

Wetlands occur within the corridor, mostly at lower elevations close to the two rivers, but the routes could probably avoid them. Wetlands also pose a problem near Baker Lake and must be considered in route location.

Forests between Dickey and Baker Lake are commercially managed. The primary softwood species, spruce and fir, are grown for pulp. This area is an important fiber producing area. Hardwoods also grow here. A network of unpaved roads surfaced with local materials has been developed. Road conditions vary but generally the roads could be used for construction and would reduce the amount of new roadway needed to maintain the line.

Baker Lake-Jackman--There are many lakes and mountains between Baker Lake and Jackman. They lie within each of the corridors. Mountains in this area tend to be isolated and do not form ranges. Important mountains include Green Mountain and Boundary Bald Mountain. The mountains can be avoided, but the presence of lakes near Boundary Bald Mountain will raise location problems.

Wetlands also pose problems in certain lower areas, particularly near the Penobscot River. The Penobscot, potentially, is a national wild and scenic river. All corridors are designed so that the river would be crossed only once. Detailed route studies of the wetlands reaching to the river would be required.

Commercial forests are also important in this area. Again, a number of logging roads could be used to construct and maintain a transmission line. These roads are usually privately owned. Many are not permanently maintained.

The proposed midway switching station on this route would be located near Jackman. The exact site is not known at present, but several good sites exist.

In comparing the alternative corridors within this section, it should be pointed out that the corridors farther east lie closer to a greater number of lakes and wetlands.

Jackman-Groveton--Steep mountains stand between Jackman and Groveton. Much of this area lies above the 2,500-foot elevation and is ecologically sensitive. Construction above this elevation should be avoided where possible.

Corridors which avoid most of the higher elevations have been identified between Jackman and Groveton. These corridors cross mountains where the shallow depth of bedrock will increase construction costs. The proposed corridor skirts major wetlands in the low areas to the east. However, corridors in these lowlands are still being studied as potential routes.

Few permanent residences would be affected. The area is sparsely populated. However, there are a number of homes that are used part of the year, largely as a result of scenic values and recreation.

Visual concerns include lakes as well as a crossing of Maine's Scenic Highway 27. Mitigating measures would impose constraints on right-of-way clearing and line location. This would add to the costs of the line, but would be necessary to reduce its impact.

In the western portion of this subsegment, the routes enter a more densely populated agricultural area. In the Upper Connecticut Valley, a line would cross farm land. The effect upon productivity would be minimal because only ground near the base of structures would be affected. The line would probably pass near and be visible from several rural homes. The other major corridor in this area goes along the southern end of Aziscohos Lake and approaches Groveton parallel to an existing line. This corridor does not impact as much agricultural land as two more westerly corridors.

Groveton-Comerford--Between Groveton and Comerford, there are many routing alternatives within a broad corridor that has been defined. Some alternatives parallel existing lines and others do not. They pass through scenic, rural areas where the use of land for farming and recreation is important. Problems related to access, topography, and soils should not be significant.

Added costs would be incurred in this area partly as a result of increased right-of-way acquisition costs, and partly because more angle structures would be needed. Special consideration must also be given to one alternative that would cross the Connecticut River. The crossing span would be about 2,000 feet long and would have visual impacts.

Comerford-Beebe--A 345-kV transmission line would be required between Comerford and Beebe at the ultimate level for all western plans. Some of the higher peaks in the White Mountains are between Comerford and Beebe. The corridors identified which connect these two substations skirt these higher peaks. As a result, the corridors fall in areas which already support existing development. This could lead to land use conflicts, thus increasing construction and acquisition costs to make the line more compatible with existing uses. The fact that corridors go around the mountains would increase the length and cost of a line in this segment. This problem is especially significant for the southernmost corridor.

The scenic values and recreational potential of this area cannot be overemphasized. The presence of a 345-kV transmission line would introduce a new element into the landscape. The effect, however, could be minimized by selecting a location for the line with care and by selective clearing.

Although landslides occur in various portions of the White Mountains, it is likely that lines would avoid areas of potential slide danger. Erosion could also be a factor for a line built in this mountainous area. However, the corridors for this segment mostly cross flat, low areas where erosion is not expected to be a problem.

Dickey-Lincoln School - Fort Kent - Common to all plans is a 138-kV transmission line connecting substations at Dickey, Lincoln School, and Fort Kent.

This line would be about 30 miles long. It has two segments: Dickey-Lincoln School and Lincoln School - Fort Kent.

Except at the dam sites, the line could be located mostly out of view of travelers using Highway 161 along the St. John River. Between Lincoln School and Fort Kent, it could be placed at the transition between the hills and valley. This would avoid most of the farm land in the valley and minimize clearing.

The line could be served from spur roads off Highway 161. From Dickey to Lincoln School the line would be routed across rolling, forested terrain. Access along this segment would need to be developed but Highway 161 could be used.

If the Dickey-Lincoln School project is built, it would be advisable to build this line in a permanent location to 138-kV standards prior to the construction of the dam. The line could then be energized at a lower voltage and used for station service power while the dam is being built.

Summary of Plan Comparison - The DOI reconnaissance and location staff at Bangor has made an overall comparison of the eastern and western plans based on their field observations. A brief summary of this comparison follows:

Length--From a transmission line engineering standpoint, the biggest disadvantage of the eastern plans is the added length and extra material required when compared with the western plans.

Topography--Construction conditions for the eastern plans would be slightly better than for the western plans. In some cases construction and maintenance could be hampered by steep terrain in remote sections along the western plans. Both plans include water bodies and wetlands most of which can be avoided by locating routes with care.

Soils and Geology--The potential for soil erosion is slightly higher per mile for the western plans. However, the overall erosion potential is greater for the eastern plans because of additional length.

Agriculture--The eastern plans cross considerable agricultural land, particularly between Sugarbrook and Comerford. Although a transmission line right-of-way does not seriously impact agricultural land, the structures do pose an inconvenience to the land owner in planting, cultivating, and harvesting crops. The western plans cross little farm land.

Forest Resources--Either the eastern or western plans would cross forest lands where wood fiber production is important. The eastern plan affects more forested area.

Access--Access to the corridors in the eastern plans would be better than that for the western plan. Access is important to construction and to future maintenance activities. The ability to reach any point on the line quickly is important in maintaining a reliable transmission system.

Climate--The winter climate is more severe in mountainous segments of the western plans than in the eastern plans. Design parameters can be adjusted to accommodate the elements.

Population--Because of the population distribution within the study area, the eastern plans would have greater impact on populated areas, as compared with the western plans.

Recommendation--The reconnaissance and location team has concluded that the problems associated with the western plans are fewer and of less magnitude than those of the eastern plans. This team, therefore, recommends the western plan.

CONCLUSION

Thus, this Transmission Planning Summary documents and summarizes three general transmission studies made to date and the conclusions drawn.

On the basis of the work completed, a preferred plan of service for integrating the generation (Plan E) has been proposed. Transmission corridors within which the lines might be constructed are also proposed.

Future efforts must now focus on additional and more detailed environmental impact studies of routes over which the proposed transmission facilities would be built.

Detailed environmental impact studies will be conducted on alternative transmission line routes. Efforts will be made to gather information on ecological, land use, socio-economic, visual, recreation, geotechnical, and historic and archaeological resources. Atmospheric and electrical effects also will be addressed. These impact assessment studies will provide detailed information to be included in the Environmental Impact Statement. These studies are scheduled to begin in January 1977. (See figure 12.)

Preliminary field observations have noted certain areas along the proposed corridor where problems caused by construction, maintenance, and operation of the proposed facility would be minimal. However, the DOI is aware that portions of the proposed plan would traverse areas that are highly scenic, offer recreational opportunities, or are highly sensitive environmentally.

The DOI, wherever possible, is following criteria set forth in: "Environmental Criteria for Electrical Transmission Systems", U.S. Departments of the Interior and Agriculture, February 1970.

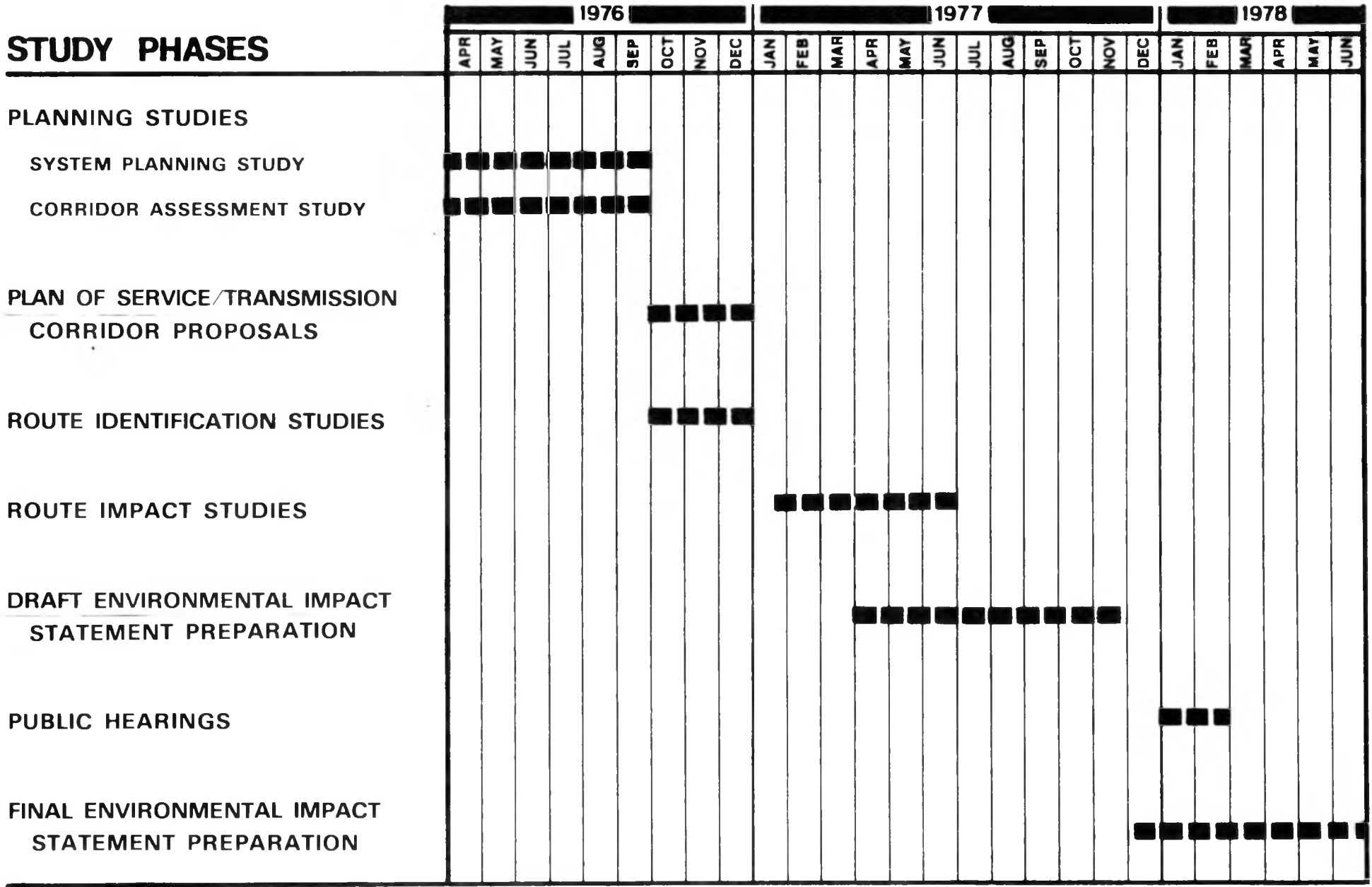


FIGURE 12 **STUDY SCHEDULE**

For example, timber would be left as a buffer where public access roads cross cleared rights-of-way. The route would be located away from and out of view of recreation areas and major lakes. Some roads, used only as "tote" roads, would be paralleled and utilized for construction and maintenance where practical. Existing access roads that are suitable for transmission requirements will be used where possible to minimize the need for additional ones. Vegetation would remain along stream banks. Care would be taken during construction to minimize erosion and siltation.

The draft environmental impact statement will discuss potential environmental impacts of the proposed and alternative plans of service, and be filed with the Council On Environmental Quality in November 1977. A series of public meetings will be held to discuss the draft's contents with people in the region early in calendar year 1978.

Comments received on the draft and responses to those comments will be considered and included where appropriate. The joint final Environmental Impact Statement will then be prepared for the project and associated transmission facilities. It is to be filed with the CEQ in June 1978.

APPENDICES

APPENDIX A

Description of Transmission Facilities

Three transmission voltage levels have been identified in connection with the five plans. Each voltage level requires different transmission structures. (See figures A-1 and A-2.) These structures may vary as to shape, height, and the number of conductors they support.

The 345-kV transmission lines proposed could be constructed to one of three transmission tower designs.

Wood pole towers for 345-kV stand about 75 feet tall. Their height depends largely on the structural limitations of wood poles. About 10 wood pole structures would be required for each circuit mile of transmission line.

Single-circuit steel towers for 345-kV average about 100 feet in height. Due to their added strength and height which enables them to support longer spans, about five towers are needed per mile.

Where two 345-kV transmission lines are required, two alternative designs are being considered. The first uses two wood pole lines adjacent to one another. The second uses a single row of steel towers that support two circuits. This structure is called a double-circuit steel tower. They average about 165 feet in height. Again, about five towers are required per mile.

A direct current line requires two conductors as compared to three for a-c lines. This results in somewhat narrower right-of-way requirements. The structure type being considered for the d-c line is built with wood poles and resembles the 345-kV wood pole type. It averages 90 feet in height. About 10 structures would be required for each mile of line.

The basic structure designs are being considered for the 138-kV lines. The first would use two wood poles similar to the 345-kV wood pole design. However, the poles for 138-kV would be smaller in diameter and about 60 feet tall. Again, about 10 structures would be required per mile of line. (See figure A-2.)

The second 138-kV type structure would carry the conductors on a single pole. This pole could be either wood or steel and would average 65 feet in height. The single pole design requires about 20 structures per mile. (See figure A-2.)

Right-of-Way Requirements

A transmission line right-of-way is linear. Rights-of-way generally vary in width according to the type and voltage level of the transmission line.

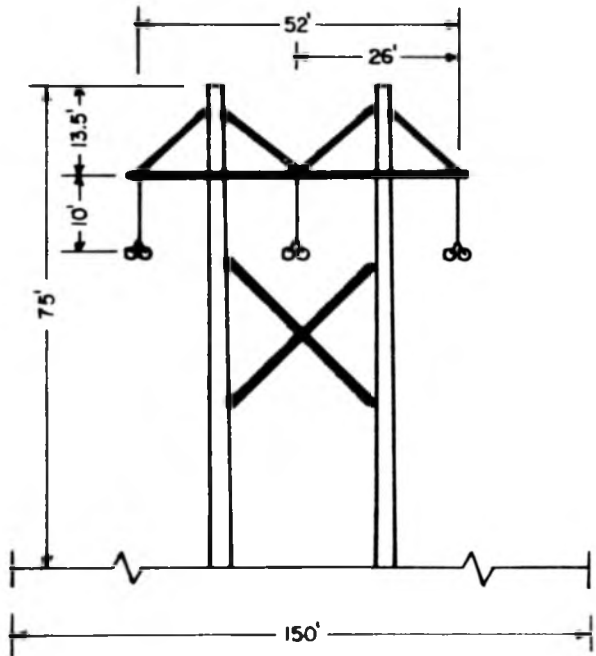
The DOI acquires right-of-way easements from landowners. The easements allow for construction, operation, and maintenance of transmission lines and access roads.

Throughout the operation of a transmission line, adequate clearance must be maintained between the conductors and vegetation. Once a line is built, activity on the right-of-way is infrequent; it usually consists of work to control the growth of vegetation or work to repair the line.

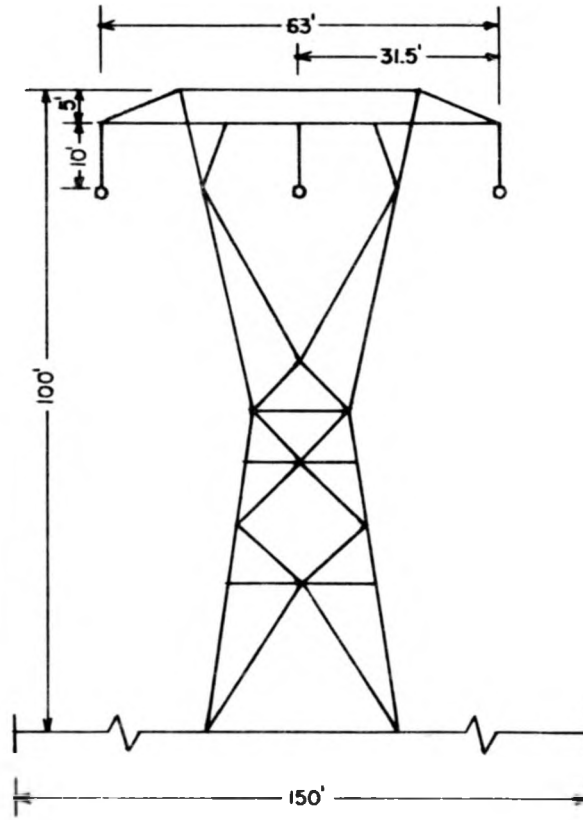
Rights-of-way clearing for Dickey-Lincoln School transmission facilities could be expected to average about 150 feet for a 345-kV wood pole line, a 345-kV steel tower line, a double-circuit steel 345-kV line, or a ± 400 k-V d-c wood pole line. Clearing would average 100 feet for 138-kV double or single wood pole line and 250 feet for two 345-kV wood pole lines.

Illustrations of typical transmission line structures and rights-of-way appear following.

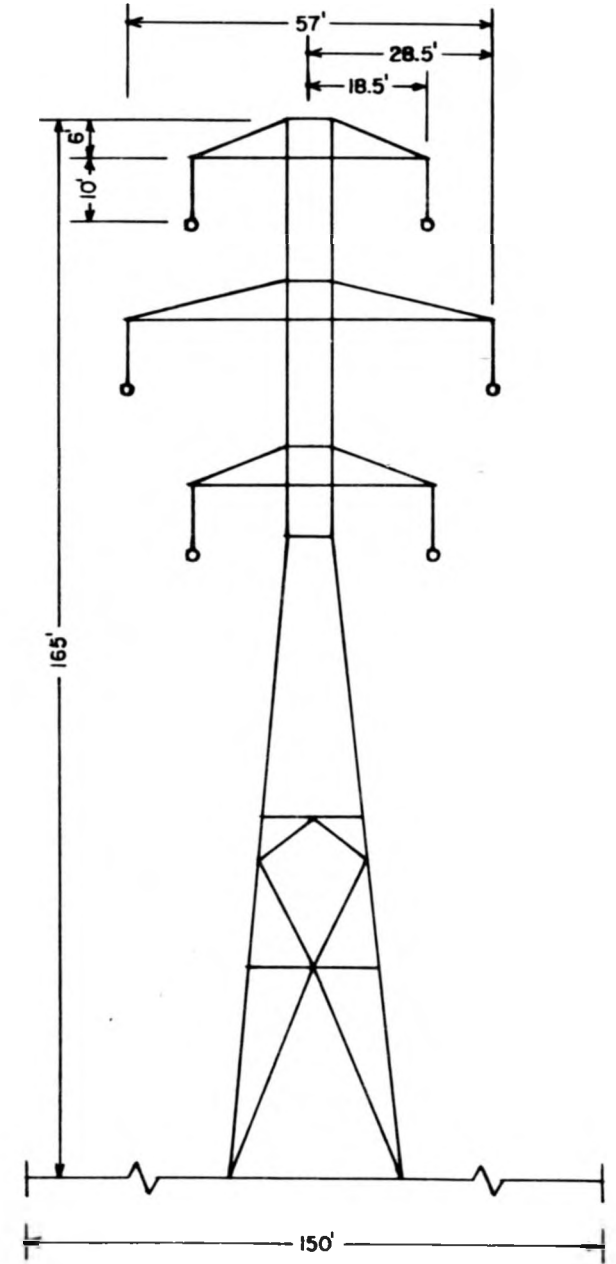
345 KV TRANSMISSION STRUCTURES



**SINGLE CIRCUIT
WOOD POLE**

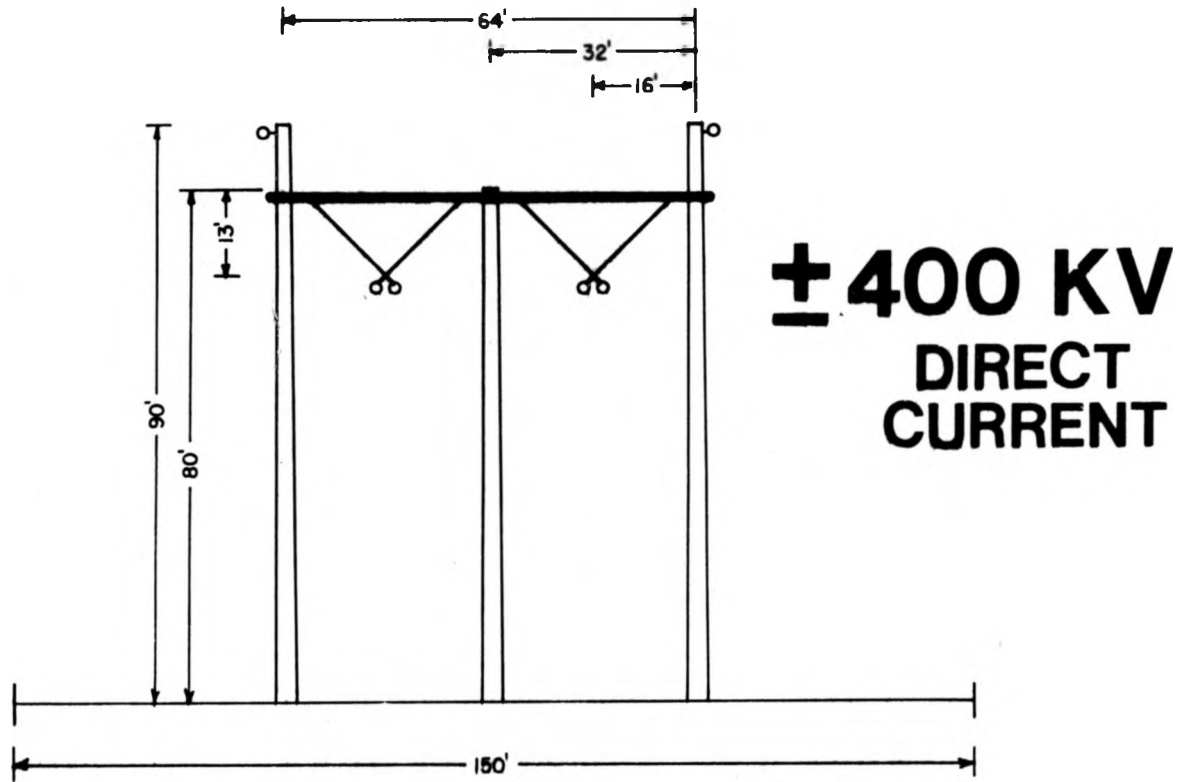


**SINGLE CIRCUIT
STEEL TOWER**

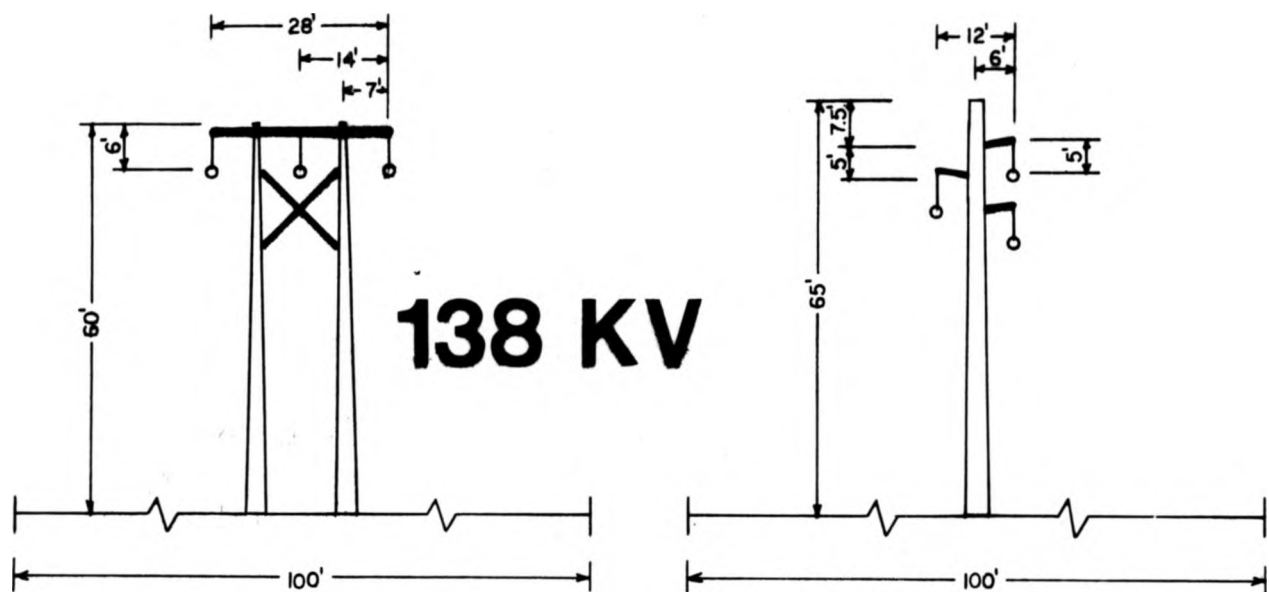


**DOUBLE CIRCUIT
STEEL TOWER**

TRANSMISSION STRUCTURES

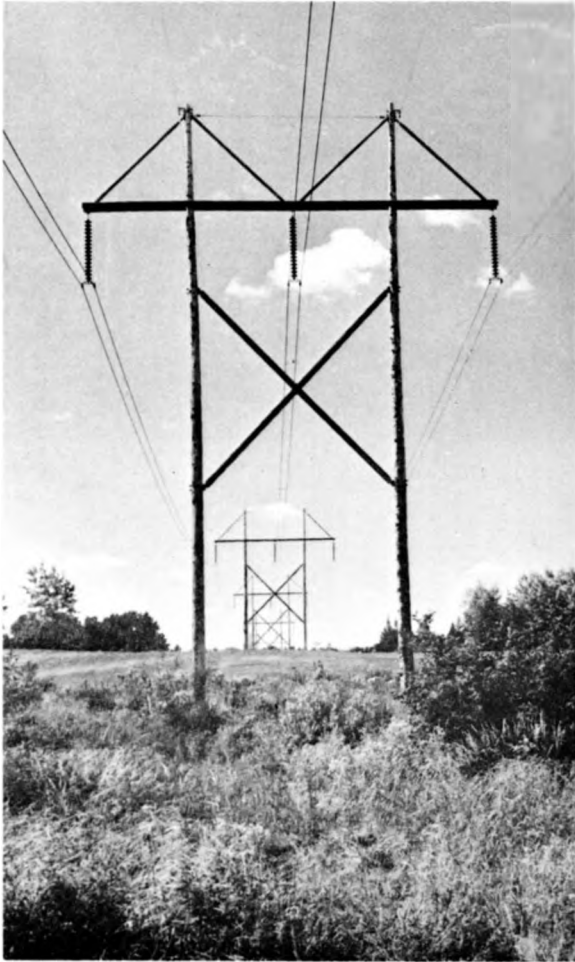


SINGLE CIRCUIT
WOOD POLE

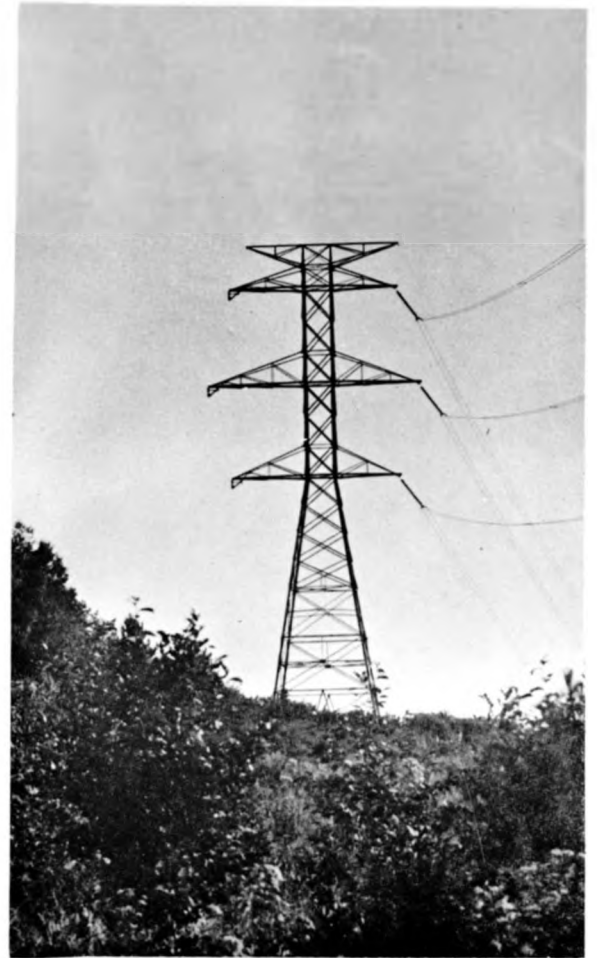


SINGLE CIRCUIT
WOOD POLE

SINGLE CIRCUIT
DAVIT ARM

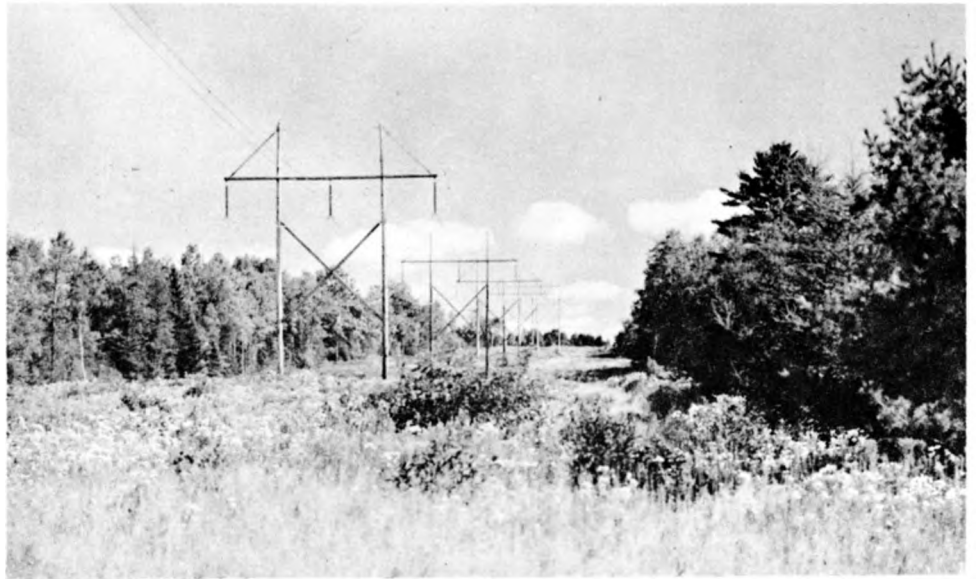


**SINGLE CIRCUIT
WOOD POLE
STRUCTURE**

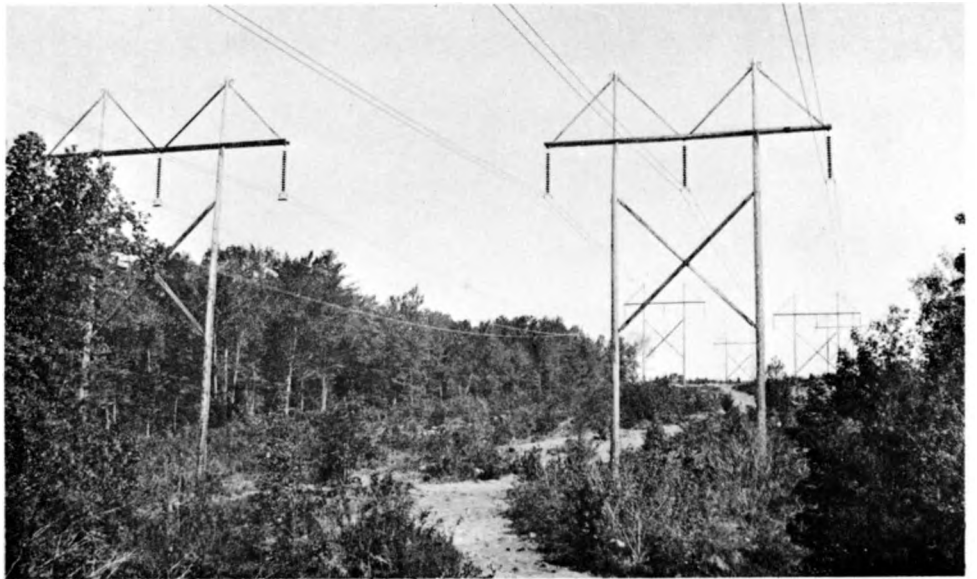


**DOUBLE CIRCUIT
STEEL
STRUCTURE**

**RIGHT-OF-WAY
FOR
ONE LINE**



**RIGHT-OF-WAY
FOR
TWO LINES**



**RIGHT-OF-WAY
THROUGH
FORESTED AREA**



APPENDIX B

Substation Facilities

Substations are integral parts of a modern electric utility system. They serve: (1) as points of interconnection for transmission lines of equal voltage - in which case they are called switching stations; (2) as points for transforming voltages from one level to another; or (3) as transformer stations and customer delivery points. In each of the two latter cases, the facilities are referred to as substations.

Electrical energy in the northeastern United States is transmitted over long distances at relatively high voltage levels - 138,000 or 345,000 volts. It is transmitted in urban areas at lower voltages - 69,000 or 115,000 volts - and is delivered by the utility to residential consumers over distribution circuits at about 15,000 volts.

Among other elements, substation equipment includes:

- Power circuit breakers (large switches) which energize and de-energize transmission lines, transformers, etc.
- Capacitors and reactors which provide a method of controlling the voltage.
- Transformers that convert the voltage from one level to another.

A dynamic brake is planned for installation at the Dickey Substation. The brake is a large 900 MW resistor which is switched onto the system for a short period of time if and when certain critical transmission lines sustain a fault. The resistor provides a short-time, temporary load on the generator bus, this decreases the acceleration of the generators during the transient condition.

Each of the alternative plans would require expansion of some of the existing substations in the region and construction of new substations.

Table B-1 lists the locations of these substation facilities, many of which would be adjacent to existing facilities. The approximate geographical locations of the substations are indicated in figures 1 to 5 in the main body of this report.

Substation sites are purchased in-fee. Each new substation would require up to about 10 acres of land.

Photographs of Comerford and Chester Substations appear on the following pages.

TABLE B-1

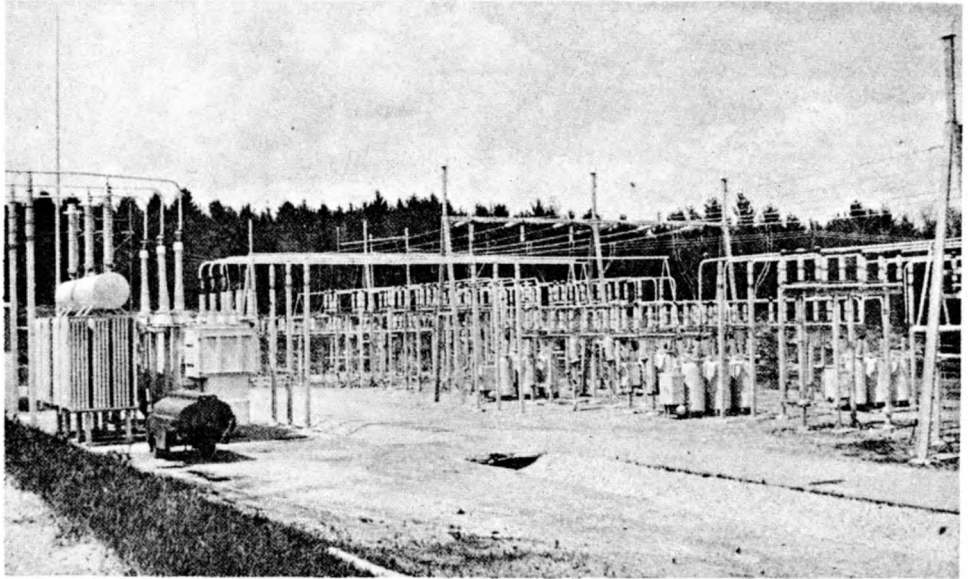
Dickey-Lincoln School Transmission System Planning Study

(Substation Additions)

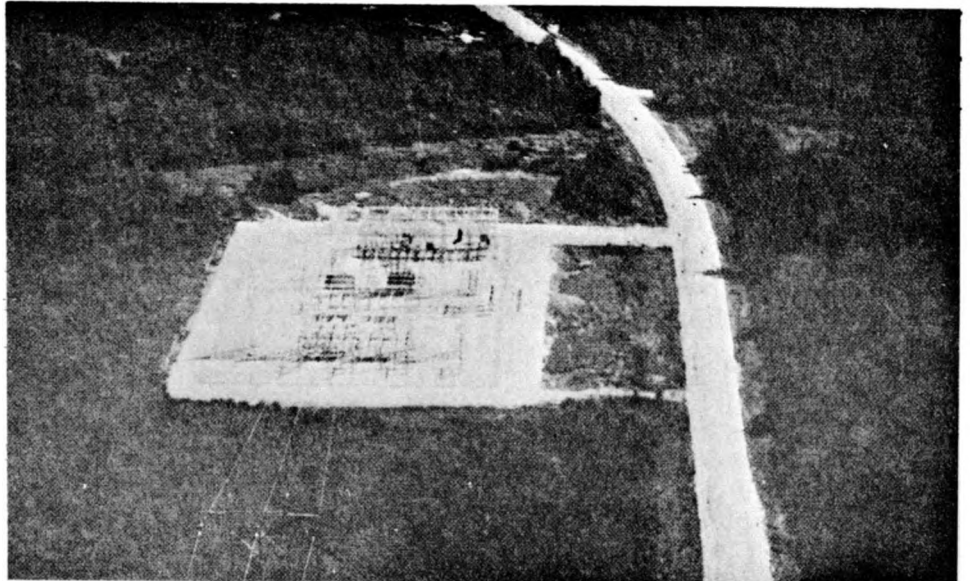
<u>Plan</u>	<u>New 345-kV Substations</u>	<u>New 138-kV Substations</u>	<u>Existing 345-kV Sub. Expanded</u>	<u>Future 345-kV Sub. Expanded</u>
A	Dickey Midpoint Chester Beebe <u>1/</u>	Dickey Lincoln School Ft. Kent	Orrington	Sugarbrook Winslow Granite Coolidge <u>1/</u>
B	Dickey Midpoint Chester Comerford <u>1/</u>	Dickey Lincoln School Ft. Kent	Orrington	Sugarbrook Winslow
C	Comerford <u>2/</u> Beebe <u>1/</u>	Dickey <u>2/</u> Lincoln School Ft. Kent		
D,E	Dickey Midpoint Comerford Beebe <u>1/</u>	Dickey Lincoln School Ft. Kent		

1/ Additions for the ultimate level of development at Dickey.2/ Converter terminals would also be constructed at these sites.

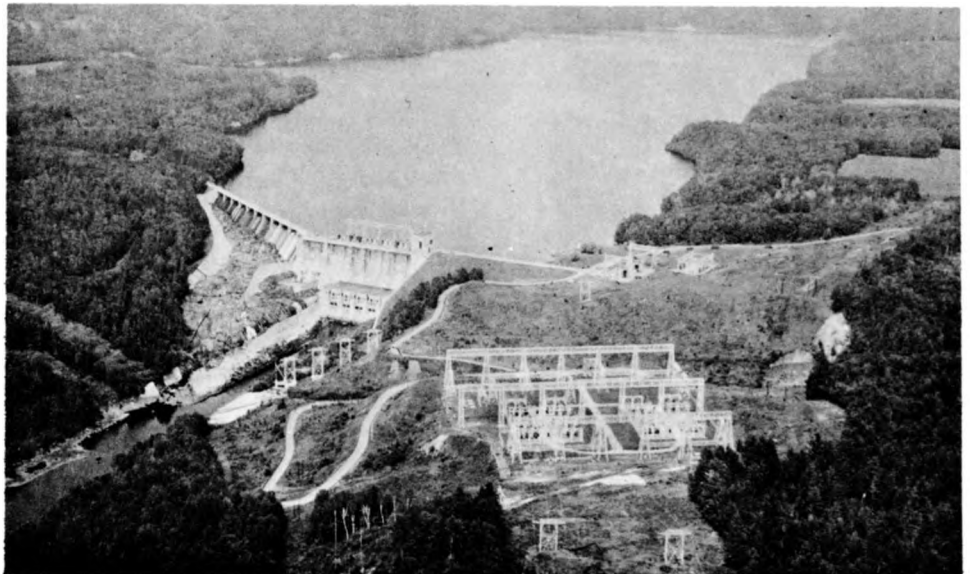
**CLOSEUP OF
MODERN
SUBSTATION**



**CHESTER
SUBSTATION
(Maine)**



**COMERFORD
SUBSTATION
(New Hampshire)**



APPENDIX C
System Control Facilities

Reliable, multichannel communication systems are important for the effective operation of a modern electrical power generation and transmission system.

Control facilities consist of a microwave system which provides channels to control and monitor the electrical power system. Voice communication channels from the dispatcher to substation or powerhouse operators are an essential part of such a system. Other channels may be used for relaying, automatic generation control, telemetering (continuous monitoring of the system), control of braking resistors, mobile radio signals, generation dropping, or supervisory (remote) control of substation equipment.

Microwave facilities are generally installed at substations and on high points for line-of-sight contact with other stations. A typical station occupies a 1/4-acre site and requires a small equipment building, a microwave tower upon which to mount antennas, an access road, and an electric power supply. The New England electrical transmission system is controlled through an existing microwave system.

Three preliminary communication system plans have been developed to perform power system control functions for the Dickey-Lincoln School project—one for the eastern alternative plans and two for the western alternative plans. All plans for communication system additions for the Dickey-Lincoln School project assume that the new facilities will interconnect with the existing New England Shared Microwave System (NESMS). Sufficient microwave sites have been identified so as to provide an indication of the maximum land use impact of the communication systems. These selections are, however, tentative pending further studies involving environmental effects, availability, feasibility, etc.

Figure C-1 shows the existing microwave communication system.

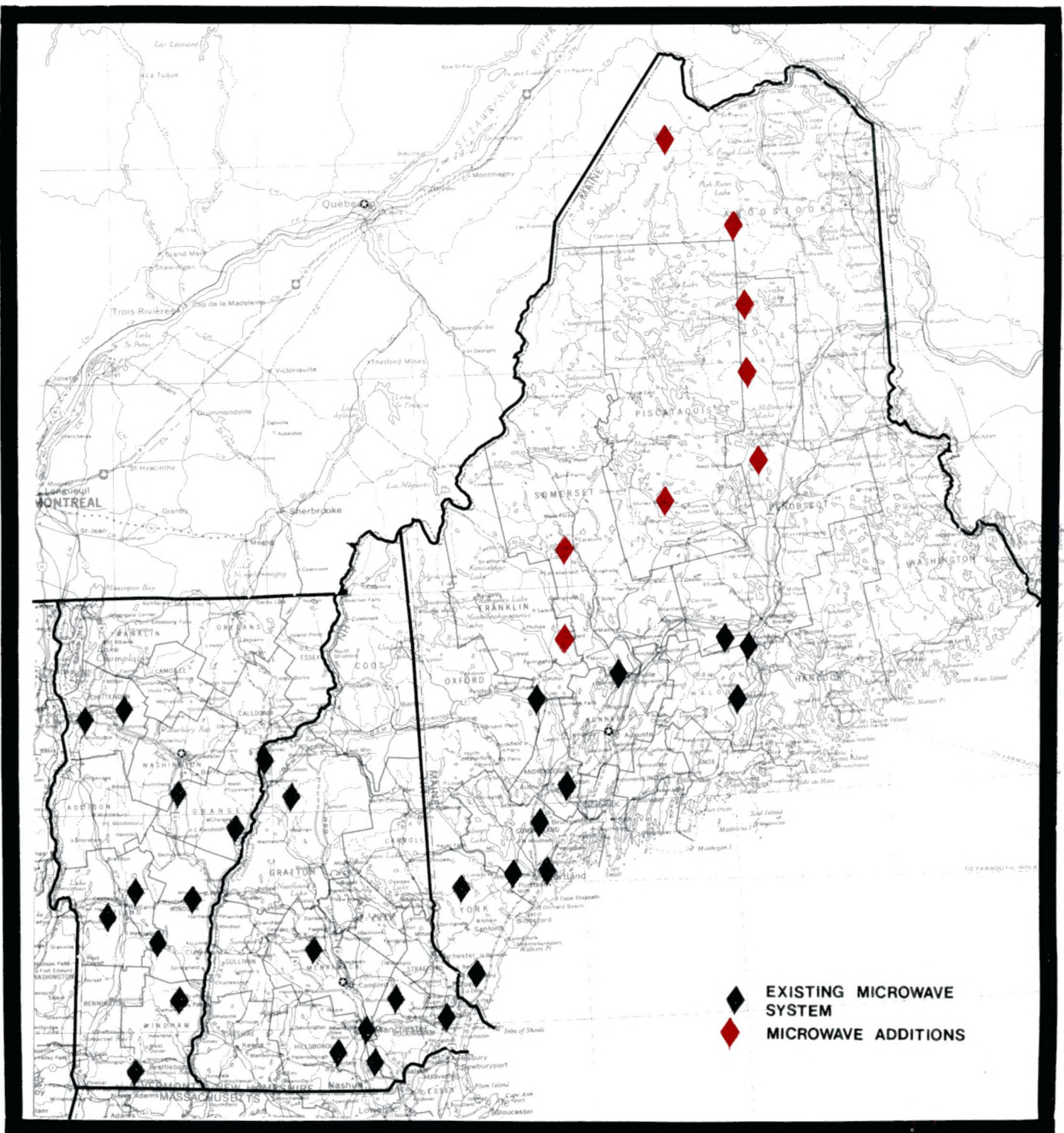
Figure C-1 also shows the preliminary microwave plan for the eastern alternatives. To the extent possible the stations will be located along the transmission line routes.

Two preliminary microwave plans are indicated for the western alternatives. The first plan, shown in figure C-2, assumes that a microwave system can be installed in close proximity to the transmission line right-of-way between Dickey and Comerford. This could be achieved if sites can be picked close to existing roads. Availability of central station a-c electric power would also be desirable.

A second microwave plan for the western alternatives assumes that a more economical system could be achieved by providing channels to Comerford over the existing system, and to Midpoint (near Jackman, Maine) and Dickey by extending the existing system from the vicinity of Bangor, Maine.

This system, shown in figure C-3, does not provide for complete VHF mobile coverage of the transmission line between Dickey and Comerford.

A photograph of a typical microwave installation also appears below.



MICROWAVE COMMUNICATION SYSTEM

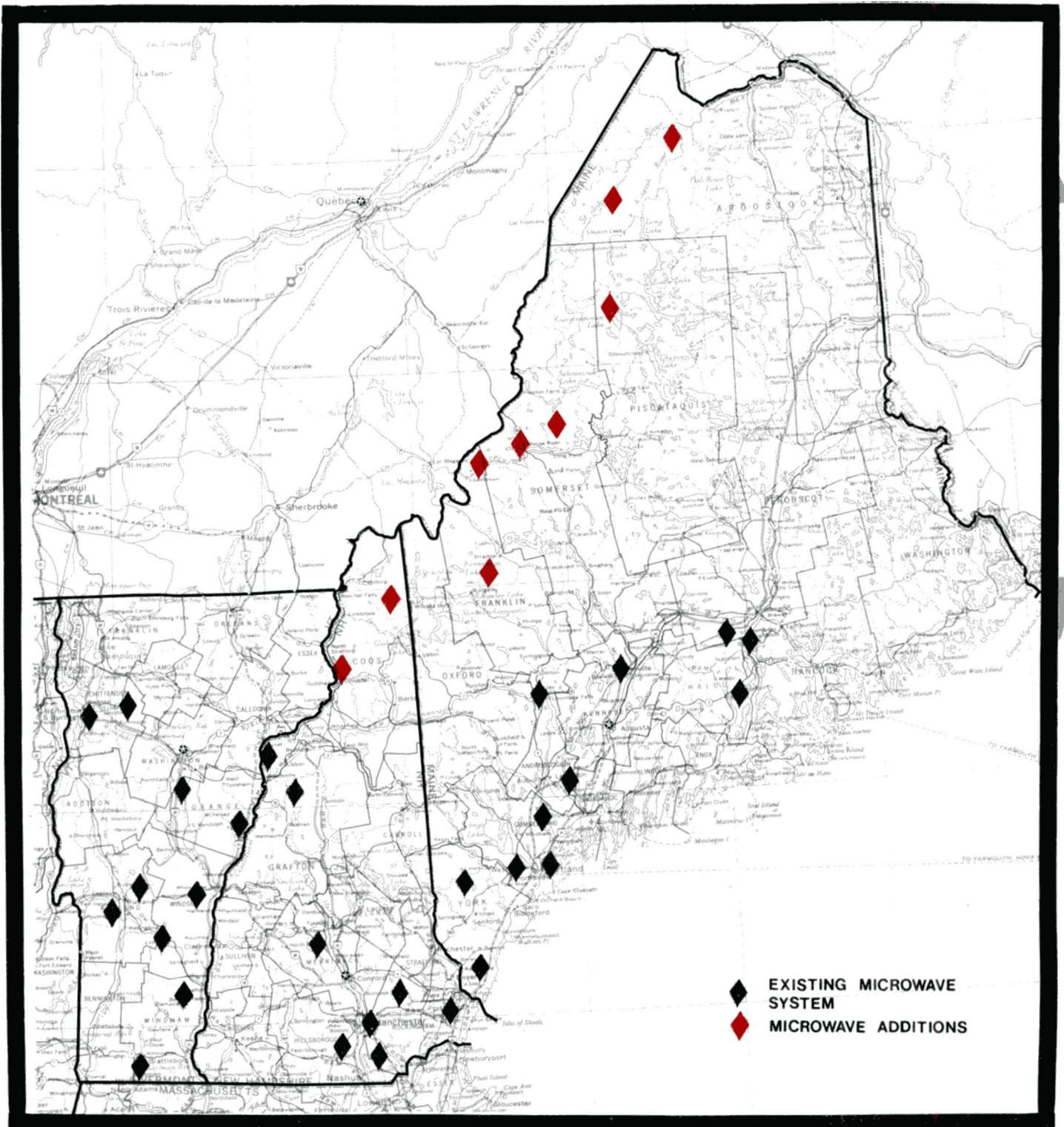
Eastern Plan

DICKEY / LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November, 1976

FIGURE C-1



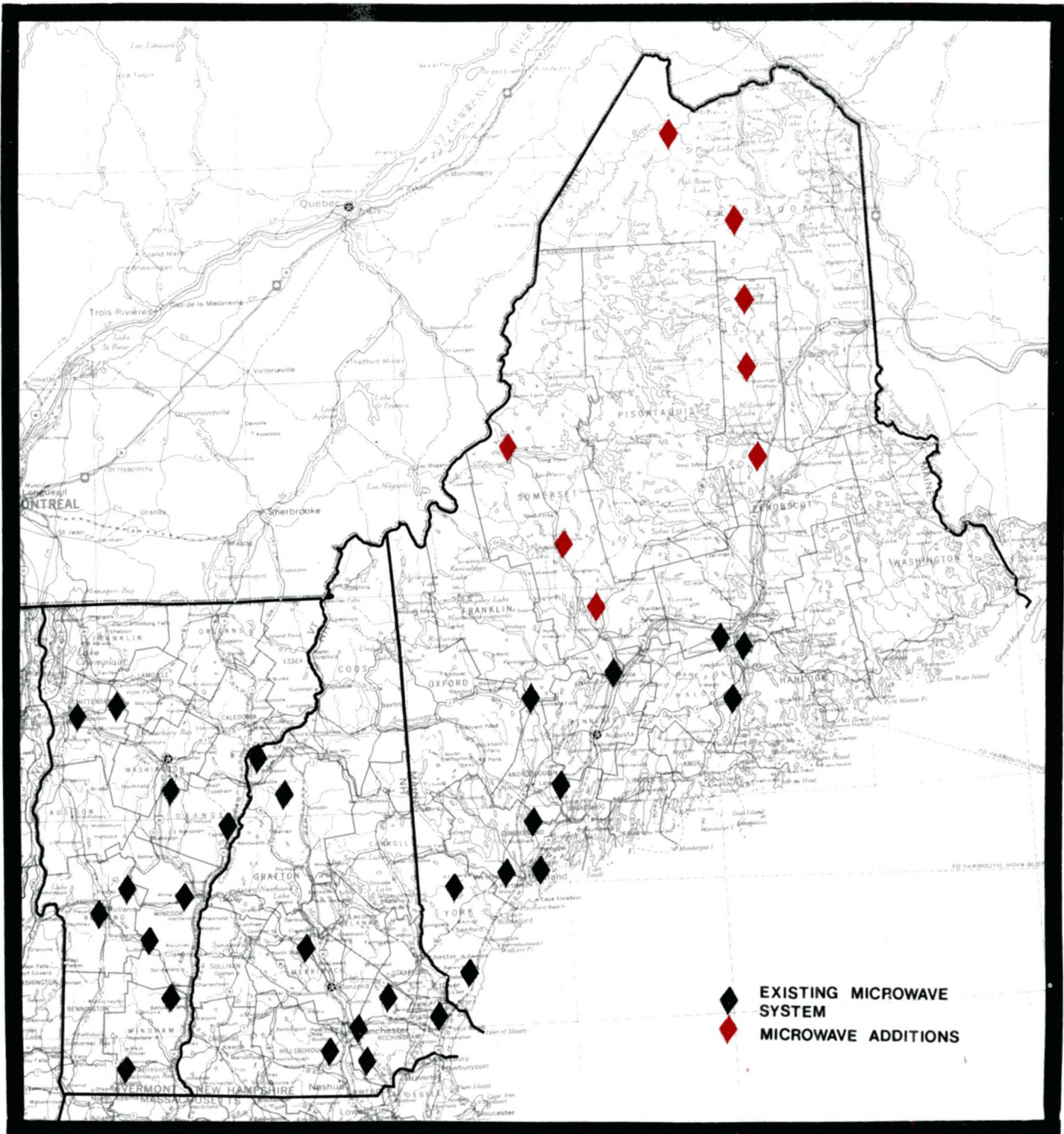
MICROWAVE COMMUNICATION SYSTEM

Western Plan No. 1

DICKEY / LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November, 1976



MICROWAVE COMMUNICATION SYSTEM

Western Plan No. 2

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November, 1976



**CLOSEUP OF
MICROWAVE
STATION**

APPENDIX D

GLOSSARY OF TERMS

ACRE-FOOT - Unit of hydraulic volume measurement used to describe a quantity of storage in a reservoir. One acre, one foot deep.

ALTERNATING CURRENT (AC) - An electric current that reverses its direction of flow at regular intervals and has alternately positive and negative values.

BRAKING RESISTOR - A massive electrical resistor used to stabilize an electric power system by decreasing the amount of acceleration of generators that suddenly change speed due to a fault or a disturbance.

CAPACITY - The maximum load at which a machine, transmission line, station, or system is rated.

CIRCUIT - A system of conductors through which an electric current is intended to flow. Three conductors or three sets of conductors for a 3-phase circuit or two conductors or two sets of conductors for a high-voltage direct-current circuit.

CORRIDOR - A broad path identified during early stages of transmission line planning and environmental analysis within which a line could be located as a result of further evaluation.

CONDUCTORS - The metallic cable over which the electrical energy is transmitted on high-voltage lines.

DIRECT CURRENT (DC) - An unidirectional, practically non-pulsating current.

ELECTRICAL LOSSES - Total power loss in an electric system consisting of transmission, transformation, and distribution losses between sources of supply and points of delivery.

ENERGY - The capability of doing work. In electrical power systems energy is expressed in kilowatthours.

FAULT - An unintentional short circuit in a power system due to a breakdown in insulation, causing abnormally large current flows. When the fault current flows into the earth, the fault is called a ground fault.

KILOVOLT (KV) - 1,000 volts

KILOWATTHOUR (KWHR) - The basic unit of electric energy equal to one kilowatt of power supplied to or taken from an electric circuit steadily for one hour.

LOAD - The amount of electric power delivered or required at any specified point or points on a system. Load originates primarily at the power-consuming equipment of the customers.

LOAD FLOW STUDIES - See Power Flow.

MEGAWATT (MW) - 1,000,000 watts; 1,000 KW

NAMEPLATE RATING - The full-load continuous rating of a generator and its prime mover or other electrical equipment under specified conditions as designated by the manufacturer. Nameplate rating is usually less than the demonstrated capability of the installed machine.

PEAKING POWER PLANT - A plant which is normally operated to provide power during maximum load periods - daily, weekly or annually.

PEAK LOAD - The maximum electrical load consumed or produced in a stated period of time. It may be the maximum instantaneous load or the maximum average load within a designated interval of time, for example, the maximum average load for a period of 1 hour.

POWER FLOW STUDIES - Studies of line and equipment power loading on transmission or distribution networks for specific conditions of system generation load and line configurations. The term power flow usually applies to simulations of the present or future system.

PUMPED STORAGE - An arrangement whereby a reservoir is filled with water by pumping during off-peak periods. It is run back through the turbines to generate power during peak load periods. This method of operating a hydro plant stores water which can be used at a more appropriate time or saves water which would otherwise be lost.

RELIABILITY - In a power system, the ability of the system to provide continuous electrical service. Line or generator outages can be tolerated without accompanying outages of service to customers.

STABILITY - A description of the dynamic operating conditions of a power system. A power system consists of several generators which are connected together and to a load by transmission lines. The amount of power that can be transferred from one machine to another following a disturbance such as a line fault is limited. When this limit is exceeded, the machines become unstable and may lose synchronism with each other. When this happens, relays operate to separate the generators not running in synchronization. Otherwise, the disturbance would move out over the system, somewhat like a storm moving outwards from its center, and result in cascading outages. Stability is therefore defined as that attribute of a system which enables it to develop restoring forces equal to or greater than the disturbing forces so as to maintain a state of equilibrium.

RESOURCE - In electrical sense, the amount of generation available within the system being studied.

TRANSFER CAPABILITY - The ability of an electrical system to move bulk power from one location to another.

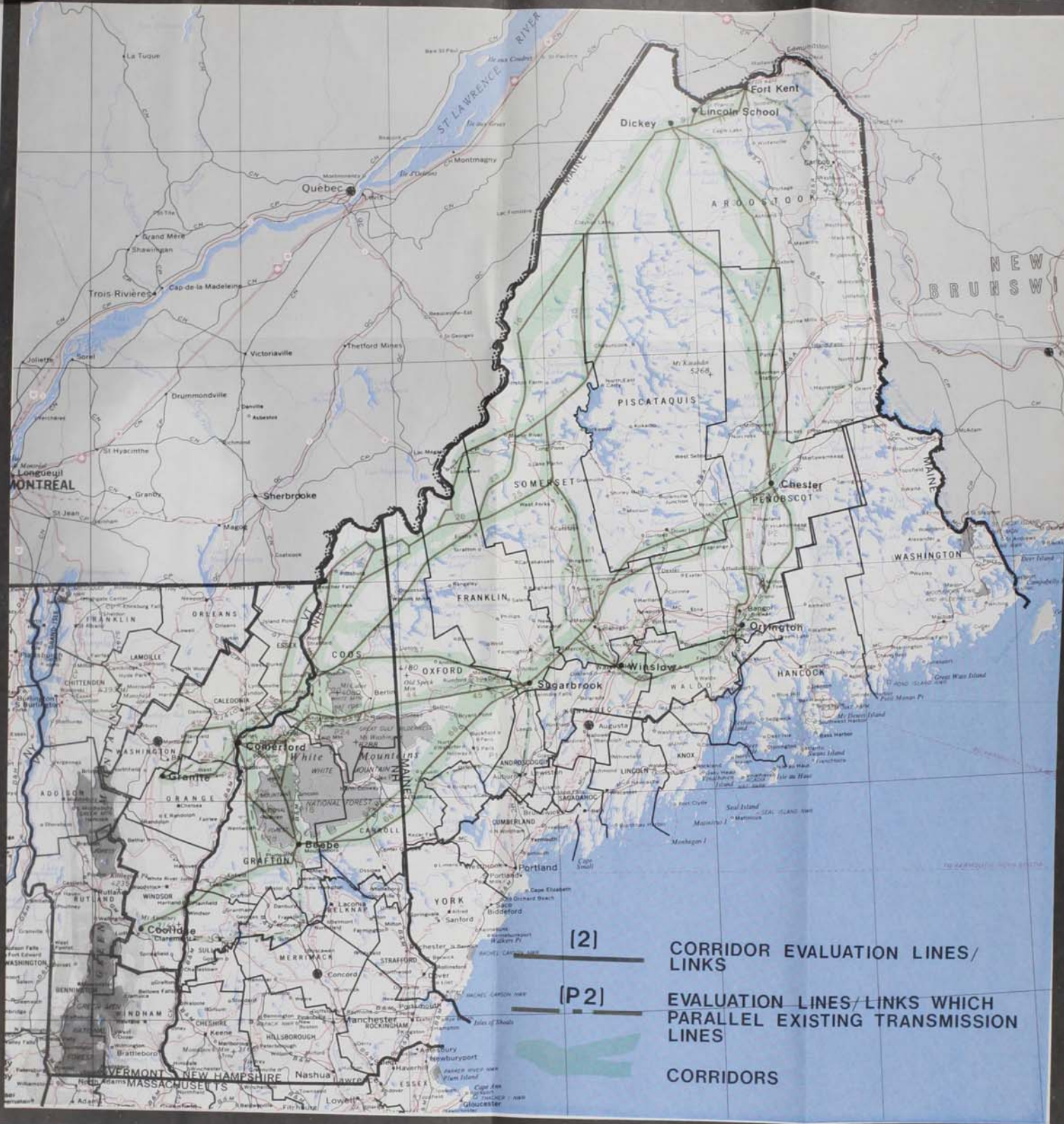
TRANSFORMER - A device usually used to transform electrical energy from one voltage level to another.

TRANSMISSION - In power system usage, the bulk transport of electricity from large generation centers over significant distances, at relatively high-voltages.

VOLT - The unit of electromotive force or electric pressure (analogous to water pressure in pounds per square inch in a water system).

WATT - The electrical unit of power or rate of doing work. It is analogous to horsepower or footpounds per minute of mechanical power.

WHEELING - The transmission of large blocks of power over the transmission system of another utility. Wheeling permits better use of existing transmission facilities and avoids expensive duplication of transmission lines.



TRANSMISSION CORRIDORS

DICKEY/LINCOLN SCHOOL LAKES PROJECT

U.S. Department of the Interior

November 1976

SYSTEM PLAN RANKINGS

RANKING BY
NUMERIC METHOD

QUALITATIVE CONSIDERATIONS

AUTHORIZED LEVEL

	A-B	A	B	D	E
System Plans	4	4	3	3	1
Type of Construction (by Corridor)	4	4	3	3	1
Corridors Evaluated (See Table 9)	4	4	3	3	1
Total Plan Length (Miles)	4,500	6,390	4,500	2,805	2,805
Total Plan Impact Score	7,338	10,962	8,724	7,651	4,750
Plan Rank by Impact Score	2	4	3	3	1
Average Impact Score by Mile	1.63	1.71	1.94	2.73	1.70
Plan Rank by Impact per Mile	1	2	3	4	2
Acres of Right-of-Way	7,500	9,800	11,570	7,970	4,920
Number of Streams and Rivers Crossed	46	50	46	82	82
Proposed Accessibility	94	99	94	74	74
Low	313	493	313	127	127
Moderate					
High					
Number of Wild and Scenic Rivers Crossed	26	26	26	114	114
Number of Anadromous Fisheries Crossed	26	26	26	114	114
Number of Road Crossings	2	5	2	7	7
Number of Scenic Road Crossings	2	2	2	7	7
Number of Scenic Trails Crossed	64	90	64	10	10
Proximity to Town Centers	25	28	25	7	7
Proximity to National and State Parks and Forests (Miles)	22	31	22	11	11
Proximity to Scenic Wayside Areas	13	21	13	6	6
Proximity to Intensive Recreation Areas	6	7	6	2	2
Proximity to Archeological Sites	13	20	13	6	6
Proximity to National Register Historic Sites	6	6	6	1	1
Proximity to State Register Historic Sites	11	11	11	1	1
Proximity to Potential State Historic Sites	11	11	11	8	8
Proximity to Unique Resources	5	5	5	2	2
Proximity to Critical Areas Maps	4	5	4	2	2
Proximity to National Natural Landmarks	4	5	4	2	2
Proximity to National Research/Wilderness Areas	3	5	3	2	2
Proximity to Wilderness Study Areas	3	5	3	2	2
Proximity to Threatened/Endangered Wildlife Species	6	10	6	2	2
Proximity to Wildlife Species of Special Concern	28	40	28	8	8
Proximity to Wildlife Restoration Areas	13	22	13	1	1
Proximity to Threatened/Endangered Vegetation Species	13	22	13	1	1
FINAL RANKING	2	4	3	3	1

ULTIMATE LEVEL

	A	B	D	E
System Plans	4	3	2	1
Type of Construction (by Corridor)	4	3	2	1
Corridors Evaluated (See Table 9)	4	3	2	1
Total Plan Length (Miles)	6,390	4,500	3,245	3,245
Total Plan Impact Score	10,962	9,836	8,453	5,592
Plan Rank by Impact Score	4	3	2	1
Average Impact Score by Mile	1.71	2.18	2.60	1.71
Plan Rank by Impact per Mile	2	4	5	1
Acres of Right-of-Way	9,800	7,500	8,590	5,290
Number of Streams and Rivers Crossed	50	46	86	86
Proposed Accessibility	99	94	83	83
Low	493	313	158	158
Moderate				
High				
Number of Wild and Scenic Rivers Crossed	26	26	138	138
Number of Anadromous Fisheries Crossed	26	26	138	138
Number of Road Crossings	5	2	1	1
Number of Scenic Road Crossings	2	2	1	1
Number of Scenic Trails Crossed	90	64	14	14
Proximity to Town Centers	28	25	18	18
Proximity to National and State Parks and Forests (Miles)	31	22	11	11
Proximity to Scenic Wayside Areas	21	13	6	6
Proximity to Intensive Recreation Areas	7	6	2	2
Proximity to Archeological Sites	20	13	6	6
Proximity to National Register Historic Sites	28	11	2	2
Proximity to State Register Historic Sites	24	11	4	4
Proximity to Potential State Historic Sites	24	11	11	11
Proximity to Unique Resources	11	5	3	3
Proximity to Critical Areas Maps	5	4	2	2
Proximity to National Natural Landmarks	5	4	2	2
Proximity to National Research/Wilderness Areas	5	3	2	2
Proximity to Wilderness Study Areas	5	3	2	2
Proximity to Threatened/Endangered Wildlife Species	10	6	2	2
Proximity to Wildlife Species of Special Concern	40	28	14	14
Proximity to Wildlife Restoration Areas	22	13	2	2
Proximity to Threatened/Endangered Vegetation Species	22	13	2	2
FINAL RANKING	4	3	2	1

LEGEND

NUMERIC METHOD: High impact scores indicate greater environmental impact.
 QUALITATIVE CONSIDERATIONS: Number of "+" is a measure of the number of times the corridor crosses a resource.
 PROXIMITY ACCESSIBILITY: A measure reflecting both of corridor crossing area of the corridor in high accessibility.
 PROXIMITY TO: A measure reflecting the number of times the corridor crosses the resource within 1/2 mile of the "centerline" of the corridor.

* Indicate corridors in which steel tower or wood pole construction is required.
 ** Authorized System Plans A and B are ranked in the same manner for purposes of this comparison.
 *** Requires 121 private wood pole contracts.

~~TK~~

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