DOE/EIS-0129F

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New England/Hydro-Quebec ± 450 kv Transmission Line Interconnection-- Phase II

FINAL
Environmental Impact Statement

U.S. Department of Energy
Economic Regulatory Administration
Office of Fuels Programs

August 1987

DOE/EIS-0129F

New England/Hydro-Quebec $\pm$ 450 kv Transmission Line Interconnection-- Phase II

FINAL
Environmental Impact Statement

U.S. Department of Energy
Economic Regulatory Administration
Office of Fuels Programs
Washington, D.C. 20585

August 1987

DOE F 1325.8
(12-84)

United States Government | Department of Energy

memorandum

DATE: July 7, 1987

REPLY TO ATTN OF: EH-25

SUBJECT: Approval of the Final Environmental Impact Statement for the New England/Hydro-Quebec Phase II Interconnection (DOE/EIS 0129F)

TO: Marshall A. Staunton
Administrator
Economic Regulatory Administration

As requested in your memorandum of June 3, 1987, we have reviewed the subject final environmental impact statement (EIS) in accordance with our responsibilities under Department of Energy Order 5440.1C. The final EIS responds appropriately to public comments on the draft EIS. EH and ERA staff have agreed to a minor change on p. 4-26 and the inclusion of a paragraph in the Foreword reflecting the recent decision by Canada's National Energy Board to overturn Hydro-Quebec's contract to sell power to the applicant. Based on my staff's review and analysis and their recommendations and after consultation with the Office of General Counsel, I have determined that the final EIS is adequate for publication, subject to the changes noted and attached.

The Office of NEPA Project Assistance will continue to assist in filing the final EIS with the Environmental Protection Agency and other distribution matters. We look forward to reviewing the Record of Decision, which may be issued no sooner than 30 days after public notice of the final EIS.

Mary L. Walker
Assistant Secretary
Environment, Safety and Health

Attachment

COVER SHEET

FINAL ENVIRONMENTAL IMPACT STATEMENT

NEW ENGLAND/HYDRO-QUEBEC TRANSMISSION LINE INTERCONNECTION-PHASE II

a) Lead Agency: U.S. Department of Energy, Economic Regulatory Administration

b) Proposed Action: Amendment of Presidential Permit PP-76 issued to Vermont Electric Power Company

c) For additional copies or further information on this statement, please contact:

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Washington, D.C. 20585 (202) 586-5935

For general information on the DOE's Environmental Impact Statement process, contact:

Carol M. Borgstrom, Acting Director
Office of NEPA Project Assistance
Office of the Assistant Secretary for
Environment, Safety and Health
1000 Independence Ave., SW
Washington, D.C. 20585 (202) 586-4600

d) Designation: Final EIS (FEIS)

e) Abstract: This Final Environmental Impact Statement (FEIS) was prepared by the Economic Regulatory Administration. The proposed action is the issuance of an amendment to Presidential Permit PP-76 to the Vermont Electric Transmission Company to operate the international interconnection therein authorized at power levels above those stipulated in PP-76, and to construct new transmission facilities to distribute this power. The proposed new facilities, referred to as Phase II, consist of the extension of the Phase I ±450-kV DC transmission line (predominantly along existing transmission rights-of-way) between the town of Monroe, New Hampshire (the terminus of Phase I) and the town of Groton, Massachusetts; the construction of an 1800-MW DC/AC converter terminal at the terminus of the proposed DC line; and the construction of two new linearly connected 345-kV AC transmission lines along existing transmission rights-of-way and terminating at an existing substation at West Medway, Massachusetts. These new transmission lines are needed to reinforce the existing

New England 345-kV AC transmission system and thereby allow the NEPOOL system to operate reliably at the higher levels of import. The principal environmental impacts of the construction and operation of the transmission facilities will be incremental in nature and will include the conversion of a small amount of primarily forested land to right-of-way (shrubland/grassland vegetation) or to other project-related uses, and minor visual impacts.

FOREWORD

This Final Environmental Impact Statement (FEIS) is issued by the U.S. Department of Energy (DOE). It assesses the environmental impacts of issuing an amendment to Presidential Permit PP-76 that would result in the construction of certain new electric transmission facilities in New Hampshire and Massachusetts.

The DOE determined that the issuance of the proposed amendment would be a major federal action significantly affecting the quality of the human environment. Therefore, in accordance with the National Environmental Policy Act of 1969 (NEPA), as implemented by the regulations promulgated by the Council on Environmental Quality (CEQ) (40 CFR 1500-1508, November 1978) and DOE's implementing guidelines (45 CFR 20694, March 28, 1980), DOE has prepared this FEIS to provide environmental input to the decision to grant (with conditions and limitations) or deny the amendment. A Notice of Intent to prepare this EIS was issued May 8, 1985, and a public scoping process was conducted. A Draft Environmental Impact Statement (DEIS) was issued in August 1986. Federal and state agencies, as well as the public, were requested to comment on the DEIS. After all comments were considered and appropriate modifications made, this FEIS is being issued. DOE will issue a Record of Decision not less than 60 days following publication of the notice of availability of this FEIS.

The format of this FEIS follows the suggested format in the CEQ regulations. Section 1 documents the purpose and need for a decision. Section 2 summarizes and compares alternatives and predicted environmental impacts. Section 3 summarizes the affected environments along the proposed transmission line route and at other facilities. Section 4 provides detailed information on analyses of the environmental consequences of the various alternatives. Section 5 presents a glossary, and Section 6 presents the names and professional qualifications of the persons responsible for preparing the statement. More detailed information and analyses are provided in several appendices.

On June 18, 1987, the Canadian National Energy Board denied an application by Hydro-Quebec for a license to export the energy associated with the Phase II project. Hydro-Quebec is appealing this decision. Upon Canadian resolution of this issue, DOE will determine whether this EIS needs to be revised or is adequate as presented.

SUMMARY

The proposed action is the issuance of an amendment to Presidential Permit PP-76 to the Vermont Electric Transmission Company (VETCO) to operate the international interconnection therein authorized at power levels above those stipulated in PP-76, and to construct new transmission facilities to distribute this power. This international direct current (DC) interconnection, referred to as Phase I, is currently in operation and was authorized to permit the New England Power Pool (NEPOOL) to transmit surplus hydroelectric energy purchased from Hydro-Quebec, the provincial utility of Canada, to load centers in central New England.

The proposed new facilities, referred to as Phase II, consist of three principal elements. The first is the extension of the Phase I ±450-kV DC transmission line (predominantly along existing transmission rights-of-way) between the town of Monroe, New Hampshire (the terminus of Phase I) and the town of Groton, Massachusetts. The second element is the construction of an 1800-MW DC/AC converter terminal at the terminus of the proposed DC line, on a site adjacent to an existing 345-kV AC substation. The third element is the construction of two new linearly connected 345-kV AC transmission lines along existing transmission rights-of-way and terminating at an existing substation at West Medway, Massachusetts. These new transmission lines are needed to reinforce the existing New England 345-kV AC transmission system and thereby allow the NEPOOL system to operate reliably at the higher levels of import.

To minimize impacts to the extent practicable, DOE has identified in this Final Environmental Impact Statement numerous mitigative measures. Should PP-76 be amended, that amendment will include terms and conditions that require the Applicant to implement these mitigative measures. The Applicant has committed to these measures, and they are considered part of the proposed action.

Because of these mitigative measures, and the fact that almost all of the proposed transmission line would be constructed within established transmission line corridors adjacent to existing transmission lines, most of the environmental impacts associated with the proposed action would be incremental in nature or would result from construction activities that would be transitory in nature. These impacts include clearing and control of vegetation, loss or alteration of wildlife habitat, displacement and/or disturbance of wildlife, disturbance of aquatic resources, release of gaseous pollutants and dust, and disruption of agricultural activities. Impacts from operation and maintenance of the transmission facilities include collision of birds with structures, visual intrusion of an additional line within the transmission corridor, and possible health and safety effects of the electromagnetic environment in close proximity to the proposed line.

A total of about 145 ha (358 acres) would be converted from present uses (mostly forested land) to project-related uses, such as widening of the right-of-way and construction of the converter terminal. Of this total, less than

20 ha (50 acres) would be permanently converted to project-related uses that would preclude other uses such as farming or wildlife cover.

Visual impacts of the proposed project would be minor and incremental in nature, i.e., adding to the visual intrusiveness of the existing lines or structures in the transmission corridor.

The operation of the proposed line and associated facilities would not pose any significant hazards associated with electric fields or related effects, or seriously affect other components of human health and welfare in the project region.

Several who commented on the draft EIS expressed concern that hydro-electric generation in Canada to meet Phase II energy requirements could have adverse impacts, particularly on migratory birds, in the James Bay region of Quebec, Canada. Although there is no requirement that this topic be addressed in the EIS, a discussion of this issue has been included as Appendix C of this document. The staff concludes on the basis of the analysis presented in Appendix C that no significant adverse effects on migratory bird populations in the James Bay region would be expected as a result of Phase II contract sales.

Operation of the interconnection would result primarily in supplying imported electrical energy that would be used to reduce oil consumption in the region. The availability of the additional electricity would have a beneficial effect on the economy and should enhance continued growth and improvement in the service area.

Three principal alternative DC corridor routes and six alternative converter terminal sites were considered. The alternative routes and sites were identified on the basis of existing rights-of-way or facilities and provided an adequate basis for comparative evaluation. This evaluation revealed that none of the corridors or terminal sites was environmentally preferable to the proposed route or site.

If DOE were to deny an amendment to PP-76, the Applicant could implement an alternative action to obtain the necessary capacity or maintain the status quo (no action). Alternatives to the proposed action that were evaluated by DOE include no action, construction and operation of new conventional or unconventional generating facilities, conservation and load management, decentralized energy sources, fuel conversion, and purchase of power from other utilities. All of these alternatives were deemed less desirable than the proposed action either because they were not deemed to be viable alternatives or they would result in greater adverse environmental impacts than would the proposed action.

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1. PURPOSE AND NEED

1.1 INTRODUCTION

In March 1983, the member utilities of the New England Power Pool (NEPOOL)* entered into a formal agreement with Hydro-Quebec to purchase 33 billion kilowatt hours (kWh) of surplus hydroelectric energy over an 11-year period beginning in 1986. To provide a means of delivering this energy, the construction of certain transmission facilities was proposed. These facilities, referred to as Phase I, included: (1) a ±450-kilovolt (kV) direct current (DC) transmission line extending from the U.S.-Canadian border near the town of Norton, Vermont, to a site adjacent to the existing Comerford generating station in the town of Monroe, New Hampshire, and (2) a converter terminal at the terminus of the DC transmission line. On April 5, 1984, the Economic Regulatory Administration (ERA) issued a Presidential permit in Docket PP-76 to the Vermont Electric Transmission Company (VETCO) authorizing the construction, connection, operation, and maintenance of these facilities. The Secretary of Energy, with concurrence by the Secretary of Defense and the Secretary of State, has the authority to grant or deny such a Presidential permit for the construction of transmission facilities that cross an international border of the United States.

The environmental consequences of the construction and operation of the Phase I facilities have been evaluated in an Environmental Impact Statement (EIS) (U.S. Department of Energy 1984). The Phase I interconnection was placed in service on October 1, 1986. The Phase I converter terminal was designed with a capacity of 690 megawatts (MW; 1 megawatt = 1000 kilowatts) to match the capability of the New England alternating current (AC) transmission system to absorb the additional power delivered to Monroe, New Hampshire. The ±450-kV DC line was designed with the capability to transmit additional levels of power should further contracts with Hydro-Quebec be deemed desirable.

Subsequent to the issuance of Presidential Permit PP-76, the members of NEPOOL concluded that additional purchases of hydroelectric energy would be beneficial to the New England region. Accordingly, NEPOOL, on behalf of its member utilities, has signed a firm energy contract with Hydro-Quebec for the purchase of an additional 70 billion kWh of energy over a 10-year period currently scheduled to begin in 1990. In order to accept delivery of this

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*NEPOOL is an operating entity within the Northeast Power Coordinating Council, which is one of nine regional reliability councils in North America. All planning, construction, and operation of generating and transmission facilities are highly coordinated among NEPOOL members. Generating units are centrally controlled and NEPOOL members share in the economies achieved through all pool ventures. A total of 92 individual public and investor-owned utilities constitute the NEPOOL organization. Included among the 92 utilities are 5 small investor-owned utilities, 40 public or municipal utilities, and 9 large investor-owned utilities, which in turn represent 38 subsidiaries or affiliated utility companies.

additional hydroelectric energy, it will be necessary for the Phase I facilities to operate at power levels above the 690-MW level previously authorized by Presidential Permit PP-76. In addition, it will be necessary to construct certain new facilities to transmit this additional hydroelectric energy to load centers in central New England. Consequently, on March 4, 1985, VETCO applied to ERA to amend the Presidential permit in Docket PP-76 to authorize an increase in the nominal operating level of the previously permitted facilities and the construction of certain new facilities required to implement the new energy purchase agreement with Hydro-Quebec.

Although a contract between the Applicant and Hydro-Quebec has already been signed, a denial by ERA of the amendment to Presidential Permit PP-76 would preclude construction of the Phase II facilities and also the use of the Phase I facilities at levels of power imports in excess of those authorized in the original permit.

The purpose of this EIS is to provide a sound environmental evaluation as input to DOE's future decision to grant or deny an amendment to PP-76 for the proposed additions to the New England/Hydro-Quebec Interconnection. To ensure public input to the planning and preparation of this EIS, public scoping meetings were held in June 1985 in Concord, New Hampshire, and Boston, Massachusetts. During those meetings, and the subsequent comment period, DOE received comments from agencies, groups, and individuals. Special attention was given in the draft EIS to those concerns and suggestions resulting from the scoping process.

A notice of the availability of the draft EIS was published by the Environmental Protection Agency on August 15, 1986. A 45-day comment period then ensued, which closed on September 29, 1986. This final EIS incorporates modifications resulting from consideration of the comments received during that time period. Comments received and responses thereto are reproduced in Appendix F.

1.2 PROJECT SUMMARY AND PURPOSE

1.2.1 Phase II Facilities

The proposed new facilities, referred to as Phase II, consist of three principal elements (see Figure 1.1). The first is the extension of the ±450-kV DC transmission line (predominantly along existing transmission rights-of-way) between the town of Monroe, New Hampshire, and the town of Groton, Massachusetts, a distance of 214.4 kilometers (km) (133.2 miles [mi]). The second element is the construction of an 1800-MW DC/AC converter terminal at the terminus of the proposed DC line, on a site straddling the town line between Groton and Ayer, Massachusetts, adjacent to an existing 345-kV AC substation. The third element is the construction of two new 345-kV AC transmission lines with a combined length of 83.4 km (51.8 mi) along existing transmission rights-of-way. These new transmission lines are needed to

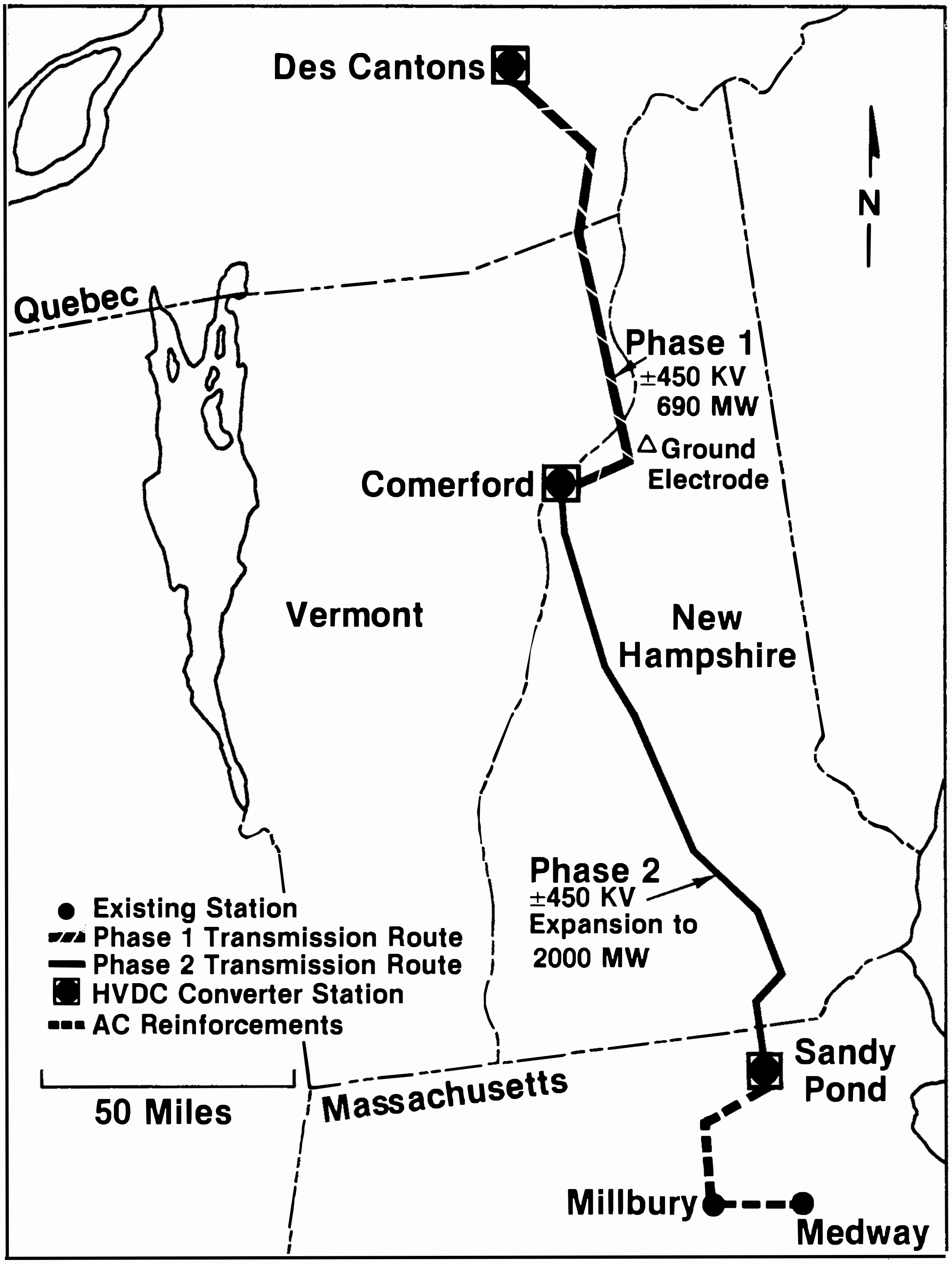

Figure 1.1. Map Showing Locations of Phase I and Proposed Phase II Features of the New England/Hydro-Quebec Transmission Line Interconnect.

reinforce the existing New England 345-kV AC transmission system and thereby allow the NEPOOL system to operate reliably at the higher levels of import. The Phase II facilities are described in greater detail in Section 2.

The proposed project is required to implement the new firm energy contract between NEPOOL and Hydro-Quebec. The benefits that would accrue to the New England region as a result of the Phase II energy contract include (1) the displacement of 12 million barrels of oil per year that would otherwise be used to generate electricity; (2) a reduction in the cost of electric generation with a concomitant reduction in the fuel component of customers' electricity bills; and (3) a reduction of 900 MW in the amount of new, as yet unplanned, generating capacity required to maintain adequate levels of electric reliability in the New England region.

1.2.2 Phase II Energy Contract

The Phase II agreement that has been signed by between NEPOOL and Hydro-Quebec provides for the guaranteed delivery by Hydro-Quebec of 7 billion kWh of energy per year for the 10-year term of the agreement beginning in 1990. For the years 1990 through 1996, this 7 billion kWh per year will be in addition to the 3 billion kWh per year expected to be delivered under the terms of the Phase I energy contract (see Volume 1, p. 29, of the Applicant's Environmental Report [hereinafter referred to as the "ER"]).

The pricing provisions of the Phase II agreement provide that for each of the first 5 years of the contract, the price of the imported energy will be 80% of NEPOOL's average fossil fuel costs (in ¢/kWh) incurred during the previous year. During the second 5 years, the 80% figure would increase to 95%. The average fossil fuel cost reflects the weighted average cost of energy generated from the use of coal, oil, and natural gas.

1.3 COST/BENEFIT OF PROPOSED ACTION

The proposed action should provide economic benefits to the New England region in three ways: (1) a reduction in fuel costs through a reduction in the amount of oil used to generate electric energy; (2) a reduction of 900 MW in the amount of new generating capacity required to maintain the desired level of reliability on the NEPOOL system during the 1990s; and (3) a reduction in the electrical losses incurred when transmitting electric energy to the load centers in southern New England.

The values appearing in this section of the draft EIS were based on fuel price projections developed for the Applicant by Data Resources, Inc., in January 1985. The cost/benefit analysis appearing in this final EIS uses fuel price projections that were revised by Data Resources, Inc. (and adopted by the Applicant) in March 1986. In addition, the Applicant has revised the estimated capital cost of the Phase II project and the weighted cost of capital for financing the project. This revised cost/benefit analysis, as well as a fuel price sensitivity analysis, was provided by the Applicant in a supplement to the ER that included comments on the draft EIS.

1.3.1 Fuel Cost Savings

The Applicant estimates that the cumulative present worth (in 1990 dollars) of the savings in fossil fuel costs over the 10-year period of the Phase II agreement will be $1.4 billion.* In current dollars, savings would range from about $104 million in 1991 to about $588 million in the year 2000.

DOE Staff has reviewed the assumptions and methodology used in this analysis and has determined that both appear to be reasonable. However, because the imported energy will displace oil-fired generation almost exclusively and be priced relative to the price of all fossil fuels, fuel cost savings will vary directly with the future price of oil and inversely with the future price of coal. Although some savings in fuel costs will result from any and all fuel price levels (because the imported energy is priced at less than 100% of actual costs), a drastic reduction in the price of oil could reduce savings to the point that the entire Phase II project was no longer economically viable. In order to evaluate this possibility, the Applicant performed a sensitivity analysis in which the projected price of fossil fuels was varied ±25%, and -50% from the base values used.

The Applicant has estimated that, using base-case fuel price projections, the cumulative present worth of fuel cost savings (in 1990 dollars) would be $1.4 billion over the 10-year life of the Phase II firm energy contract. By increasing the projected price of fossil fuels 25%, these savings increase to about $1.7 billion. A 25% reduction in the estimated price of fossil fuels reduces estimated gross savings in fuel costs to $1.1 billion. A 50% reduction in projected fossil fuel prices reduces expected savings to $0.7 billion.

DOE Staff performed a similar independent analysis and obtained results that were consistent with those submitted by the Applicant. However, the DOE analysis was more comprehensive and included calculations of the "break-even" price for fossil fuels; i.e., the price at which the economic benefits of the Phase II project exactly equal the cost of the project. DOE determined this level of fuel prices to be about 65% below the base fuel prices assumed in the March 1986 Data Resources, Inc., projections. This 65% reduction in fossil fuel prices would equate to $6.60/barrel oil and $19/ton coal in 1990 and $24/barrel oil and $32/ton coal in the year 2000.

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*The methodology and the assumptions used in this analysis (as it originally appeared in the draft EIS) are described on pages 23 through 54 of Volume 1 of the ER. The revised assumptions on fuel price, project capital cost, and cost of capital used in this final EIS appear in Exhibit A of the comments submitted by the Applicant on the draft EIS.

1.3.2 Capacity Benefits

The terms of the Phase II firm energy contract provide for a high degree of control by the Applicant in scheduling or "calling for" the delivery of energy from Hydro-Quebec. The Applicant is not purchasing capacity. However, in performing reliability analyses, the Applicant has determined that the Phase II contract will reduce by 900 MW the amount of new generating capacity required to maintain the desired level of reliability on the NEPOOL system during the 1990s.

In determining the economic benefits of this 900-MW reduction in new capacity requirements, the Applicant assumed that the capacity would have come from the installation of gas turbines. The DOE Staff feels that this is a reasonable assumption since gas turbines have a relatively low capital cost, are quickly installed, and are installed (generally) for reliability reasons only. Furthermore, if the Phase II project were not undertaken (or the amendment were denied by DOE), gas turbines are the only central station capacity source that could be installed in the required time period.

The economic analysis performed by the Applicant shows that the "capacity benefit" of the proposed action (when coupled with the Phase II firm energy contract) reduces the revenue requirements associated with new capacity additions by $407 million on a cumulative present worth basis (in 1990 dollars).

1.3.3 Reduction in Incremental Energy Losses

The net change in energy losses associated with the proposed action has three components: (1) an increase in losses associated with installation of the Phase II DC facilities, (2) an increase in losses associated with the increased energy flow through the Phase I DC facilities, and (3) a reduction in losses on NEPOOL's existing AC transmission system.

The increased losses associated with the DC system produce a cost increase of approximately $55 million (cumulative present worth) in 1990 dollars. Reduced losses on the existing AC system produce savings of approximately $82 million. The result is a net savings of approximately $27 million (Applicant's comments, Exhibit A, p. 5-9). Varying the projected price of fossil fuel (as discussed in Section 1.3.1) will produce differences in incremental energy loss savings. These differences are noted in Table 1.1.

1.3.4 Gross Savings

Table 1.1 shows the estimated gross savings for the Phase II project under each of the fossil fuel price scenarios considered.

Table 1.1 Gross Savings
(Cumulative present worth, millions of 1990 dollars)

Fossil Fuel Prices	Fuel Cost Savings	Capacity Credit	Incremental Loss Savings	Gross Savings
-65%	490	407	10	907
-50%	707	407	14	1,128
-25%	1,060	407	20	1,487
Base	1,415	407	27	1,849
+25%	1,770	407	34	2,211

1.3.5 Costs

The total capital costs associated with the Phase II facilities are estimated to be $547 million. Table 1.2 contains a breakdown of these costs for each component of the project.

The Applicant conducted a revenue requirements analysis over the life of the Phase II firm power agreement. Table 1.3 contains the economic assumptions used in that analysis. The results of the analysis show that a $547 million project cost would produce $901 million of revenue requirements on a cumulative present worth basis (1990 dollars).

The capital costs of the project were determined on the basis of "study grade" estimates that the Applicant feels are accurate to only ±25%. In recognition of this fact, the Applicant performed additional revenue requirement analyses for projected capital costs of $410 million (25% lower than the base estimate) and $684 million (25% higher than the base estimate).

Using the assumptions in Table 1.3, the $410 million capital cost estimate produced revenue requirements of $676 million (cumulative present worth, 1990 dollars). With capital costs of $684 million, revenue requirements would increase to $1,126 million.

1.3.6 Net Benefits

Table 1.4 compares estimated project costs with projected benefits. Costs are represented by the cumulative present worth of revenue requirements generated by the capital costs of the project. Project benefits include the estimated gross savings from fuel costs, capacity credits, and reductions in incremental energy losses.

Table 1.2. Capital Construction Cost Estimate for Proposed Facilities

Item	Capital Construction Cost Estimate[a] (millions of dollars)
133.2 miles of ±450-kV DC transmission line	170.9
One 1800-MW converter terminal connected to Sandy Pond substation	236.6
36.0 miles of 345-kV AC transmission line connecting Sandy Pond and Millbury No. 3 substations	37.6
16.1 miles of 345-kV AC transmission line connecting Millbury No. 3 and West Medway substations	16.5
345-kV AC circuit breakers and miscellaneous equipment at Sandy Pond, Millbury No. 3, and West Medway substations	17.0
Remove and rebuild two sections of two 115-kV AC transmission lines and remove and rebuild portions of two 69-kV AC transmission lines and support structures on the Sandy Pond to Millbury right-of-way; install 115-kV AC circuit breakers and miscellaneous substation equipment	42.1
Other miscellaneous facilities	26.4
TOTAL	$547.1

[a] Capital construction cost estimate represents the sum of current-year construction, escalation, and allowance for funds used during construction (AFUDC).

Table 1.3. Assumptions Used in Revenue Requirements Analysis

Item	Assumption	
Cost of Money		
DC facilities	60% Debt @	9.5%
	40% Equity @	15.0%
	Weighted Total	11.7%
AC lines	45% Debt @	9.0%
	10% Preferred Stock @	8.5%
	45% Equity @	13.0%
	Weighted Total	10.75%
Present Worth Rate		8.8%
Property Taxes		
Converter	1.0% of project capital cost	
AC and DC lines	2.5% of project capital cost	
Escalation Rate	2.5% per year	
O&M Costs		
Converter	1.9% of project capital cost	
DC line	0.6% of project capital cost	
AC lines	0.7% of project capital cost	
Escalation Rate	5.0% per year	
Land/Right-of-way lease charges	2.3% of project capital cost	
Life of Facilities		
Tax	15 years	
Book	10 years for DC line and converter 30 years for AC lines	
Normalized	10 years for DC line and converter 30 years for AC lines	
Tax Rates		
Federal Income	46.0%	
Massachusetts Income	6.5% (70% subject to income tax)	
New Hampshire Income	9.03% (30% subject to income tax)	
Investment Tax Credit	10.0% deferred and amortized over book life	
Depreciation		
Book	Straight line	
Tax	Rate set by Accelerated Cost Recovery System tax laws	
In-Service Date	December 1990	

Source: Applicant's comments, Exhibit A, p. 4.

Table 1.4. Net Benefits of the Proposed Project
(millions of 1990 dollars)

Fuel Oil Prices	Gross Savings	Project Costs: Capital Costs	Project Costs: C.P.W. Rev. Req.[a]	Net Benefits
-65%	907	+25%	1,126	-219
		Base	901	6
		-25%	684	223
-50%	1,128	+25%	1,126	2
		Base	901	227
		-25%	684	444
-25%	1,487	+25%	1,126	361
		Base	901	586
		-25%	684	803
Base	1,849	+25%	1,126	723
		Base	901	948
		-25%	684	1,165
+25%	2,211	+25%	1,126	1,085
		Base	901	1,310
		-25%	684	1,527

[a] C.P.W. Rev. Req. = Cumulative present worth revenue requirements.

Table 1.4 shows that the economic benefits to the New England region could range from a net cost of $219 million to a net savings of $1.5 billion over the 10-year life of the Phase II firm energy contract. It is significant to note, however, that a net cost of $219 million would result only for the most pessimistic scenario of highest capital cost and lowest cost of fossil fuel. In order to produce this net cost to the New England region, fossil fuel prices in 1990 would need to be about two-thirds below present levels.

In addition to the economic benefits identified above, the construction of the Phase II facilities could provide other benefits not yet quantified. These potential benefits include:

- The opportunity for increased energy banking whereby NEPOOL members could transmit relatively inexpensive energy north to Quebec during off-peak periods and receive equal amounts of energy during on-peak periods when generation costs in New England are much higher. The basic Energy Banking Agreement was established under Phase I but the amount of energy banking was limited to power levels of 690 MW by the capacity of the Phase I facilities. Construction of the Phase II facilities would raise the potential level of energy banking to almost 2000 MW.

- Additional opportunities for energy interchange, whereby if Hydro-Quebec has additional surpluses of energy, it could sell the surpluses to New England at a fraction of New England's avoided fuel cost.

- Increased ability to make emergency transfers of power to either side of the border for mutual reliability purposes.

1.4 RESOURCE PLAN AND SUPPLY REQUIREMENTS

The Applicant is a member of NEPOOL and as such it is relevant to consider the supply and demand situation on a NEPOOL basis.

As shown in Table 1.5, the NEPOOL region is heavily dependent upon oil (mostly foreign) for the production of electric energy. In 1985, 37% of all electricity generated in the New England area was produced by burning oil. However, future supply plans developed by NEPOOL (New England Power Pool 1986)* could reduce the region's dependence on imported oil for the production of electric energy. By 1995, these plans call for the installation of 2300 MW of nuclear capacity, the development of approximately 1600 MW of cogeneration in the region, and the importation of hydroelectric energy through the terms of the New England/Hydro-Quebec Phase I and Phase II agreements.

Table 1.5 also shows that even with the construction of the Phase II facilities and the implementation of the Phase II firm energy contract, oil-fired generation in New England is projected to reach 34.0 million MWh by 1995 (28% of total generation). This will require the burning of approximately 59 million barrels of oil (North American Electric Reliability Council 1986).

If the energy from the Phase II agreement were not available, oil-fired generation in 1995 would rise to 41 million MWh (34% of total generation). This would require the burning of approximately 71 million barrels of oil--12 million barrels more than with the energy from the Phase II firm energy contract.

An additional impact of the Phase II interconnection and the Phase II firm energy contract is to reduce the amount of generating capacity required to maintain adequate levels of reliability. In order to determine the "capacity benefit" of the interconnection, the Applicant performed a loss-of-load analysis. This analysis considers the variability of system load and the random outages of generating units in determining the probability that the amount of generating capacity available at any time would not be sufficient to supply all of the customer demand for electricity. Based on this analysis, the Applicant has determined that the "capacity benefit" of Phase II is equivalent to 900 MW.

*Throughout this document, complete citations for references cited in a chapter are listed at the end of that chapter.

Table 1.5. NEPOOL Generating Mix

	Installed Generating Capacity (summer)			
	1985 Actual[a]		1995 Projected[a]	
Source of Energy	MW	%	MW	%
Oil	9,309	44	8,620	34
Natural Gas	1,097	5	1,075	4
Coal	2,725	13	2,773	11
Nuclear	4,218	20	6,529	26
Hydro	2,935	14	2,902	11
Other[b]	953	4	3,524	14
TOTAL	21,237	100	25,423	100

	Electrical Energy Generated			
	1985 Actual[c]		1995 Projected[c,d]	
Source of Energy	Million MWh	%	Million MWh	%
Oil	29.1	37	34.0 (41.0)	28 (34)
Natural Gas	4.6	3	0.4	0
Coal	16.4	16	15.4	13
Nuclear	27.2	26	43.2	35
Hydro[e]	3.7	5	3.3	3
Other[f]	0.9	1	11.3	9
Net Purchases	12.8	12	14.7 (7.7)	12 (6)
TOTAL	94.7	100	122.3	100

[a] Source: New England Power Pool (1986).

[b] Values for 1985 include 52 MW of wood-burning capacity, 169 MW of cogeneration, and 732 MW of net purchases and sales. Values for 1995 include 52 MW of wood-burning capacity, 1743 MW of cogeneration, 1687 MW of net purchases and sales.

[c] Source: North American Electric Reliability Council (1986).

[d] These values represent projected generation for each fuel type if the proposed project is installed. The values in parentheses represent projected generation if the proposed project is not installed.

[e] Values shown are net of pumped hydro pumping losses.

[f] Values for 1985 include 0.6 million MWh of cogeneration and 0.3 million MWh produced from wood and refuse. Values for 1995 include 11.3 million MWh of cogeneration and 0.025 million MWh produced from wood and refuse.

Another measure of system reliability is the capacity reserve margin. Reserve margins are defined as the difference between planned resources and peak demand, expressed as a percentage of peak demand. The resource plan submitted by the Applicant shows that NEPOOL will have reserve margins ranging from a low of 4.6% to a high of 31.5% during the 10-year period of the Phase II agreement. Without the 900 MW "capacity benefit" associated with Phase II, the range of NEPOOL reserve margins would drop to between 0.8% and 27%. Details of the NEPOOL reserve margins for the 10-year period of the Phase II agreement appear in Table 1.6.

Table 1.6. NEPOOL Load and Generating Capacity Projections

Power Year[a]	Total NEPOOL Load (MW)	Total NEPOOL Capacity[b] (MW)	NEPOOL Reserve Margins[b] (MW)	NEPOOL Reserve Margins[b] %
1990/1991	19,700	25,915 (25,015)	6,215 (5,315)	31.5 (27.0)
1991/1992	20,113	25,536 (24,636)	5,423 (4,523)	27.0 (22.5)
1992/1993	20,635	25,445 (24,545)	4,810 (3,910)	23.3 (18.9)
1993/1994	21,126	25,437 (24,537)	4,311 (3,411)	20.4 (16.1)
1994/1995	21,561	25,474 (24,574)	3,913 (3,013)	18.1 (14.0)
1995/1996	22,151	25,105 (24,205)	2,954 (2,054)	13.3 (9.3)
1996/1997	22,533	25,101 (24,201)	2,568 (1,668)	11.4 (7.4)
1997/1998	22,875	24,839 (23,939)	1,964 (1,064)	8.6 (4.7)
1998/1999	23,269	24,604 (23,704)	1,335 (435)	5.7 (1.9)
1999/2000	23,472	24,557 (23,657)	1,085 (185)	4.6 (0.8)

[a] A power year begins on November 1 and ends on October 31.

[b] These values represent NEPOOL's total generating resources and capacity reserve margins assuming a 900-MW capacity benefit of the Phase II facilities and firm energy contract. The values in parentheses represent the NEPOOL resources and reserve margins that would result if the Phase II facilities were not installed and the Phase II firm energy contract were not in place.

Although it is typical for utilities to plan for reserve margins between 15% and 25%, various utility system characteristics, such as average generating unit size, number and type of units, unit availabilities, and other factors can cause the level of reserves required for adequate reliability to vary considerably from system to system. Consequently, the projected range of capacity reserve margins (with and without Phase II) for the NEPOOL system cannot be construed as either inadequate or excessive without further detailed studies. However, based on the reserve margins historically maintained on the NEPOOL system (25% to 30%), it is likely that NEPOOL would seek additional capacity resources during the early 1990s if the 900 MW "capacity benefit" of Phase II were not available.

1.5 REFERENCES FOR SECTION 1

New England Power Pool. 1986. NEPOOL Forecast Report of Capacity, Energy, Loads and Transmission, 1986-2001. New England Power Pool.

North American Electric Reliability Council. 1986. Electric Power Supply and Demand, 1986-1995. North American Electric Reliability Council.

U.S. Department of Energy. 1984. Environmental Impact Statement, New England/Hydro-Quebec ±450-kV Direct Current Transmission Line Interconnection. DOE/EIS-0103. U.S. Department of Energy, Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness, Washington, DC.

2. PROPOSED ACTION AND ITS ALTERNATIVES

2.1 PROPOSED ACTION

The proposed action is to amend Presidential Permit PP-76, granted to the Vermont Electric Transmission Company (the Applicant), to allow member utilities of the New England Power Pool (NEPOOL) to purchase additional quantities of energy from Hydro-Quebec, the provincial utility of Quebec, Canada, and to construct several new facilities in order to utilize the additional power purchased under the proposed amendment. The new facilities (see Figure 1.1 in Chapter 1) include (1) an extension of the ±450-kilovolt (kV) direct current (DC) line authorized in the original Presidential permit by about 214 km (133 mi) southward from the Comerford converter terminal in Monroe, New Hampshire, to a location between Groton and Ayer, Massachusetts; (2) a new 1800-megawatt (MW) converter terminal (referred to as Sandy Pond) at the terminus of the new DC transmission line; (3) two new 345-kV alternating current (AC) transmission lines extending a total of 84 km (52 mi) from an existing substation adjacent to the proposed converter terminal to an existing substation in Millbury and thence to an existing substation in Medway, Massachusetts; and (4) a dedicated metallic return conductor extending for the length both of the proposed Phase II DC transmission line and the Phase I DC transmission line. The construction of these facilities is herein referred to as Phase II of the New England/Hydro-Quebec Interconnection.

One of the data sources used for the description of the proposed Phase II project is the Applicant's Environmental Report, submitted to the U.S. Department of Energy (DOE) as part of Docket PP-76A from May to September 1985; hereinafter this report is referred to as the "ER". Along the proposed route, data are compiled primarily by town, which is a geographical and governing unit somewhat analogous to townships in other regions. Several towns make up a county, and a town may include several villages or population concentrations.

2.1.1 Study Area Selection and Description

The term "study area" as used in this document refers to those areas investigated in order to characterize the environs and evaluate the potential impacts of the proposed project. For a given resource, the study area was chosen so as to (1) provide sufficient data in a context broad enough to allow description of the existing condition of that resource, and (2) encompass the area within which impacts could be reasonably expected to occur. Thus, the extent of a specific study area depended on the environmental resource being considered. For instance, the socioeconomic study areas were based primarily on town, or in some cases county, boundaries along the proposed route; while climatic considerations were based on a broader area (central Massachusetts and interior New Hampshire). In a similar manner, consideration of expected level of impact to soils and vegetation was confined mainly to the actual work areas, while evaluation of visual impacts involved considering an extended area away from the immediate project site. Descriptions of the study areas considered for each resource (or affected environmental parameter) are provided in Section 3.

2.1.2 Corridor and Route Selection

Based on its review of the general purposes of the proposed action, route selection and facility siting procedures, and other issues involved (ER, Vol. 4), the DOE Staff concurs with the Applicant that because of economic, environmental, and service reliability considerations the proposed route (and alternatives) should meet the following criteria:

(1) The northern terminus should be located at the Comerford converter terminal site (built during Phase I) in order to avoid the requirements of building a new DC line from the Canadian border;

(2) The southern terminus should be located based on system reliability and economic considerations of AC transmission system reinforcements that would be required in association with the new converter terminal; and

(3) Both the DC and AC transmission lines should be located, where practical, within existing utility corridors.

Use of existing corridors is consistent with federal routing guidelines. Additionally, any routing outside of existing, dedicated, and already utilized corridors would lead to far greater economic and adverse environmental impacts. Locations where new transmission lines could be sited on or adjacent to existing transmission line rights-of-way were initially identified by the Applicant. In total, nine transmission-line plans were evaluated based on six potential locations for the Phase II converter terminal. These alternatives allowed comparisons of AC vs. DC lines (converter located at Comerford, New Hampshire), a compromise between AC and the planned DC extension (converter located at Londonderry, New Hampshire), and alternative locations for the converter terminal with the proposed DC extension (converter terminal located at Ludlow, Millbury, Tewksbury, or Sandy Pond, Massachusetts). The proposed route was then determined based on additional factors suggested by local authorities, local planning and zoning regulations, cost and engineering criteria, and environmental and land-use factors. (A map showing the proposed route and the three alternative routes is provided in Figure 2.1.) Public opinion on the proposed route was next solicited and considered through procedures required by the states of New Hampshire and Massachusetts and through a public scoping meeting conducted on June 4 and 5, 1985, by the U.S. Department of Energy. That meeting was designed to solicit concerns and suggestions from property owners, local residents, government agencies, and public interest groups. The Staff concurs with this approach.

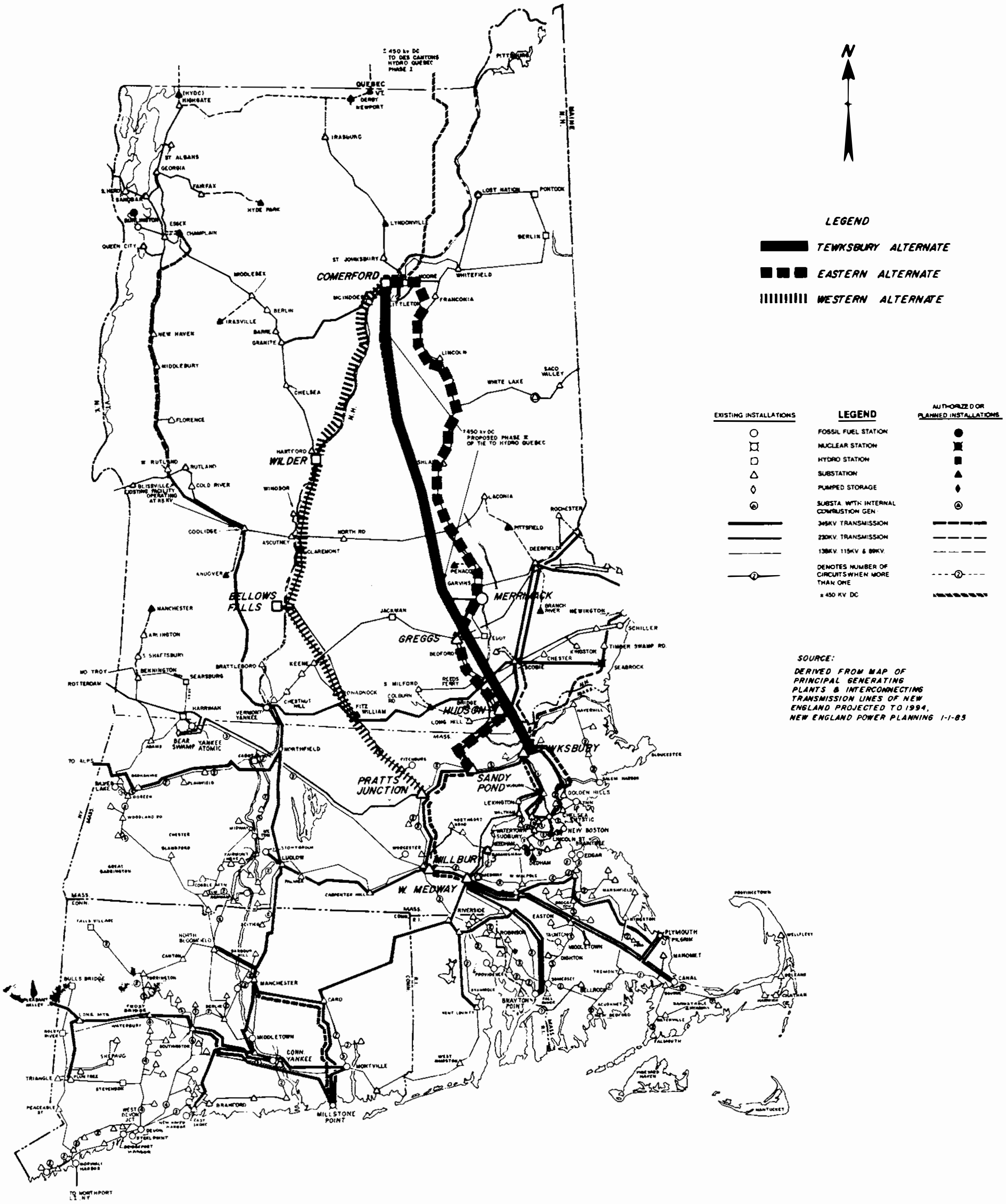

Figure 2.1. Locations of Proposed and Alternative Routes for Phase II. (The proposed and Tewksbury alternative DC line routes follow the same corridor from Comerford to Hudson, New Hampshire. From there, the proposed route turns southwest to Sandy Pond, while the Tewksbury alternative continues southeast to the Tewksbury alternative converter terminal site.) (From ER, Vol. 4--Fig. III-1)

2.1.3 Description of the Proposed Route

The proposed route (Figures 2.2 through 2.4) would begin at the Phase I converter terminal site in the town of Monroe, New Hampshire. The first portion of the route would be for the new ±450-kV DC transmission line that would extend 214 km (133 mi) to the Groton/Ayer town line in Massachusetts. Except for the first 1.3 km (0.8 mi), which would be on existing utility property, the DC line would be located entirely within occupied transmission line rights-of-way. For the first 181 km (112.5 mi) from Monroe to Sandy Pond Junction (in Hudson, New Hampshire) the DC line would be located between two single-circuit, 230-kV AC transmission lines, extending in a south-southeasterly direction. The proposed DC line would then exit the 230-kV AC transmission line right-of-way and extend in a south-southwesterly direction within an existing 345-kV AC transmission line right-of-way between Sandy Pond Junction and Groton/Ayer Massachusetts, a distance of 33 km (20.5 mi). The terminus of the proposed DC line would be at the proposed 1800-MW converter terminal at a site straddling the town line between Groton and Ayer, Massachusetts. The converter terminal would be constructed adjacent to an existing 345-kV AC substation known as Sandy Pond substation.

A new 345-kV AC transmission line is proposed to be built on an existing right-of-way between the Sandy Pond substation in Ayer, Massachusetts, and the existing Millbury No. 3 345-kV AC substation in Millbury, Massachusetts. From the Sandy Pond substation, this line would extend in a south-southwesterly direction to the town of West Boylston, and thence southerly to the Millbury No. 3 substation. The line would traverse a distance of about 58 km (36 mi) and would be located on an existing right-of-way between an existing 345-kV AC transmission line and two existing 115-kV AC transmission lines. For the majority of this right-of-way, the existing single-circuit, 115-kV AC steel-lattice structures would be removed and replaced with double-circuit, single-shaft, steel-pole structures (ER, Vol. 2--Figs. II-7, II-10, II-11, and II-12). Where the proposed 345-kV AC line would cross the Wachusett Reservoir, the existing 69-kV AC structures would be removed and replaced by steel-pole H-frame crossing structures (ER, Vol. 2--Fig. II-9).

A second new 345-kV AC transmission line would extend from the Millbury No. 3 substation to the West Medway substation in Medway, Massachusetts. From the Millbury substation, this line would extend east-southeast for approximately 26 km (16 mi). The transmission line would be located on an existing right-of-way and would parallel an existing 345-kV AC line and two existing 115-kV AC lines.

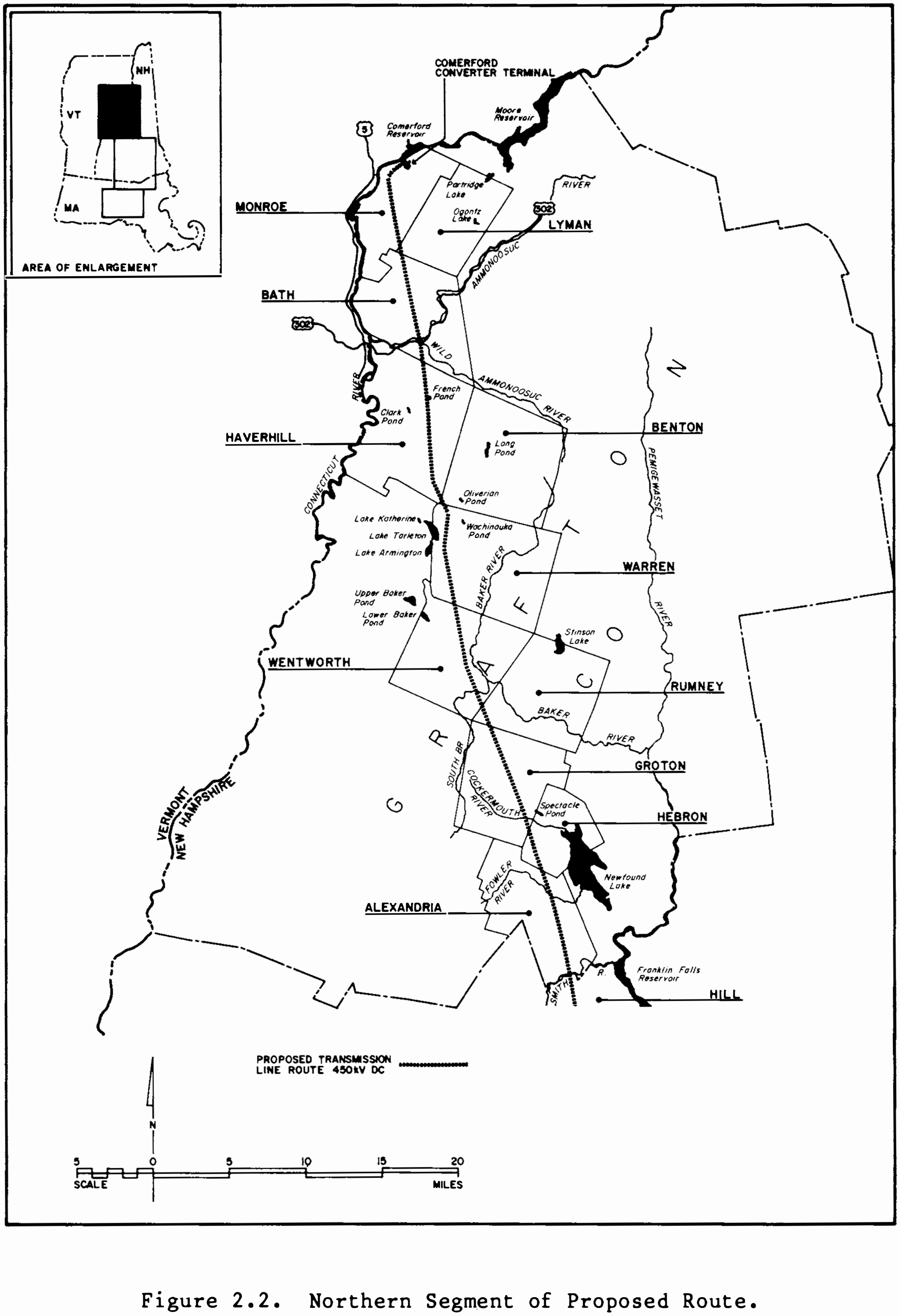

Figure 2.2. Northern Segment of Proposed Route.
(Map provided by the Applicant.)

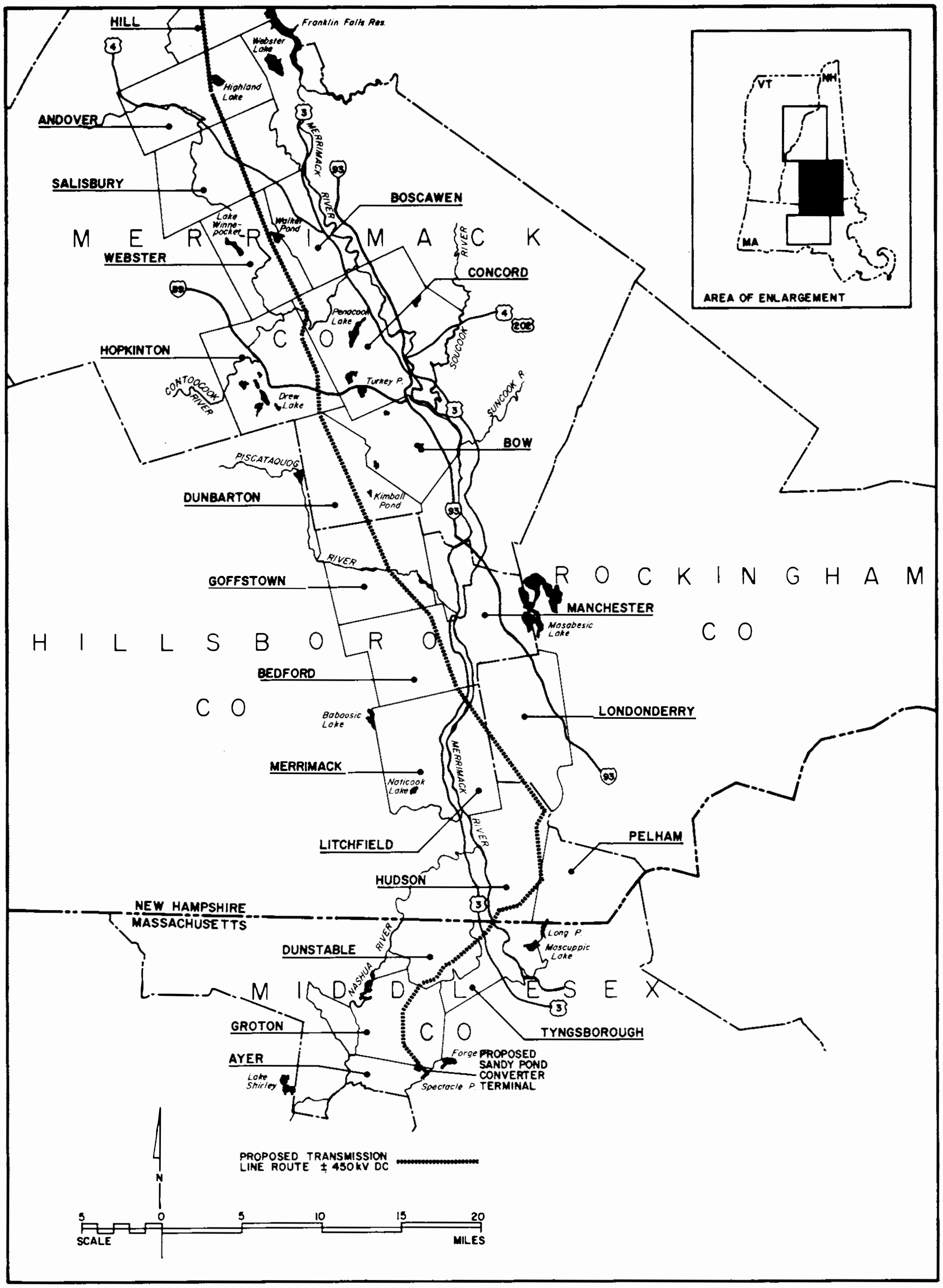

Figure 2.3. Central Segment of Proposed Route. (Map provided by the Applicant.)

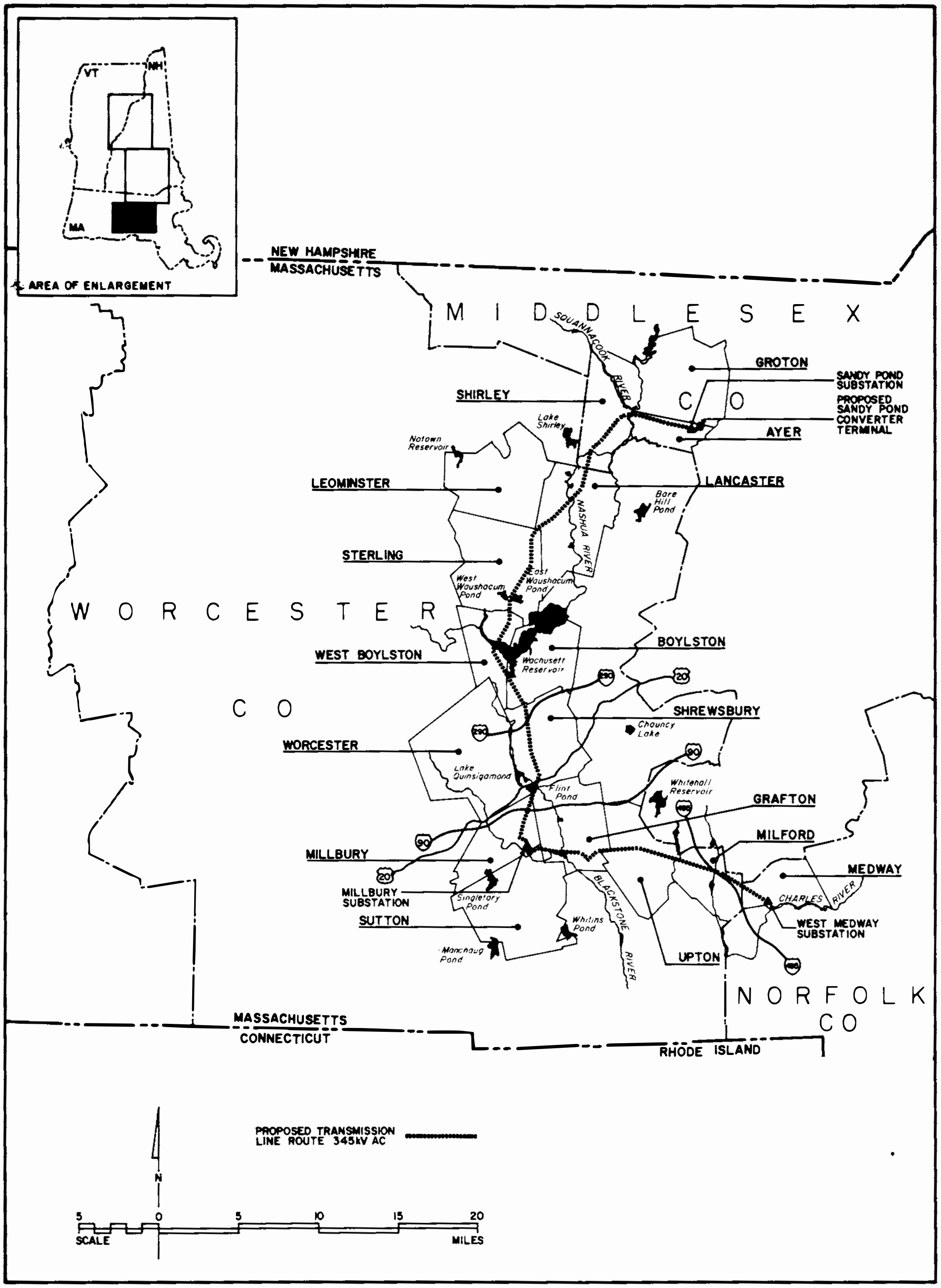

Figure 2.4. Southern Segment of Proposed Route. (Map provided by the Applicant.)

2.1.4 Proposed Design and Construction Activities

2.1.4.1 Design Description

Line Specifications

Basic design parameters for the proposed DC transmission line are listed in Table 2.1. Each of the two current-carrying conductors would consist of three-bundle aluminum and steel (ACSR) subconductors. The subconductors would be installed in an inverted triangular formation (i.e., apex down). There would also be a single, dedicated metallic return conductor extending the length of the DC line. It would connect the new converter terminal at Sandy Pond, Massachusetts, to the Phase I converter in Monroe, New Hampshire, and then extend to the U.S./Canadian border on Phase I structures beginning at structure #320 in Littleton, New Hampshire, and ending at Norton, Vermont. At that point the dedicated metallic return conductor would be connected to the dedicated metallic neutral return conductor that would be installed on Hydro-Quebec transmission structures that extend from the border to the Des Cantons converter terminal in Sherbrooke, Quebec (ER, Supplement, Sept. 29, 1986). The dedicated metallic return conductor would be a single 2839.8-kcmil ACSR conductor, approximately 5 cm (2-in) diameter.

The conductors would be protected from lightning strikes by installation of a buried counterpoise wire and two aerial groundwires (shield wires), one above each conductor bundle.

Basic design parameters for the two proposed AC transmission lines are listed in Table 2.2. The three current-carrying pole conductors would each consist of two-bundle ACSR subconductors. The subconductors would be spaced in a horizontal plane. Spacing of electric conductors would vary with type of support structure. Where standard 345-kV H-frame structures were used there would be 7.9-m (26-ft) phase spacing, and where narrower 345-kV H-frame structures were used there would be 6.1-m (20-ft) phase spacing. The conductors would be protected from lightning strikes by installation of a buried counterpoise wire and two aerial groundwires (shield wires).

Both AC and DC transmission lines would be designed to meet the National Electric Safety Code specifications for heavy ice loading conditions (ice buildup of 12.7 mm [0.5 in] thickness and 0.8 kPa [16 lb/ft^2] of wind pressure) and extreme wind conditions (wind pressure of 0.2 kPa [4 lb/ft^2]). In addition, the transmission structures would be designed to withstand heavy icing (determined from a review of meteorological data) and imbalancing due to ice buildup.

Support Structures

Lattice-steel, H-frame support structures are proposed for use on the DC line from the Comerford converter terminal to Sandy Pond Junction in the town

Table 2.1. Design Parameters for Proposed DC Transmission Line for Phase II of the New England/Hydro-Quebec Interconnection

Parameter	Value
Length of line	214.4 km (133.2 mi)
Voltage	±450 kV DC
Configuration	Bipolar, horizontal pole spacing
Capacity	2000 MW
Conductor type	Aluminum/steel
Conductor size	50 mm (2 in) nominal diameter
Minimum clearance: conductor to ground at mid-span	12.2 m (40 ft)
Lightning protection	Two aerial shield wires and a buried longitudinal counterpoise wire attached to each structure.
Tangent structures	Lattice steel H-frame (first 181 km [112.5 mi]), single-shaft steel-pole (last 33.3 km [20.7 mi])
Height of tangent structures	23-49 m (75-160 ft); typically 27.4 m (90 ft)
Average span length	183 m (600 ft)
Right-of-way widths (beginning at the Comerford Converter Terminal in New Hampshire)	61-m (200-ft) ROW[a] for 1.3 km (0.8 mi); within 107-m (350-ft) ROW for 173.5 km (107.8 mi); 172.7-m (566.5-ft) ROW for 6.3 km (3.9 mi); 82-m (270-ft) ROW for 13.7 km (8.5 mi); 76-m (250-ft) ROW for 10.3 km (6.4 mi); 102-m (335-ft) ROW for 6.6 km (4.1 mi); and 76-m (250-ft) ROW for 2.7 km (1.7 mi).

[a] ROW = Right-of-way.

Source: ER, Vols. 1-3; Reilly 1986.

of Hudson, New Hampshire. Single-shaft steel poles would then be used for the remainder of the DC line (ER, Vol. 4). Lattice steel waist-type structures may be used at line angles and dead ends along the northern 181-km (112.5-mi) portion of the DC line (ER, Supplement, Sept. 29, 1986). The AC line would generally use wood- or steel-pole, H-frame support structures, except for a few locations along the Sandy Pond to Millbury right-of-way, where single-shaft, steel-pole structures would be used (ER, Vol. 2). Coloration for the steel poles would be provided by use of natural-weathering steel (CORTEN or similar).

Table 2.2. Design Parameters for Proposed AC Transmission Lines for Phase II of the New England/Hydro-Quebec Interconnection

Parameter	Value
Length of lines	58 km (36 mi) and 26 km (16.1 mi)
Voltage	345 kV AC
Conductor type	Aluminum/steel
Minimum clearance: conductor to ground at mid-span	7.6 m (25 ft)
Lightning protection	Two aerial shield wires and a buried longitudinal counterpoise wire attached to each structure
Tangent structures	Wood- or steel-pole H-frame and single-shaft steel-pole
Height of tangent structures	19-37 m (61-120 ft), typically 23 m (75 ft), for H-frames and 26-37 m (85-120 ft), typically 29 m (95 ft), for single-shafts
Average span length	183 m (600 ft) from Sandy Pond to Millbury and 152 m (500 ft) from Millbury to West Medway
Right-of-way width	Various widths ranging from a minimum of 58.8 m (193 ft) to a maximum of 123 m (405 ft)

Source: ER, Vol. 2; Reilly 1986.

Converter Terminal

At the town line between Groton and Ayer, Massachusetts, a building would be erected on a cleared, 12-ha (30-acre) site to house high-voltage, direct current (HVDC) converter equipment for the proposed converter terminal (ER, Vol. 1). The converter terminal yard would be a square area 300 m (1000 ft) on a side and would cover an area of 9.3 ha (23 acres). The building would be 76 m (250 ft) long, 30 m (100 ft) wide, and 18 m (60 ft) high. It would be a metal building constructed on a concrete foundation. The color would be selected to be visually inconspicuous. Normally the building would be unattended. An auxiliary building measuring 18 m (60 ft) by 12 m (40 ft) by 7.5 m (25 ft) high would be located near the converter terminal building to house spare parts for the electronic conversion equipment (ER, Vol. 1).

The terminal building would be surrounded by a switchyard containing electric power equipment and associated structures. The highest structures would be for the transmission line terminations. They would be about 24 m (80 ft) tall for the DC line and 23 m (75 ft) tall for the AC lines. Electric conductor and bus work in the switchyard would be of the modern, open-construction type. All power equipment would be painted a visually inconspicuous color.

Communication to and from the converter terminal would be via a microwave system connected to the existing New England system at an existing station on the Shared Microwave System at the Sandy Pond substation (ER, Vol. 1).

The converter terminal would be connected to NEPOOL's existing AC power system at the Sandy Pond 345-kV AC substation southwest of the terminal site. Two 345-kV AC connector lines, each about 0.5 km (0.3 mi) long, would extend from the converter terminal to the Sandy Pond substation. The connector lines would be supported by single-circuit wood or steel H-frame structures varying from 18 m (60 ft) to 32 m (105 ft) high. Each structure would carry two bundled ACSR conductors per phase (six conductors) and two 1.0-cm (3/8-in) diameter, seven-strand, utility-grade galvanized steel aerial groundwires. Also, one 1.0-cm (3/8-in) diameter, common-grade galvanized steel or #4 Copperweld counterpoise wire would be buried for each connector line.

Dedicated Metallic Return Conductor

Rather than expand the Phase I ground electrode system as part of the proposed Phase II project (as originally planned -- see ER, Vol. 8); the Applicant now plans to install a dedicated metallic return conductor (ER, Supplement, Sept. 29, 1986). Similar to a ground electrode, the dedicated metallic return conductor would correct for current imbalance between the positive and negative halves of the HVDC interconnection and accommodate abnormal operating conditions. The decision to use a dedicated metallic return conductor was based on performance tests for the Phase I ground electrode. The tests were conducted to determine if its operation and subsequent operation as expanded for Phase II would potentially affect pipelines, municipal water system pipes, underground telephone lines, and other systems known to be impacted by underground electric currents. While the Phase I ground electrode would function as planned, the tests indicated that more mitigative measures than originally planned would be required if the ground electrode system were expanded (ER, Supplement, Sept. 29, 1986).

During normal operation of the proposed DC line, the dedicated metallic return conductor would carry less than 20 amperes of electricity at a voltage close to ground potential. In cases of abnormal operating conditions, the voltage of the dedicated metallic return conductor would not exceed 15 kV at a current of 2450 amperes. At this voltage the line would not be in corona (ER, Supplement, Sept. 29, 1986). The dedicated metallic return conductor is expected to be used for abnormal operating conditions 20 to 30 times per year.

2.1.4.2 Construction Activities

Schedule

Design and construction of the proposed Phase II transmission lines, coupled with required relocations of the 115- and 69-kV AC transmission lines, would take place over a 5-year period. The proposed converter terminal would be constructed over a 3-year period.

Design of the proposed DC line began in March 1985 and will continue through 1986; design of the proposed AC lines will continue through the first quarter of 1989 (ER, Vol. 2). Material would be ordered for the transmission lines from August 1986 through August 1989. Construction of the proposed DC line would start in September 1987 and be completed in January 1990. Relocations of the 115- and 69-kV lines would occur between August 1987 and July 1989. The proposed 345-kV AC lines would be constructed between September 1988 and April 1990.

Site preparation for the proposed converter terminal was started early in 1987 (Walker 1986), and should be completed by January 1988. Site foundation work would be completed by October 1988. The building and switchyard structures are expected to be completed by July 1989, with the electrical power equipment to be installed by March 1990. Final facility testing would be completed by July 1990.

Right-of-Way Clearing Practices

As necessary, transmission line rights-of-way would be cleared of trees (with shrubs retained where possible) to facilitate (1) staking, access, assembly, and erection of structures; (2) installation of conductors; and (3) maintenance. This would also provide adequate clearance for energized lines. The clearing program would be planned and implemented to encourage growth of desirable, low-growing plants. This would help stabilize the rights-of-way against erosion and provide for natural vegetation control. Areas requiring clearing are discussed in Section 4.1.4.1.

Generally, tall-growing trees would be cut near ground level, leaving the stumps and roots in place. Stumps would be removed in areas where access roads and structures are to be located. Sawlogs, pulpwood, and cordwood resulting from clearing would be sold or stacked and left at the edge of the right-of-way. Slash would be chipped and removed or spread over designated areas of the right-of-way. In areas inaccessible to logging machinery, felled timber would be left. These practices comply with applicable state regulations (ER, Vols. 2 and 3).

Access Roads and Construction Staging Areas

To the extent possible, existing roads would be used to gain access to project sites, although it is anticipated that some of the roads would need upgrading, such as alignment improvement, grading, and widening. Some new access roads would be required both within the rights-of-way and from existing roads to the rights-of-way. Off-road access may be pursued in special cases to avoid areas such as steep slopes, wetlands, and agricultural areas (ER, Vols. 2 and 3). The number and location of the new access roads have not been determined, but the need for new roads would be limited because most of the proposed transmission lines would be constructed within existing rights-of-way. To the extent possible, construction staging areas would be located at existing cleared areas along the proposed route. However, about 11 sites (no more than five in Massachusetts and no more than six in New Hampshire) would be located from the right-of-way. Attempts would be made to secure abandoned gravel pits, open fields, or railroad sidings for these laydown areas (Reilly 1986).

Methods to mitigate erosion related to construction of access roads and staging areas are listed in Sections 2.1.5.2 and 2.1.5.3.

Support Structure Installation, Framing, and Stringing

In upland areas, construction of support structures would include excavation, setting the structure, and backfilling the excavation. The 345-kV AC H-frame structures would be directly embedded with either locally excavated material or selected clean backfill. The H-frame structures for the ±450-kV DC line would employ concrete cylindrical caisson, spread-footing, or steel grillage foundations. The single-shaft DC structures; single-steel-pole, 345-kV AC structures; and double-circuit, 115-kV AC, single-steel-pole structures would be directly embedded or set in concrete cylindrical caisson foundations. Most steel pole angle structures would require concrete cylindrical caisson foundations.

Directly embedded structures would require excavations ranging from 3 to 7.5 m (10 to 25 ft) deep and 1 to 3.7 m (3 to 12 ft) in diameter. The concrete cylindrical caisson foundations would require excavations 4.6 to 11 m (15 to 35 ft) deep with a 1.8- to 3.7-m (6- to 12-ft) diameter opening. A spread-footing foundation would require an excavation of 4.6 to 9.1 m (15 to 30 ft) in width and length and about 3 to 4.6 m (10 to 15 ft) in depth. The steel grillage foundation would require an excavation 3 to 6 m (10 to 20 ft) by 6 to 9 m (20 to 30 ft) and a depth of 3 to 4.6 m (10 to 15 ft). Grillage of heavy steel members would then be built up from the bottom of the excavation to the original grade. The excavation would be backfilled and legs of the H-frame structure bolted to the exposed members of the grillage (ER, Vols. 2 and 3).

Three methods of structure placement would be used in wetlands. The first is direct embedment within an excavation 1 to 2 m (3 to 7 ft) in diameter and 3 to 9 m (10 to 30 ft) deep. The second method is to drive piles into underlying firm ground and attach the structures to the piles. The third method is to install a concrete foundation and set the structure on the foundation. Site-specific evaluations based on structure types, soil strength, structural loads, environmental impact, and economics would need to be made by the Applicant in determining which structure placement method to use (ER, Vols. 2 and 3).

After support structures were in place, insulators would be installed and aerial groundwires and conductors would be strung. Conductors would be pulled through the stringing blocks by tensioning equipment.

Converter Terminal

Construction of the proposed converter terminal would include (1) site preparation, (2) foundation work, (3) erection of buildings and structures, (4) installation of power equipment, and (5) testing and commissioning. Site preparation would include surveying, clearing, and grading of the terminal site. Where feasible, a buffer zone of uncut vegetation would be left around the site to act as a screen. The cleared site would be covered with a layer of crushed rock to prevent regrowth of vegetation and then would be fenced. Foundation work would include forming and pouring foundations for the buildings and switchyard structures. Concrete and other building materials would be trucked in from offsite. Erection of the buildings and switchyard structures and installation of the electrical power equipment would require cranes, utility trucks, and other construction equipment.

Dedicated Metallic Return Conductor

For the length of the proposed Phase II DC transmission line, the dedicated metallic return conductor would be strung along with the aerial groundwires and conductors. Stringing of the dedicated metallic return conductor along the length of the Phase I DC transmission line would be done with light- and medium-weight trucks. The conductor would be pulled through stringing blocks by tensioning equipment, with all access along existing roads. The transmission line structures for Phase I were designed and constructed so that a return conductor could be installed on them if needed (ER, Supplement, Sept. 29, 1986).

2.1.5 Mitigative Measures Committed to by the Applicant

The following subsections summarize the measures committed to by the Applicant to mitigate the largely transitory impacts of construction and the mostly incremental impacts (i.e., incremental to the impacts of the existing corridor and transmission lines) of operation, and maintenance of proposed project facilities. The environmental consequences of the project, evaluated in Section 4, are based on the assumption that these mitigative measures will be carried out. If DOE determines that an amendment to the Phase I permit is in the public interest, a condition will be placed in that amendment requiring the Applicant to implement the mitigative measures identified in this section.

2.1.5.1 Air Quality and Noise

Practices that the Applicant would implement to mitigate impacts to land and water resources (see below) generally also would help mitigate impacts on air quality and, in some cases, noise. These include the following:

- *Except where transmission lines and an access road enter and leave the proposed converter terminal site, natural vegetation would be left intact between the proposed converter terminal and areas where the public has access.* [While this mitigative measure would primarily minimize ecological and visual impacts, it also would mitigate noise impacts to nearby residents.]

- *The transmission line systems have been designed so that air-quality changes resulting from their operation would be minimal and generally confined to the right-of-way.*

- *Construction work would occur primarily during daylight, which would minimize off-hour noise impacts to nearby residents. Power equipment at the converter terminal site would be designed and located so that the noise at the nearest residence would not be objectionable relative to existing ambient noise levels.*

2.1.5.2 Land Features and Use

<u>Land Features</u>

Impacts related to unstable slopes would be mitigated through the use of careful siting of structures and use of thoroughly supervised construction practices. Judicious siting of project facilities would be employed to minimize the impacts associated with geological instability, such as landslides, slumping, mass wasting, and earthquakes. The following criteria represent specific mitigative measures committed to by the Applicant:

- *To reduce the potential for erosion and mass soil movement, areas that are known to be susceptible to erosion or slope instability would be evaluated during final design. Transmission structures would be located to avoid large areas of steep or unstable slopes wherever practical, and other construction work would, when possible, be conducted in a manner that minimizes changes in natural topography and disturbances of unstable areas. In areas where this is not possible, excess excavated materials not used as backfill would be removed to a suitable disposal site.*

- *Landscape alterations for transmission structure foundations and access roads would be minimized to reduce erosion losses. The converter terminal switchyard would be surfaced with crushed rock. In general, grading and leveling would be avoided at potentially unstable areas.*

- *Typically, excavation for structures would be limited to transmission structure foundation holes and the converter terminal site.* [This is not expected to create other than minor problems of instability.]

- *Existing access roads, bridges, and cleared areas would be used to the extent possible during construction. Construction of new roads would be held to a minimum to ensure the least disturbance to soil, vegetation, and water.*

- *New access roads would follow, wherever practical, the natural contour of land so that excessive cutting and filling would be avoided.*

- *Access roads would be maintained to minimize erosion due to construction traffic, and traffic would be confined to the right-of-way and designated roads.*

- *Overland travel would be minimized where the right-of-way crosses riverbanks or passes close to lakes, wetlands, or other surface waterbodies to minimize potential soil erosion and sediment transport.*

- *In areas subject to erosion, roads used for construction which will not be used for maintenance access would be restored to the original natural contour of the land and revegetated, after construction. Where construction roads will be used for maintenance access, drainage and erosion control devices would be left in place and side slopes would be graded and stabilized to blend with the terrain.*

Land Use

Criteria adopted for routing the proposed transmission lines would tend to limit land-use impacts. For example, the proposed route is direct, thus minimizing the overall length of the lines. Furthermore, the proposed lines would be constructed almost entirely within established rights-of-way, thus essentially maintaining compatibility with existing land-use patterns and minimizing additional impacts to adjacent land uses. Furthermore, the following mitigative measures would be instituted:

- *Wherever possible, placement of transmission structures in agricultural areas would be avoided. Where feasible, the heights of structures would be increased in order to span croplands.*

- *Reasonable attempts would be made to place proposed transmission structures directly opposite to, or in line with, existing structures, thus concentrating structures in one portion of the agricultural area and minimizing inconvenience to operators of farm machinery.*

- *Typically, structures would be self-supporting and no guy wires would be used, thus minimizing the amount of cropland unavailable for production.*

- *After construction, access roads in cropland areas where the soil has been compacted would be loosened through tillage and seeded or left fallow, depending on the land owner's wishes.*

- *Fences and stone walls would be repaired upon completion of construction.*

- *Clearing operations would be supervised by experienced foresters and construction supervisors.*

- *Slash and small trees would be chipped and the material would be either spread over designated areas on the right-of-way or hauled offsite for disposal. At the converter terminal site, grubbed stumps would be hauled offsite and buried. Where practicable, merchantable timber would be cut to length, skidded offsite, and sold.*

- *Wherever possible, construction and maintenance access roads would be located so as to minimize disturbance of residential and commercial areas.*

- *Construction activities would be intermittent and would be spread along the entire length of the proposed lines, thereby reducing the potential for local traffic congestion due to the proposed project.*

- *During line-stringing operations, guard structures would be placed at all highway, railroad, and existing utility line crossings to ensure public safety and minimize disruption of traffic flow patterns.*

- *Construction of the proposed lines would be closely coordinated with affected railroads in order to minimize interference with scheduled rail traffic.*

- *The Federal Aviation Administration would be notified relative to the proximity of proposed lines to airports, and measures required by the FAA would be implemented.*

- *Crossings of the proposed lines over existing transmission lines would be coordinated with owner utilities.*

- *All conductor clearances of the proposed lines over highways, railroads, and existing transmission lines would be in accord with the National Electric Safety Code and appropriate state codes.*

- *Following project construction, the construction laydown and staging areas that had been established at various locations along the proposed transmission line routes would be restored to conditions similar to what existed prior to project construction.*

2.1.5.3 Hydrology, Water Quality, and Water Use

Construction of the transmission line system and use of related access roads could increase soil erosion and stream channel siltation due to alteration of near-surface materials. However, careful location, construction, and maintenance of the transmission facilities and access roads could minimize these adverse impacts. Specific mitigative measures would include the following:

- *Proposed facilities would be designed and constructed so as not to interfere with local drainage patterns.*

- *In general, streambank grading for construction sites and access routes would be avoided; machine clearing would be prohibited within steep-slope areas adjacent to streams; and river fording would be held to a minimum. Streams would be forded only where streambanks and bottom materials were sufficiently stable. Fording by heavy equipment and vehicles would be minimized or avoided where practicable.*

- *Gravel would not be removed from stream bottoms, although it might be moved to enable culvert placement.*

- *As a general practice, transmission line structures and foundations would not be placed in rivers or lakes; structures would be set back as far as practical from riverbanks and streambanks to reduce the potential for erosion and sedimentation; and transmission line facilities would span existing water supply reservoirs.*

- *Where feasible, stream and river crossings would be at or near right angles to the water course. Access roads would be located to avoid streams and wetlands to the extent feasible.*

- *Where practicable, vegetation buffers (native ground cover, brush, and low-growing trees) would be left along streams to stabilize the soil, trap sediments, and thus minimize surface runoff erosion and other adverse impacts to water quality.*

- *Construction sites and access routes would be located to avoid areas of unstable soils, steeply sloped riverbanks, streams, and wetlands wherever feasible.*

- *Excavated soils from structure foundations would not be disposed of in waterbodies.*

- *Construction sites would be prepared in a manner that minimizes erosion and probability of stream or wetland sedimentation.*

- *In the vicinity of streams, existing roads and bridges would be used as much as practical for transporting materials and equipment during construction. Any damage to permanent access roads, bridges, ditches, and culverts caused by transportation of construction equipment or supplies would be repaired.*

- *Culverts, ditches, and waterbars would be installed, as needed, at stream crossings to control surface runoff, maintain existing drainage patterns, and minimize erosion.*

- *Unless they are to be used for transmission-line or right-of-way maintenance, temporary bridges, culverts, and other such facilities would be carefully removed, and the disturbed area restored after project completion.*

2.1.5.4 Ecology

Since herbicide use has the potential to affect both aquatic and terrestrial resources, the Applicant has committed to the following mitigative measures that relate to herbicide use in general and to its use near water bodies:

- *The Applicant would only use herbicides that are registered with the U.S. Environmental Protection Agency and approved for use in right-of-way management by the states in which they are to be applied.*

- *Herbicides would only be applied by means of selective spray application by workers using hand-held application tools, and there would be no broadcast application. Only state-licensed or certified operators would supervise herbicide applications.*

- *No herbicides would be applied to surface waters, and state and company guidelines would be followed which establish buffer zones around sensitive areas (such as public water supplies, wells, and residences). These guidelines specify for each type of sensitive area whether no herbicides would be used, only certain herbicides would be used, or only certain herbicide application methods would be used (see Table B.1 in Appendix B for the current guidelines).*

Terrestrial Vegetation

- *All construction and vehicular activities not involved in right-of-way clearing, transmission line structure construction, or wire stringing would be restricted to designated work areas or access roads.*

- *The growth of herbaceous species, most shrubs, and some low-growing trees that are considered desirable ground cover for the right-of-way would be encouraged.*

- *No equipment containing polychlorinated biphenyls (PCBs) would be located at the converter terminal.*

- *Power transformer equipment containing insulating oil would be placed over pits capable of containing the entire volume of oil.*

Terrestrial Wildlife

The primary means by which impacts to wildlife would be mitigated are by careful routing and design of the transmission lines, including the following considerations:

- *The transmission lines have been designed to minimize corona effects (and hence, minimize air ion production, audible noise, radio and T.V. interference, and ozone production), and the large distances between the conductors and grounded structure parts minimize the likelihood of bird electrocution.*

Aquatic (Including Wetlands)

The mitigative measures discussed in Section 2.1.5.3 to minimize impacts on water quality also would minimize impacts on aquatic ecosystems, including wetlands. Additional details on mitigation of impacts to floodplains and wetlands are provided in Appendix B.

Threatened and Endangered Species

- *Final structure locations and construction schedules would be designed to avoid jeopardizing the continued existence of any endangered or threatened species found along the corridor.*

2.1.5.5 Socioeconomics

In general, socioeconomic impacts are projected to be minor and short term, and no significant mitigative measures have been developed, with the following exception:

- *The Applicant would reduce potential adverse effects to local traffic flows during construction through judicious choice of access roads and prior notification to communities.*

2.1.5.6 Visual Resources

The Applicant has conducted a visual resource characterization study of the natural and man-made features along the rights-of-way involved in this phase of the project (ER, Vols. 7 and 8). These mitigative measures are based, in part, on the results of that study. Mitigation proposed by the Applicant for visual resource impacts consists of measures in four general categories: design and location of structures, right-of-way treatments, measures involving the converter terminal site, and construction laydown and staging areas. Measures related to the design aspects of line structures include the following:

- *Tangent structures would be similar to adjacent existing structures in form and color; line angle steel pole structures would be self-supporting structures to avoid the visual impact of guy wires (lattice steel H-frame structures may require guy wires at line angles and dead ends).*

- *Structure heights would be minimized at points where significant reductions in line visibility could be achieved, consistent with other environmental objectives, such as spanning wetlands, croplands, or cultural resource areas.*

- *Two existing 115-kV lines would be rebuilt as a double-circuit line to minimize the number of structures within the Sandy Pond-Millbury right-of-way and eliminate the need for right-of-way expansion.*

Mitigative measures involving locations of line structures include the following:

- *Where feasible, placement of structures in visually sensitive areas would be avoided. In addition, when feasible, structures would be set back at least 15 m (50 ft) from public roadways.*

- *Where feasible, new structures would generally be located opposite or in line with existing structures to avoid a staggered appearance of structures and promote symmetry within the right-of-way.*

Considerations of right-of-way treatments would include the following:

- *Clearing would be minimized to permit preservation of a tree buffer along the edges of rights-of-way where practicable.*

- *When feasible, indigenous low-growing species would be preserved across rights-of-way at road crossings to provide visual screening. Where feasible, new plantings would be established in selected areas along or across rights-of-way and at the converter terminal at locations where screening would appreciably reduce visual impacts.*

- *Those converter terminal facilities with suitable finish would be painted colors compatible with the surrounding environment.*

- *Following use during construction, the construction and staging areas located along the proposed routes would be reclaimed. Disturbed surfaces would be covered with stockpiled topsoil, if needed, and the overall appearances of the areas would be restored to conditions similar to those existing prior to project construction.*

2.1.5.7 Cultural Resources

The Applicant has conducted a literature/file search for previously recorded cultural resource sites along the proposed route and has conducted field surveys for archeological sites and historic structures (New England Power 1986). (The methodology and results of the surveys are described in Section 3.7). Proposed structure locations have been moved in those cases where archeological sites would lie within the estimated 9.3-m^2 (100-ft^2) construction-impact area. All federal and state regulations pertaining to cultural resources will be adhered to during construction. Additional mitigative measures include the following:

- *The Applicant would conduct further archeological testing, prior to construction, as appropriate should any proposed structure locations be moved to an archeologically sensitive area that has not previously been tested.*

- *Identified surficial cultural features on the right-of-way would be flagged to facilitate avoidance during the construction phase.*

- *The Applicant would assess potential impacts and the need for mitigation measures for adversely affected historic structures in proximity to the proposed rights-of-way in consultation with the New Hampshire and Massachusetts Historic Preservation Officers and, if necessary, the Advisory Council on Historic Preservation (New England Power 1986--p. 11).*

2.1.5.8 Health and Safety

- *Standard work practices and regulations would be followed to ensure the health and safety of workers to the fullest extent possible.*

- *All vegetation clearing, construction, and maintenance activities near public drinking water supplies would be done so as to avoid or minimize changes to water quality or quantity.*

- *Standard utility company practices would be followed where it is necessary to ground stationary objects such as fences, large metal roofs, fuel containers, and antennas that are located under the transmission lines.*

- *Special maintenance practices would be used near public and private wells and near public water supply reservoirs (hand-cutting of vegetation, use of specific herbicides, or specific herbicide application methods).*

- *Limitations on herbicide use established by the states of New Hampshire and Massachusetts would be followed (see Table B.1 in Appendix B for the current limitations).*

2.1.5.9 Radio and Television Interference

Radio and television interference from operation of the proposed AC and DC transmission lines could be mitigated by one or more measures. Mitigation typically involves reorientation, relocation, and/or replacement of receiver antennas. Television interference resulting from the physical presence of transmission facilities is usually also remedied by changes of antenna systems. Interference due to gap sparking is mitigated by routine maintenance of the transmission line facilities.

- As a matter of policy, any television interference problems that can be attributed to the operation of the project facilities would be corrected by the Applicant.

2.1.6 Related Consultation and Permitting Requirements

Consultation with certain federal and state agencies is required by statute. In addition, many federal and state agencies have some degree of responsibility for certain geographical or topical areas addressed in the environmental impact statement (EIS) (U.S. Department of Energy 1984). DOE requested consultation with each of the agencies identified in Table 2.3, and each was invited to contribute information and views to be considered by DOE staff while preparing the EIS. The U.S. Army Corps of Engineers was granted the role of cooperating agency in these proceedings. Table 2.4 presents a list of the federal licenses and/or approvals expected to be sought in connection with the Phase II facilities.

2.2 DESCRIPTION OF ALTERNATIVES TO THE INTERCONNECTION

The decision under consideration by DOE is to grant or deny an amendment to Presidential Permit PP-76 that would authorize an extension of a previously authorized international interconnection to be used for electric power exchanges between NEPOOL and Hydro-Quebec. A granting of the amendment by DOE would result in the construction of the Phase II facilities and the associated economic benefits. A no-action decision on the part of DOE is equivalent to denial of the permit amendment. Upon denial of the permit amendment, the Applicant could choose one of two basic courses of action: (1) maintaining the status quo by also taking no action or (2) pursuing alternatives to the interconnection.

2.2.1 No-action Decision -- Maintain Status Quo

As discussed in Section 1, the benefits associated with the proposed action include a reduction in oil used to generate electricity, a reduction in the cost of electricity in New England, and a reduction in the requirements for future generating capacity additions. If a "no-action" decision were chosen by DOE and the Applicant chose to maintain the status quo by not pursuing an alternative action, the oil consumption, electricity cost, and

Table 2.3. Consultations

Subject Area	Legislation	Agency
Endangered Species	Endangered Species Act of 1973, as amended; state laws	U.S. Fish and Wildlife Service; state agencies
Historic Preservation	Archeological and Historic Preservation Act of 1974; Archeological Resources Protection Act of 1979	State Historic Preservation Offices; Advisory Council on Historic Preservation
Work in Navigable Water	Section 404 of Federal Water Pollution Control Act	Corps of Engineers
Prime and Unique Farmlands	CEQ Memo of August 30, 1976	Soil Conservation Service
Floodplains	Executive Order 11988	Corps of Engineers; state agencies
Wetlands	Executive Order 11990	Corps of Engineers; state agencies
Water Pollution, Air Pollution	Various water pollution and air emissions acts (Federal Water Pollution Control Act, Clean Air, Clean Water Emissions Standards)	U.S. Environmental Protection Agency; state agencies
Land Use	Federal Land Policy and Management Act of 1976	Soil Conservation Service; state agencies
Water Use and Availability	Water Resources Planning Act of 1965; Safe Drinking Water Act; others	Office of Water Policy; state agencies
Soils	Soil and Water Resources Conservation Act of 1977	Soil Conservation Service
Noise	Noise Pollution and Abatement Act of 1970; Noise Control Act of 1972	U.S. Environmental Protection Agency; state agencies
Siting, Planning	State siting acts; county zoning commission regulations	State and county agencies
Solid Wastes	State laws	State agencies
Herbicide Use	State laws	State agencies

Table 2.4. Federal Licenses and Approvals

License/Approval	Agency
Amendment of Presidential Permit for Transmission of Energy at International Boundaries	Department of Energy, Economic Regulatory Administration
Amendment of Energy Export License	Department of Energy, Economic Regulatory Administration
Possible Amendment of Water Power Project License	Federal Energy Regulatory Commission
Rate Schedules and Financing[a]	Federal Energy Regulatory Commission
Dredge or Fill	Army Corps of Engineers
Cross Navigable Waters	Army Corps of Engineers
Possible National Pollutant Discharge Elimination System Permit	Environmental Protection Agency and Massachusetts Department of Environmental Quality Engineering, Division of Water Pollution Control
Notice of Construction Affecting Navigable Airspace	Federal Aviation Administration
Microwave Facilities	Federal Communications Commission
Financing and Transactions between Affiliates[a]	Securities and Exchange Commission

[a] These licenses/approvals are related to financing and corporate matters as distinguished from construction-type licenses or approvals.

capacity requirement savings associated with the proposed action would not occur. This would mean the New England region would continue to rely on the use of oil for the production of approximately 34% of its 1995 electric energy requirements. This would increase oil consumption by approximately 12 million barrels per year over that which would be required if the Phase II interconnection were in service. Without the Phase II interconnection, New England oil consumption for electric generation is projected to be approximately 71 million barrels in 1995.

In addition, the unrealized savings in fuel costs and incremental energy losses, and the loss of 900 MW of capacity benefits would combine to increase the cost of producing electricity in New England by approximately $948 million (cumulative present worth, 1990 dollars) over the 10-year period of the Phase II contract.

Another impact of maintaining the status quo would be a reduction in the planned generating reserve margins on the NEPOOL system. Without the 900-MW capacity benefit of the Phase II firm energy contract, NEPOOL reserve margins would fall below 25% by the summer of 1992 and below 20% by the summer of 1993 (see Table 1.6). Although these levels of reserves would not necessarily render he NEPOOL system unreliable to the point of causing blackouts, they are below the level of reserves historically maintained on the NEPOOL system. In fact, even with the Phase II facilities in service, NEPOOL reserve margins are projected to fall below 25% by 1993 and below 20% by 1995. These reserve margins indicate that the NEPOOL utilities must pursue other supply options even if the Phase II project comes to fruition.

2.2.2 No-action Decision -- Pursue Alternative Actions

As indicated in the previous section, it is unlikely that the Applicant would respond to a no-action decision by DOE by maintaining the status quo. The reserve margin analysis in Table 1.6 already assumes the development of approximately 1,700 MW of cogeneration and the use of load management to reduce peak demand by 769 MW by the year 1992. Even with these resource additions and demand reductions, without the 900-MW capacity benefit of Phase II, NEPOOL would need to add an additional 500 MW of capacity by 1992 in order to achieve a 25% reserve margin.

The following alternatives to the proposed Phase II facilities are evaluated on the basis of cost, environmental impact, timeliness, and oil-reducing capability.

2.2.2.1 Construction and Operation of a New, Conventional Central Station Generating Facility

One of the alternatives to be considered is the construction of a new central-station, non-oil-fired generating plant. Candidate plant types would be nuclear and coal. The available data suggest that a hydroelectric facility of the required size is not a viable candidate plant type for consideration as an alternative. (See Section 2.2.2.5 for discussion of small, decentralized energy sources; nonconventional energy sources -- such as biomass, solar, and wind, etc. -- are discussed in Section 2.2.2.3.)

While construction of a non-oil-fired generating plant could achieve the same level of reduction in oil consumption as the proposed action, the time required to license and construct such a plant (either nuclear or coal-fired) would not permit placing these alternatives in service before the mid to late-1990s. The Energy Information Administration has found that the amount of time required to license and build a new nuclear plant is between 10 and 15 years. Also, the average lead time for a new coal-fired plant is 8 years (Energy Information Administration 1984). This means that it is not likely that a new coal-fired plant could be placed in service before 1995, and that the earliest in-service date for a new nuclear plant would be 1997. Neither of these plant types could be placed in service in time to supplement the sub-25% reserve margins which would exist in 1992 if DOE were to deny the requested amendment.

In addition to coal and nuclear units not being viable alternatives due to lead time requirements, a comparison of the life-cycle costs of energy from new non-oil-fired generating plants and the proposed transmission project favor the proposed action. An analysis conducted by DOE Staff concluded that the levelized cost (including capital costs, O&M, and fuel costs) of the energy to be imported over the proposed interconnection is estimated to be 4.85¢/kWh in 1990 dollars. Further analysis by DOE Staff found the projected cost of energy from nuclear and coal-fired plants in 1990 to be 13.14¢/kWh and 9.35¢/kWh, respectively (Energy Information Administration 1982; Committee for Technical and Economic Studies 1985).

Construction and operation of a new, centralized generating facility (coal or nuclear) would result in generally different environmental impacts from those associated with the proposed interconnection extension. These impacts would be highly site- and design-specific. Because the construction of a coal-fired or nuclear plant can be dismissed as a viable alternative on the basis of timeliness and cost, a detailed, site-specific analysis of the environmental impacts of these plant types is not warranted. (However, it should be noted that during the construction of a nuclear or coal-fired generating plant, certain mitigative measures would be employed in order to bring any potential impacts to within the limits established by the Environmental Protection Agency.)

Features of a coal-fired powerplant that have the greatest potential for adverse environmental impacts include mining, cleaning, and storage of coal, emission of particulate and gaseous combustion products, disposal of fly ash and flue-gas desulfurization sludge, and release of thermal effluents to aquatic systems (Dvorak et al. 1978). Mining, cleaning, and storage of coal result in land disturbance, noise, and releases of toxic liquid effluents (often termed acid drainage) into surface waters. Disposal of combustion products (ash and desulfurization sludge) requires sizable land areas and has the potential to adversely affect groundwater, soils, and aquatic systems. The toxic effects of air pollutants from combustion emissions (sulfur dioxide, nitrogen oxides, and particulates) on plants and animals can be significant. Acid precipitation, a secondary effect of combustion emissions, is suspected to cause direct and indirect impacts on terrestrial and aquatic ecosystems. Release of heated condenser cooling water to aquatic systems has the potential to be detrimental to fish, shellfish, and other aquatic organisms. Visual impacts would also result from the powerplant and its associated structures, as well as visible emissions from smokestacks and cooling towers (if any). In addition, new transmission lines would need to be built from the new central-station power source. The effects of construction of new transmission lines associated with the new powerplant would be qualitatively similar to those discussed for the proposed interconnection extension.

The most significant environmental concern associated with a coal-fired generating facility of a size that would produce power equal to that supplied by the proposed extension would probably be combustion emissions. Localized deterioration of air quality in terms of sulfur dioxide and particulates would likely result from operation of a plant of that capacity (Dvorak et al. 1978). Although the level of combustion emissions would be brought to within prescribed limits by the use of appropriate emission control strategies, the net emissions would be greater than for the proposed action, which does not require the combustion of fossil fuel.

Air-quality impacts from an operating nuclear plant are negligible, but land disturbance for plant and transmission facilities would be similar to that for a coal-fired plant, as would the potential thermal effects to aquatic systems. Currently, no new nuclear plants are under construction-license consideration by the U.S. Nuclear Regulatory Commission beyond Seabrook I and Millstone 3.

2.2.2.2 Refurbishment of Older Generating Units

The report "NEPOOL Forecast of Capacity, Energy, Loads and Transmission, 1986-2001" (NEPOOL 1986) shows that by 1988 utilities in the New England region will have placed approximately 467 MW of capacity on deactivated status. In addition, NEPOOL utilities have plans to retire approximately 458 MW of existing capacity by 1989. Refurbishment of these units would add about 925 MW to NEPOOL's generating capacity by the early 1990s.

This alternative could replace the 900 MW capacity credit for Phase II that NEPOOL would lose by a no-action decision by DOE. However, all of the capacity under consideration is oil-fired. Refurbishment and continued operation of these units would exacerbate the oil dependency of the New England region and possibly contribute to higher electricity costs. (The fuel cost component of total bus bar costs of refurbished oil-fired units would be a least 20% higher than the cost of energy from the Phase II contract. Capital costs for refurbishing older generating units could only be determined on a case-by-case basis.)

Furthermore, even if all possible refurbishments were pursued (and the permit for Phase II were denied) NEPOOL would still be approximately 330 MW deficient in the amount of generating capacity required to meet a 25% reserve margin in 1993. On the other hand, even if the permit for the Phase II facilities were granted, NEPOOL utilities likely would consider delaying some planned retirements and returning some previously deactivated units to service in order to meet reserve margin requirements in 1993 and beyond. Therefore, when considering capacity requirements, generating unit refurbishment is not likely to be an alternative to the Phase II project but a supplemental source of capacity even if the permit for Phase II were granted.

The environmental impacts of operating refurbished units likely would be greater than construction of the Phase II facilities. Each of the refurbished units would be burning oil with some resulting airborne emissions of sulfur dioxide and ash. In addition, there would be a certain amount of thermal discharge associated with the cooling cycle of thermal generating plants. It is not possible to determine the exact amount of emissions without unit-specific analyses. Some of the units which were retired or deactivated may be required to have emission-control equipment retrofitted. This would depend upon governing state and federal regulations and whether offsetting emissions were considered when the units were originally retired or deactivated. However, in general a net increase in airborne and thermal emissions could be expected for this alternative.

2.2.2.3 Construction and Operation of Nonconventional Generating Facilities

Solar-, wind-, and biomass-powered facilities of a size required to meet the energy supply level of the proposed interconnection cannot be considered as alternatives to the proposed action. The optimum technologies for the exploitation of these energy sources will not be available in time to allow oil backout in the same quantity or time frame as the proposed project. Furthermore, because New England will continue to rely on oil for at least 15% of its electric energy needs even with the proposed project in service, these technologies can be considered as additional oil-saving measures rather than alternatives to the proposed action. Notwithstanding, these fuels are now available and will be used increasingly at small, dispersed sites throughout New England (U.S. Department of Energy 1981). Dispersed use of these technologies is discussed in Section 2.2.2.5.

2.2.2.4 Conservation and Load Management

Implementation of conservation measures (e.g., insulation, weatherization, energy-efficient appliances or machinery, and more efficient lighting and heating) in any of the customer classes (residential, industrial, or commercial) results in less energy use, which may be translated into less demand for energy produced by oil-fired generating capacity.

Load management is a method to increase the base load by reducing peak power demands while filling in low demand periods of the load cycle. This more effective use of utility generating capacity is accomplished by attempting to alter customer use patterns (ER, Vol. 6). While load management initiatives have reduced, and will continue to reduce, energy demands, expected growth rates for electricity consumption are still projected to be high enough to require significant new sources of non-oil-fired generation.

Electric energy demand projections for the NEPOOL service area (see Section 1) include the assumption that by the year 2000 the effects of conservation by NEPOOL customers and utility load management and conservation programs will reduce the demand for electricity by 1000 MW from what customer demand otherwise would be without these programs in place. Therefore, the benefits of the proposed interconnection are in addition to any benefits derived from conservation and load management, and the proposed project does not preclude further pursuance of these programs.

2.2.2.5 Decentralized Energy Sources

Dispersed applications of various small-scale energy technologies -- e.g., (1) solar, primarily for single-residence or business applications of solar water or space heating, and photovoltaic power generation; (2) wind-electric generation; (3) low-head hydroelectric installations; (4) cogeneration; and (5) wood stoves for home and business space heating -- also could decrease electric energy demand and reduce the need for oil-based electric energy.

The member companies of NEPOOL are pursuing the development of alternative generation sources, and projected contributions from these sources have been included in the planning studies. For example, the resource plans submitted by the Applicant (NEPOOL 1986) also indicate the possibility of two additional cogeneration projects -- one in Vermont and one in Rhode Island. Each project is slated to burn natural gas and each would be 230 MW. This 460 MW would be in addition to the 1,700 MW of cogeneration already included in the reserve margins in Table 1.6. This alternative would provide the needed capacity and would also help reduce the use of oil in New England, although only about one-third as much as Phase II. However, the development of these facilities will be by an entity other than the Applicant. Therefore, the Applicant could not be assured of the availability of these resources in time for the 1992 summer peak.

Also, New England Electric began purchasing power (about 15 MW) from the Lawrence hydroelectric project in September 1981. Several other small hydroelectric projects are also in the development/construction stages, but these will produce less than 50 MW of capacity (ER, Vo. 6). Furthermore, a 1981 study by the New England River Basins Commission (1981) concluded that the entire New England region had the potential for developing only 144 MW of new hydroelectric facilities at 130 sites throughout the region.

New England Electric also was involved in the construction of the U.S. Windpower Windfarm at Crotched Mountain, New Hampshire, where 20 wind machines had a total installed capacity of 1 MW. While this development did not meet expectations, new windfarms near Canaan, New Hampshire, and Florida, Massachusetts, are in developmental stages (ER, Vol. 6). New England Electric also has a power swap/cogeneration arrangement with United Shoe Machinery, is cooperating in a photovoltaics project at the Beverly High School, and recently signed a special cogeneration agreement with Brown University in Rhode Island. New England Electric has signed contracts to purchase power from a number of planned alternative energy projects, including three resource-recovery facilities. Other NEPOOL companies have similar programs. Many of these alternative energy projects are similar to the pool-to-pool transfers over the proposed interconnection because they provide energy and displace oil, but they provide little or no capacity. Data Resources, Inc.

(1985--Table A-62) estimates that solar energy and other decentralized sources will contribute less than 0.1 MW to New England sources of electricity supply through the year 2000.

However, estimates by DOE suggest that a combination of solar, wind generation, low-head hydro, wood-burning stoves, and cogeneration possibly could account for up to 2,700 MW of capacity within NEPOOL by the year 1990 (U.S. Department of Energy 1981). These estimates assume that appropriate economic incentives will exist and that institutional, legislative, and unknown technical matters will not hinder implementation. The above analysis also may be overly optimistic in that it would require a concerted and coordinated effort involving the public, commercial/industrial interests, and a number of individual utilities. At any rate, even if all of the above capacity were implemented, NEPOOL would still be sufficiently dependent upon oil-fired generation for the proposed project to provide the projected oil savings and fuel-cost savings identified in Section 1. For example, 2,700 MW of dispersed, small-scale capacity operating at a 60% utilization factor would produce 14.2 million MWh of energy per year. As shown in Table 1.5, this would still leave 10.5 million MWh of oil-fired generation on the NEPOOL system by 1994. The firm energy contract associated with Phase II of the New England/Hydro-Quebec interconnection would only supply 7 million MWh of this remaining oil-based energy. Therefore, the alternatives discussed above cannot be considered alternatives to the proposed project, but simply additional ways to meet the overall objective of reduction in oil-fired generation.

2.2.2.6 Fuel Conversion

Pursuant to implementation of the Powerplant and Industrial Fuel Use Act of 1978 (FUA--Public Law 95-620), DOE evaluated the benefits and environmental effects of converting up to 42 powerplants in the northeastern United States from the use of oil and natural gas to the use of coal (U.S. Department of Energy 1981, 1982). It was concluded that as many as 27 powerplants could qualify for the voluntary conversion provisions of the Omnibus Budget Reconciliation Act of 1981 (U.S. Department of Energy 1982). A number of the plants identified were in the NEPOOL region. However, to date only 12 of these 27 powerplants have been converted. The utilities in New England are not actively pursuing conversion of the remaining plants because of scheduled retirements, site limitations, or economic considerations. Therefore, the approval or denial of a Presidential permit amendment for the proposed transmission project would neither preclude nor promote additional coal conversion activities. Furthermore, future conversions could be considered complementary rather than alternatives to the proposed action since coal conversions would reduce the average cost of fossil-fired electric generation in New England and thereby reduce the cost of energy purchased under the terms of the Phase II agreement.

2.2.2.7 Purchase of Power From Other Utilities

Presently, several NEPOOL members purchase power from the New York Power Authority (NYPA), Hydro-Quebec, the New Brunswick Electric Power Commission (NBEPC), and, to a limited extent, Ontario Hydro. The search for alternative sources of purchased power can be broken down into two areas: contiguous utility systems and systems which are far removed from NEPOOL. However, in order to be considered a viable alternative, a potential source must be able to provide NEPOOL with a comparable quantity of firm (guaranteed) energy at prices which are competitive with those of the Phase II agreement.

One of the contiguous utility systems which is a potential source of purchased power is the New York Power Pool (NYPP). NYPP consists of the major electric utilities in New York State. NYPP is heavily dependent upon oil for the production of electric energy and is presently a competitor of NEPOOL for the surplus hydroelectric energy available in Canada and the coal-fired surpluses in the midwestern United States.

Several NEPOOL members currently purchase power from the Point Lepreau Unit #1 nuclear generating unit, which is owned and operated by the NBEPC. Provincial officials in New Brunswick have indicated an interest in constructing a second unit at Point Lepreau if U.S. utilities would be willing to purchase a sufficiently large portion of the output of the unit. NEPOOL has determined that the total cost of energy from this second unit would be about 80% more expensive than the energy from the Phase II agreement. In addition, the delivery of energy from this unit to the load center in Massachusetts likely would require the construction of a 345-kV AC transmission line through the state of Maine. The DOE Staff has reviewed this assessment and has determined that, while the magnitude of the cost differential between Phase II energy and Point Lepreau #2 energy appears to be somewhat overstated (when one considers the projected cost of energy from U.S. nuclear plants), the relative economics do appear to favor the Phase II energy. Furthermore, the 345-kV transmission line required to implement this alternative would be approximately 290 km (180 mi) long, possibly not along existing rights-of-way, and would likely result in greater environmental impact.

The Midwest is considered another potential source of purchased power because of its present surplus of non-oil-fired capacity. The Midwest generally is considered to include the utilities within the East Central Area Reliability Council (ECAR). ECAR is another of the nine regional reliability councils of the North American Electric Reliability Council. This council includes electric utilities in Michigan, Indiana, Ohio, Kentucky, West Virginia, and parts of Virginia and Pennsylvania. Several factors that preclude consideration of Midwest energy as a viable alternative to the proposed action are as follows:

(1) Load and capacity projections indicate that the present capacity surpluses enjoyed by the ECAR utilities would not last long enough to sustain a firm energy sale to NEPOOL through the 1990s.

(2) Any available surpluses are likely to be purchased by utilities in the Pennsylvania-New Jersey-Maryland region (PJM) which have existing direct transmission connections to ECAR utilities.

(3) Any power purchased from ECAR must follow through the central New York State and PJM systems. The transmission systems in these areas are already heavily utilized and could not withstand the additional load imposed by wheeling Midwest energy to New England.

(4) The construction of additional transmission through New York and/or the states of the PJM systems could meet with various regulatory, legal, and environmental obstacles which could prevent or delay implementation and raise the final cost of the energy.

However, an analysis performed by the Applicant indicates that, notwithstanding the above logistical impediments to the purchase of Midwest power, the total cost of energy delivered to New England would be almost double that of the Phase II agreement. The DOE Staff has reviewed this analysis and is in agreement with this conclusion.

2.2.3 Description of Alternative Converter Terminal Sites, Routes, and Designs

Potential alternative routes were identified by the Applicant on the basis of existing rights-of-way, as discussed in Section 2.1.2. Based on these considerations, the Applicant's analyses initially identified six potential converter terminal sites and three potential DC corridor routes (ER, Vol. 4). These alternatives were then evaluated based on a number of environmental and economic considerations. The DOE Staff has reviewed the methodology and rationale employed by the Applicant in evaluating alternatives, and based on that review concludes that the alternatives identified by the Applicant are viable and provide an adequate basis for comparative evaluation with the proposed route and proposed converter terminal site.

2.2.3.1 Converter Terminal Options

Options for converter terminal locations were initially determined on the basis of system reliability (ER, Vol. 4). This criterion was then used in conjunction with economic considerations and the occurrence of existing transmission corridors to rank terminal locations. No feasible alternative to the northern terminus for the proposed Phase II project exists. Siting of the northern terminus at any location other than at the proposed Comerford terminal site at Monroe, New Hampshire, would necessitate construction of a new DC line from the Canadian border. Also, full capacity utilization of the Phase I DC transmission line could be achieved only with the northern terminus for the Phase II project located at the Comerford terminal site (ER, Vol. 4).

Six potential site areas were identified for the Phase II converter terminal: Monroe and Londonderry, New Hampshire; Ludlow, Millbury, Tewksbury, and Groton/Ayer, Massachusetts. These site areas were chosen because they provided a wide geographic range in identifying an economically optimal network or because they were located near the site of an AC substation. Based on these considerations, only the proposed Sandy Pond site at Groton/Ayer and the alternative site area of at Tewksbury were deemed feasible. This decision was based primarily on economic considerations (ER, Vol. 4). The economic considerations also translate into environmental, social, land use, and other considerations, because the extra costs are primarily associated with forest clearing, wetland modification, land condemnation, and similar activities.

Criteria deemed necessary for a converter terminal site at Tewksbury were that the site must be (1) at least 14 ha (35 acres) in size; (2) within 1.6 km (1-mi) of the New Hampshire-to-Tewksbury transmission line right-of-way and not too far south or west of the right-of-way (so as to avoid the need to acquire much new right-of-way and to minimize the number of transmission lines on a single right-of-way); (3) owned by the Applicant or capable of being placed under option in a reasonably prompt time frame; and (4) capable of being permitted, if necessary, in time to allow construction of the terminal to start on schedule (Lindsay 1986).

Based on the above criteria, nine sites were identified -- five in Dracut and four in Tewksbury. The Dracut sites were ruled out due to their proximity to wetlands and/or large housing sites, anticipated difficulties in site development, and anticipated difficulties in obtaining the requisite purchase options in sufficient time. Three of the Tewksbury sites were ruled out-- one because the property options could not be obtained in time and the site would have been located near two housing developments; one because the site would have required filling of about 5 ha (12 acres) of wetland and thus necessitating the creation of compensatory flood storage; and one because the site would have required filling of a similar area of wetlands but no additional land would be available to create a compensating floodwater storage area (Lindsay 1986).

The alternative Tewksbury converter terminal site chosen would be located near the existing Tewksbury 345-kV AC substation. This site is about 32 km (20 mi) east of the proposed converter terminal site. Land area, equipment, grounding system, communication system, and other facilities that would be required for the Tewksbury converter terminal are the same as, or similar to, those needed for the proposed Sandy Pond converter terminal (see Section 2.1). The major differences between the two terminals relates to development of the facilities. The Tewksbury terminal would require construction in a wetland and floodplain. Also, because the Tewksbury site is located in an area of numerous existing overhead transmission lines, ground-surface-installed sulfur hexafluoride bus ducts would have to be used for the two 345-kV AC circuit connections with the Tewksbury 345-kV AC substation (ER, Vol. 1). The connector circuits would each be about 0.6 km (0.4 mi) long.

2.2.3.2 AC Reinforcements

Essentially the same two AC transmission system reinforcements as proposed would be required whether the converter terminal were located at Sandy Pond or at Tewksbury. The proposed AC system is described in Section 2.1.4.1.

2.2.3.3 DC Route Alternatives

On the basis of the criteria discussed in Section 2.1.2, three alternative routes for the DC line have been identified: (1) the Tewksbury alternative (Figures 2.5 and 2.6), (2) the eastern alternative (Figures 2.7 and 2.8), and (3) the western alternative (Figures 2.9 and 2.10).

The Tewksbury alternative would involve use of the alternative Tewksbury converter site and provide as direct as possible routing of the DC line from Comerford to Tewksbury. The eastern alternative would utilize the nearest north-south right-of-way east of the proposed DC route, and would terminate at the proposed Sandy Pond terminal. Similarly, the western alternative would utilize the nearest existing north-south right-of-way west of the proposed DC line.

The first 181 km (112.5 mi) of the Tewksbury route (to the town of Hudson, New Hampshire) would be the same as the proposed DC route (see Section 2.1.3). The remaining 23.5 km (14.6 mi) of the Tewksbury route would extend within an existing right-of-way southeasterly to the alternative Tewksbury terminal site. This segment would parallel two 230-kV AC transmission lines. A 115-kV AC line presently located between the 230-kV lines would have to be relocated for a 15.1-km (9.4-mi) segment between Hudson, New Hampshire, and Dracut, Massachusetts. Additionally, a 7.2-km (4.5-mi) stretch from Dracut to Tewksbury would require relocation of an existing 230-kV AC line and a planned 345-kV AC line would be mounted on double-circuit, single-pole structures.

The eastern alternative would extend for 248 km (154 mi) from the Comerford terminal to the proposed Sandy Pond terminal site. Most of the route would be along existing rights-of-way. However, in many cases these rights-of-way are too narrow to accommodate the new DC line, and thus significant right-of-way acquisition and clearing would be required (ER, Vol. 4--p. 55). From the Comerford terminal, the eastern alternative would follow existing rights-of-way east and south for about 163 km (101 mi) to the vicinity of the Merrimack station in Bow, New Hampshire. These rights-of-way are occupied primarily by 115-kV AC lines and intermittently by a 60-kV AC

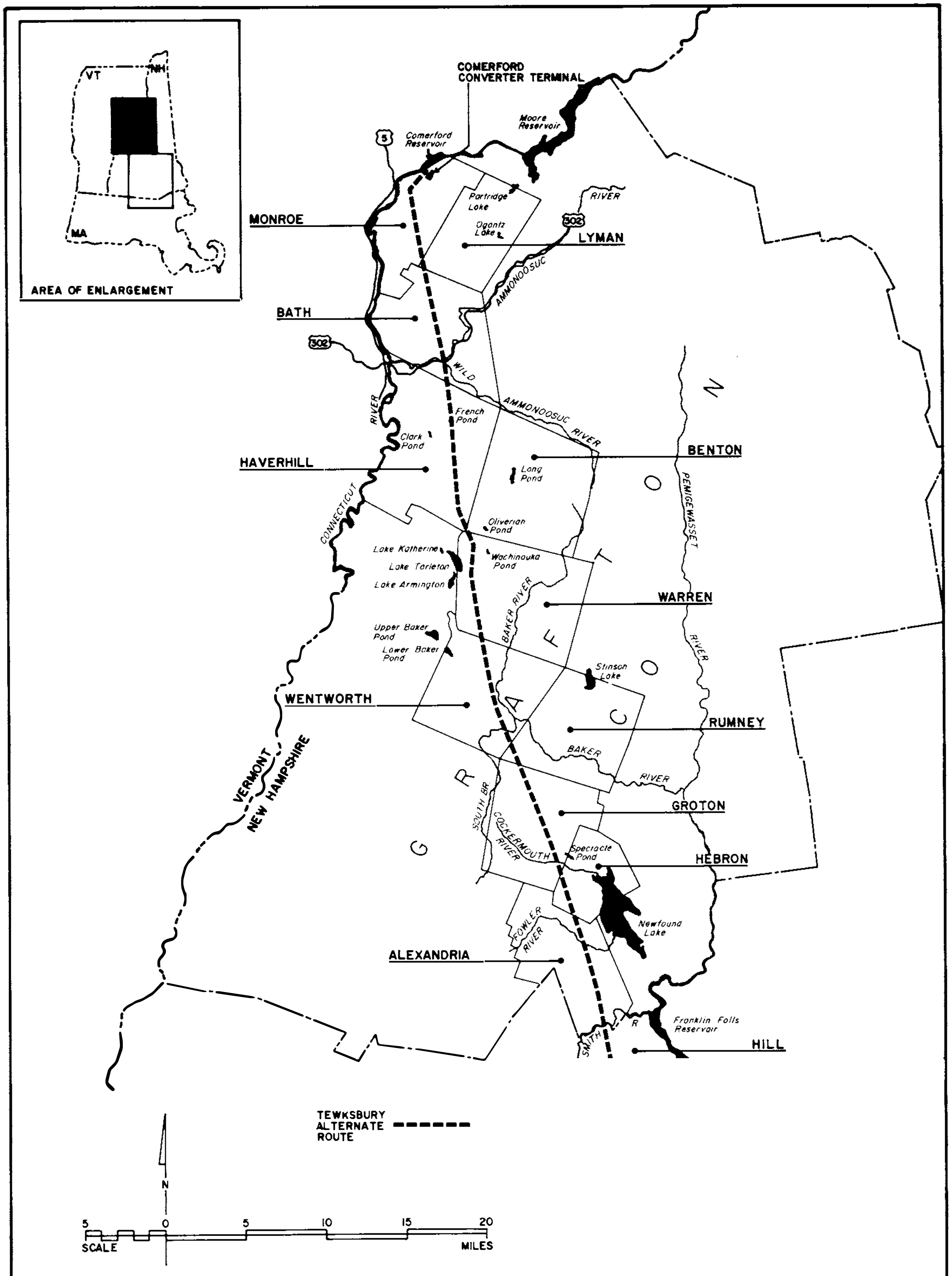

Figure 2.5. Northern Segment of the Tewksbury Alternative Route. (Map provided by the Applicant.)

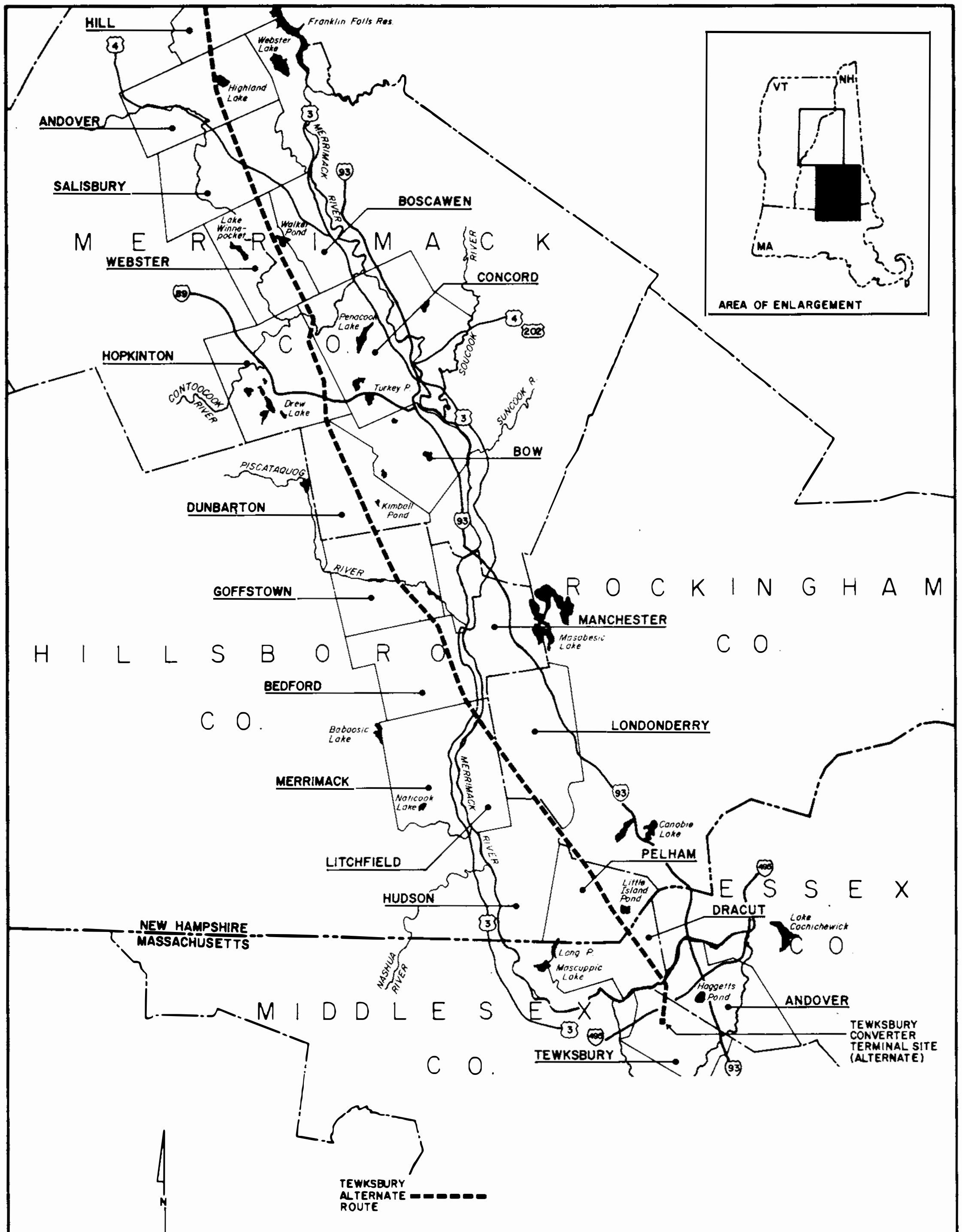

Figure 2.6. Southern Segment of the Tewksbury Alternative Route. (Map provided by the Applicant.)

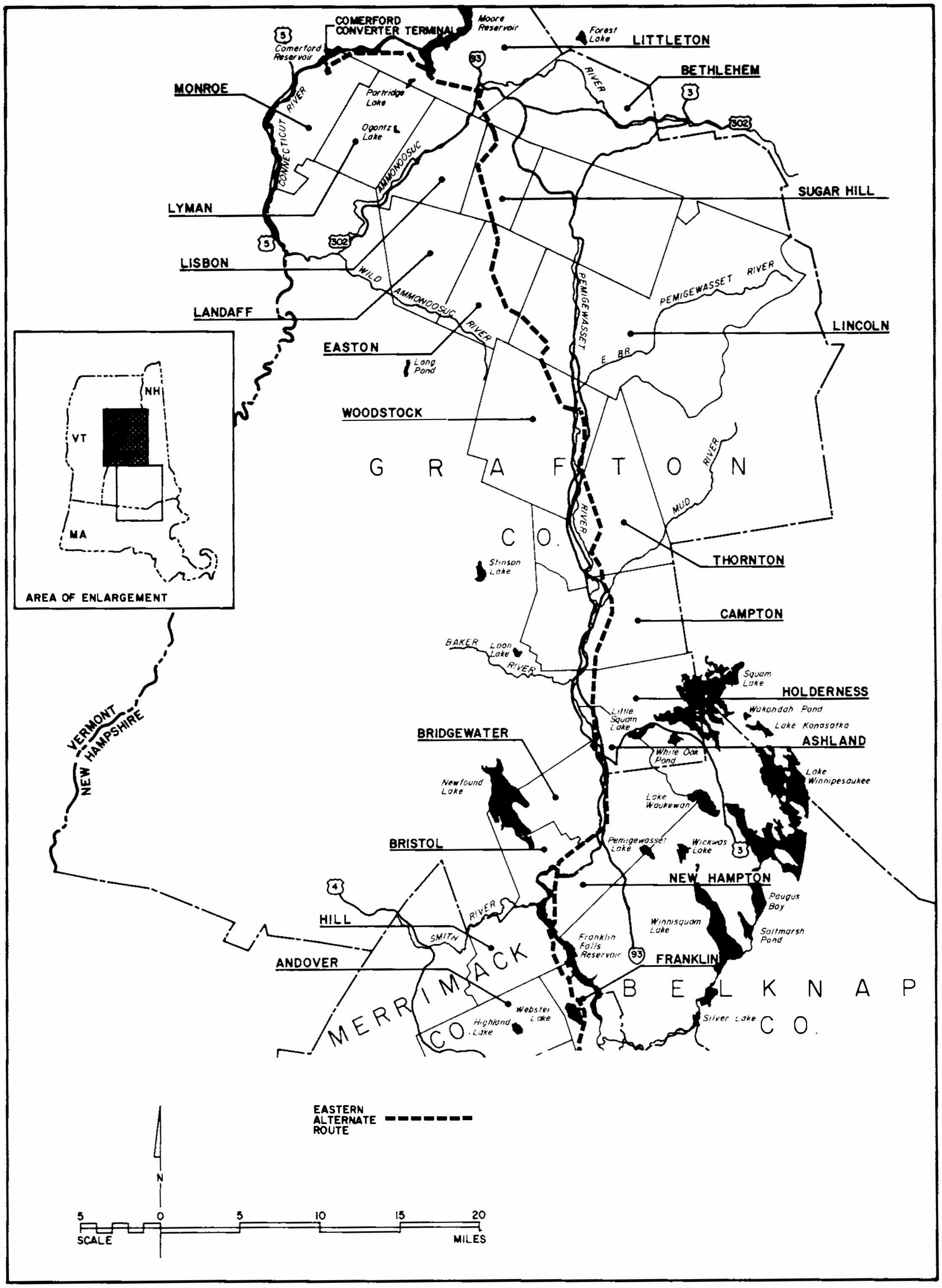

Figure 2.7. Northern Segment of the Eastern Alternative Route. (Map provided by the Applicant.)

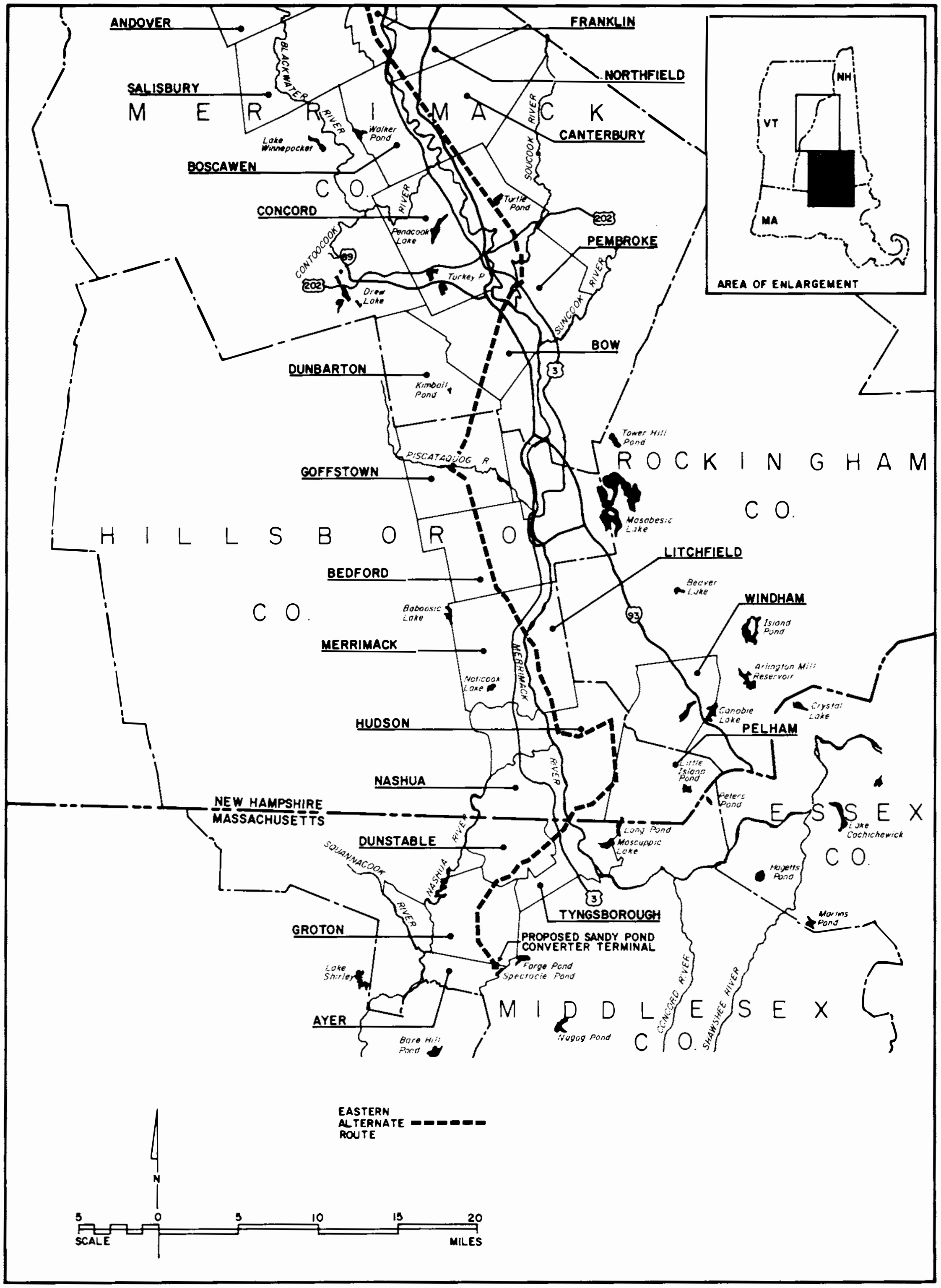

Figure 2.8. Southern Segment of the Eastern Alternative Route. (Map provided by the Applicant.)

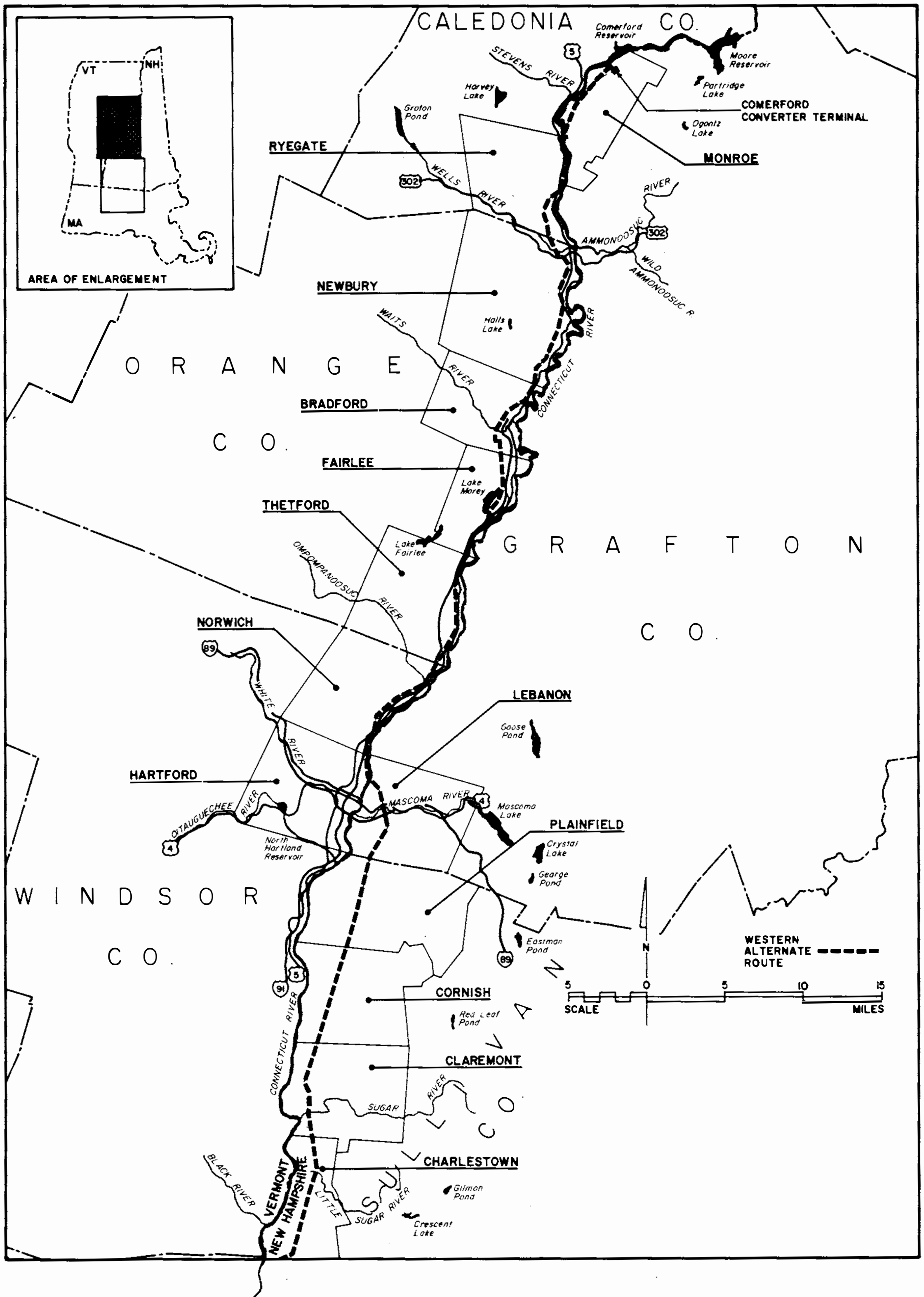

Figure 2.9. Northern Segment of the Western Alternative Route. (Map provided by the Applicant.)

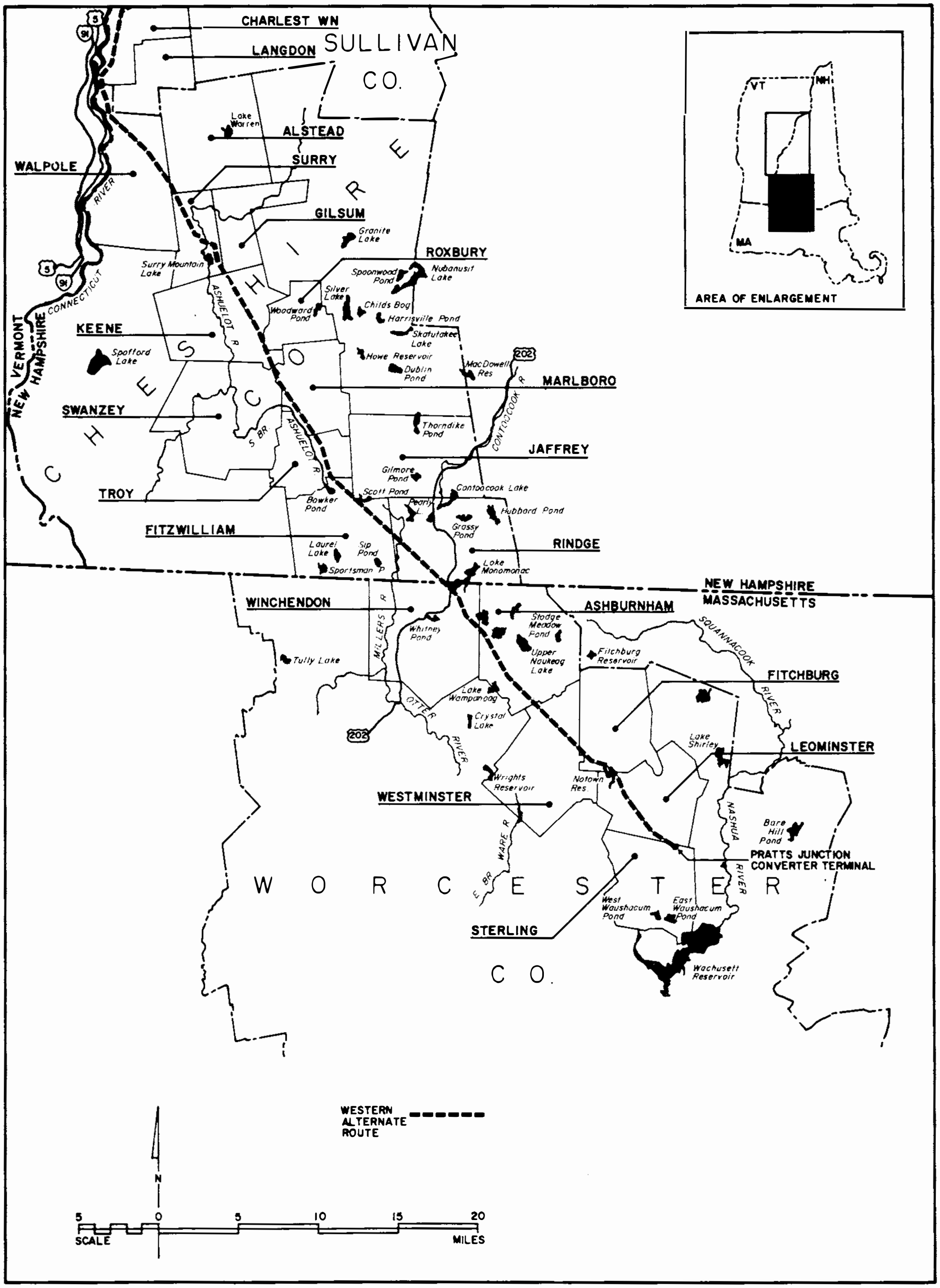

Figure 2.10. Southern Segment of the Western Alternative Route. (Map provided by the Applicant.)

line. The eastern alternative would then follow existing right-of-way southwest for about 53 km (33 mi), crossing the proposed route near the Greggs substation in Goffstown, New Hampshire, and then would proceed southeast until it joined the right-of-way of the proposed DC line in Hudson, New Hampshire. This stretch is occupied primarily by 115-kV AC lines and intermittently by low-voltage lines. The remaining 32 km (20 mi) of the eastern alternative would be identical to the proposed route (see Section 2.1.3).

The western alternative would extend for 246 km (153 mi) from the Comerford terminal to the Phase II converter terminal site. Similar to the case for the eastern alternative, the need to widen the existing rights-of-way to accommodate the new DC line would necessitate significant right-of-way acquisition and clearing along the western alternative route. From Comerford, the route would extend about 87 km (54 mi) southwest along existing right-of-way to the Wilder hydroelectric generating station in Hartford, Vermont. The existing right-of-way is occupied primarily by 34.5- to 46-kV AC lines. This right-of-way follows the Connecticut River Valley in Vermont for about 76 km (47 mi). For the next 64 km (40 mi), the western alternative would extend south within an existing right-of-way paralleling the Connecticut River Valley on the New Hampshire side to Walpole, New Hampshire. A 115-kV AC line currently occupies this right-of-way. The western alternative would parallel a double-circuit, 115-kV AC line for about 95 km (59 mi) to the Pratts Junction substation (69/115/230-kV AC) in Sterling, Massachusetts. Various segments of the 115-kV line would require relocation. Rather than running the Western alternative back north about 24 km (15 mi) to the proposed Sandy Pond converter terminal site, the Applicant would construct a converter terminal adjacent to the Pratts Junction substation. A new 345-kV AC substation at Pratts Junction would also have to be constructed to connect the converter terminal to the 345-kV AC transmission system (ER, Vol. 4).

2.2.3.4 Design Alternatives

Several alternative structure designs were considered for the DC line: steel-pole H-frame, steel-pole single-shaft, lattice steel waist-type, and lattice steel H-frame (ER, Vol. 4). These alternatives would only be practical for the northern 181 km (113 mi) of the DC line, but were not chosen due to economic and environmental considerations (ER, Vol. 4). The proposed single-shaft steel pole is the only structure type that could be used on the remainder of the DC line that would not require acquisition of additional right-of-way.

2.2.3.5 Underground Transmission System

Installing the transmission lines underground is a technically feasible alternative to construction of the proposed overhead transmission lines. However, environmental impacts and construction costs would be greater and system reliability would be lower for an underground system than for overhead systems (see Section 2.3 and ER, Vol. 4).

An underground DC line would require one bipole circuit (two cables) and one spare cable. Self-contained, oil-filled cables would be installed in a continuous trench. The trench would be at least 1.2 m (4 ft) wide and 1.5 m (5 ft) deep, with the cables placed at least 1.1 m (3.5 ft) below ground level. Thermal sand and clean backfill would be used to refill the trench. The land over and in the vicinity of the line would have to be maintained free of trees and shrubs. Improved access would also be required for the length of the line (ER, Vol. 4).

An underground 345-kV AC transmission line would require three parallel, high-pressure, oil-filled, pipe-type cables. They would be installed in a continuous trench similar to the trench for an underground DC line. Backfilling would also be similar to that for a DC line. Cable splices would be required every 0.8 km (0.5 mi) and aboveground oil pumping stations every 8 to 16 km (5 to 10 mi). One or more aboveground reactive compensation stations would also be needed. Access and ground maintenance requirements would be similar to those for an underground DC line (ER, Vol. 4).

For either line (DC or AC) to be constructed underground, a continuous work area generally about 12 m (40 ft) wide would be required. Additionally, new right-of-way acquisition would be required where the lines would have to deviate from existing rights-of-way (e.g., at archeological sites, lakes, wetlands, steep slopes, areas of high erosion, and areas of rocky terrain) (ER, Vol. 4). In a number of situations, wetlands could probably not be avoided. A similar situation would occur for stream crossings where dredging or similarly disruptive procedures would have to be used to inplace the cables. Transition stations would be required to go from underground to overhead and vice versa. These stations generally require about 61 m (200 ft) on a side for a required area of about 0.4 ha (0.9 acres). Bus work, termination structures, and a control equipment building would be located at each site. Maximum structure height would be 24 m (80 ft) (ER, Vol. 4).

Finally, operation and maintenance costs and periods of outage would be much greater for an underground system in comparison with an overhead system (ER, Vol. 4).

2.2.3.6 High-Voltage AC Transmission System

An alternative to the proposed Phase II DC transmission line would involve locating the Phase II converter terminal adjacent to the existing Phase I converter terminal and installing a single high-voltage AC transmission line into Massachusetts. However, an AC transmission line system would be more costly and less reliable than a DC transmission line system. For a DC system, only half the load would be affected by most short circuits. The entire DC line would go out of service only if both poles were affected by a short circuit (more than 90% of short circuits involve only one pole). However, any short circuit would cause an outage of an AC system. On a DC system, the metallic return conductor would allow the system to operate at 50% capacity for extended periods (hours to days). This is not possible with an AC system. Also, if a DC system is forced out of service due to insulator problems (e.g., from accumulation of impurities) the system can be returned to service by operating it at a lower voltage so that the integrity of the insulators can be maintained. This type of operation cannot be done with an AC system. There are also initial costs for AC system components that would exceed those for a DC system (ER, Supplement, Sept. 29, 1986).

2.2.3.7 Ground Electrode

Rather than string a dedicated metallic return conductor to the ground electrode system in Quebec to correct for current imbalances, the Phase I ground electrode system could be expanded as part of the proposed Phase II project. The expansion would entail construction of a second series of rods connected by cable and buried in eight vertical holes 0.3 m (1 ft) in diameter and 40 to 70 m (130 to 230 ft) deep. This second array of holes and rods would be physically separated from the Phase I array but would be electrically connected so that they would function as a single ground electrode.

The ground electrode expansion would be located on a 120-ha (300-acre) parcel of land off Oregon Road in Lisbon, New Hampshire, about 18 km (11 mi) southeast of the Phase I converter terminal. The site is heavily wooded. About 1.2 to 1.6 ha (3 to 4 acres) would have to be cleared for the electrode array, and a short, 15-m (50-ft) wide corridor would have to be cleared for the feeder line. The proposed converter terminal would be electrically connected to the expanded ground electrode by a dedicated metallic return conductor installed on the proposed DC transmission structures from the proposed converter terminal to the Phase I converter terminal. At the Comerford terminal, the conductor would be connected to the Phase I ground electrode feeder line.

Expansion of the ground electrode was originally the preferred alternative (ER, Vol. 8). However, performance test results, coupled with concerns of pipeline companies, have made the extension of the dedicated metallic return conductor into Canada a more viable option (ER, Supplement, Sept. 29, 1986). Expansion of the Phase I ground electrode system would have necessitated installation of costly mitigative measures to control potential corrosion and/or coating disbonding of linear underground steel structures such as pipelines.

2.3 COMPARISON OF ALTERNATIVES

2.3.1 Comparison of the Proposed Action and Alternative Actions

In the discussion in the preceding subsections, it was concluded that maintaining the status quo, conservation, load management, refurbishment of deactivated and aging generating units, decentralized energy production, fuel conversion, and domestic power purchases were not viable alternatives to the proposed project for one or more of the following reasons: (1) potential capacity was too low, (2) reasonable expectations of the alternative capacity and energy savings were already figured in demand and resource projections, and/or (3) the alternatives were complementary to the proposed action in that their contributions would reduce somewhat the demand for oil-fired generation of electricity in New England.

Therefore, only alternatives involving new large-capacity, centralized, non-oil-fired generating facilities could be considered viable alternatives. Such facilities would include coal- or nuclear-fueled steam-electric plants and large-scale hydroelectric installations. Large-scale hydro was ruled out because there are no remaining sites within New England where an installation with a sufficiently large generating capacity could be located. Thus, of the action alternatives examined, only coal- or nuclear-fired generating plants are considered feasible alternatives to the proposed project.

As previously stated, neither the coal nor nuclear option is as economically viable as the proposed transmission project due primarily to the higher capital requirements of these alternatives. In addition, the long period required for design, licensing, and construction of these plants would preclude either type of plant from being placed in service until the mid- to late-1990s. By comparison, the proposed transmission project could be placed in service as soon as the last quarter of 1990.

Environmental impacts also would be greater for the powerplant option. Even though impacts would be brought within established limits by the adoption of various mandatory mitigative measures, the net adverse impacts would still be greater for the powerplant alternative.

Most of the impacts associated with the proposed project would occur during the construction period; the current evaluation by DOE identified no significant adverse impacts related to the operation of the proposed transmission line and only short-term impacts related to construction of the project. Powerplant impacts would be equal to or greater during the construction period (although the construction period would be much longer and localized to the powerplant site vicinity), but certain adverse operational impacts (previously discussed) would exist for the life of the plant -- 30 years or more.

Maintaining the status quo would not produce the impacts associated with the construction of the proposed project; however, it would cause the burning of an additional 12 million barrels of oil per year in New England with a resulting increase in airborne emissions. Furthermore, the "no-action" alternative would not produce the economic benefits projected for the proposed project.

Only alternative routes and designs are concluded to be feasible alternatives to the proposed action. However, consideration of the environmental consequences of the alternative designs and routes (see Sections 2.3.2 and 4.2) indicates that the magnitude of impacts (especially economic) would be significantly greater than for the proposed project.

2.3.2 Comparison of Proposed and Alternative Converter Terminal Sites, Routes, and Designs

Extensive descriptions and comparisons of the proposed and alternative routes were provided in the Applicant's ER (Vol. 4). The more pertinent comparisons are outlined in Table 2.5 and briefly discussed in the following subsections. Above- and belowground alternatives also are discussed below.

2.3.2.1 Air Quality

The air-quality conditions at the locations for the proposed and alternative routes and converter terminal sites are very similar. These conditions are discussed in Section 3.1. The alternative routes and terminal sites are close to the sites of the equivalent components of the proposed route. Thus, greater variations in air quality would occur between the northern and southern extremes of a particular route than at equivalent sections among routes.

Changes in air-quality conditions related to construction and operation would be similar for all overhead alternative routes. Increased construction activities associated with the underground alternative would have a greater impact on air quality. Impacts (potential or real) would result from increased fugitive dust, engine emissions, and audible noise associated with the increased construction activities. The underground alternative would have less potential impacts on air quality during operation due to reduction or elimination of ozone, air ions, and magnetic and electric field effects associated with overhead transmission systems. Also, the underground alternative would not produce the noise associated with corona activity common to overhead transmission lines. However, oil pressurization/pumping stations produce noise levels much higher than that associated with corona activity.

2.3.2.2 Land Features and Use

Geology and Soils

The geologic and soil impacts associated with the overhead design options of the ±450-kV DC transmission line, 345-kV AC line, and double-circuit 115-kV AC line would be similar because major design, construction, and operational features of the lines are similar. Slope stability and resulting landslides might be a problem on sloping areas such as stream crossings. The geologic impacts of the proposed overhead transmission facilities would likely be less than those associated with an underground transmission line. Construction of an underground line would require more extensive excavation, grading, or backfilling than an overhead line, and therefore would create potential landslide or mass-wasting problems. In addition, the underground cable installation would require areas for permanent access to the splicing manholes and for temporary site storage for thermal sand and spoil material.

Table 2.5. Summary Comparison of Proposed and Alternative Routes[a,b,c]

Characteristics	Proposed Route	Tewksbury Route	Eastern Route	Western Route
Length (km)	214.4	204.5	248.0	246.2
Centerline slopes >20% (km)	9.3	9.3	21.1	22.2
Rights-of-way acquisition required (ha)	0	0	641.4	440.3
Potential home/business relocations (number)	0	0	40-60	35
Clearing required (ha)	86.2	13.7	693.3	716.3
Selected land use types crossed (km)				
Forest	24.0	N/A[d]	204.4	165.9
Wetland	15.0	15.0	10.3	6.1
Agriculture	16.4	14.8	15.0	36.5
Residential	0.8	0.3	10.8	9.5
Business/commercial	3.1	3.5	N/A	N/A
Number of crossings				
Roads	137	121	N/A	N/A
Streams/rivers	209	191	N/A	N/A
Lakes/ponds	12	10	N/A	N/A
State/national forests	2	2	N/A	N/A
State parks	0	0	N/A	N/A
Wildlife management areas	2	2	N/A	N/A
Recreational areas	21	23	N/A	N/A
Trails	2	2	N/A	N/A
Capital construction costs ($ million)	585	608	662	649

[a] Source: ER, Vol. 4--Tables IV-2, IV-4, and IV-6.

[b] Data do not include the proposed 345-kV AC transmission lines that would be common to the proposed and alternative routes.

[c] Conversions: 1 km = 0.62 mile; 1 ha = 2.47 acres.

[d] N/A = not available.

The longer construction time for the underground line would increase the potential for erosion of exposed materials and soil. Soil contamination would also be possible from leaks or spills of oil from either the underground cables or aboveground pumphouses.

There would be no significant differences in geologic and soils impacts between the Tewksbury alternative DC transmission line and the proposed route. However, geology and soil impacts associated with the eastern and western alternative routes would be greater than those associated with the proposed route, primarily because of the substantially greater right-of-way clearing that would be required (ER, Vol. 4--Table IV-4, Table IV-6).

The proposed Sandy Pond converter terminal would be located on a graded 12-ha (30-acre) site adjacent to the existing Sandy Pond 345-kV AC substation. Most of the site is an existing upland oak woodland with low to moderate topographic relief. The 11-ha (26-acre) Tewksbury alternative terminal site would be located in a wooded wetland, the Great Swamp, and partially on land occupied by an existing 345-kV AC substation. The geologic and soil impacts are expected to be similar at the proposed and alternative converter terminal sites. However, development of the Tewksbury alternative site would require creation of compensatory offsite flood storage (ER Vol. 4--p. 44). Thus, impacts on soil resources would likely exceed those associated with development of the proposed site.

<u>Land Use</u>

Design alternatives identified by the Applicant include various types of transmission structures as well as DC and AC underground transmission systems. Compared with the proposed steel lattice H-frame and other alternative designs, the steel-pole, single-shaft structures would require the least space and therefore would result in the least amount of land area dedicated to electric energy transmission.

Land-use conflicts during construction of either the DC or AC underground transmission system would be far greater than those associated with construction of the proposed overhead transmission line. Long-term considerations of land use would favor development of the underground systems. However, building an underground system within the established transmission corridor would not alleviate land-use constraints associated with the two currently existing transmission lines within the corridor.

The western and eastern alternative transmission line routes are each longer than the proposed route. Furthermore, the intensity of land-use impacts associated with the two alternative routes would also be greater than for the proposed route. The Tewksbury alternative and the proposed route correspond with established transmission line corridors and traverse relatively similar terrain; therefore, land-use impacts related to those two routes would be relatively similar. The Tewksbury alternative is about 4.6%

shorter than the proposed route (ER, Vol. 4--p. 42). Thus, land-use impacts would not be a significant issue for choosing between the two routes.

Land-use opportunities at both the proposed and alternative Tewksbury converter terminal sites are relatively limited. Although consisting of marginal forest land, the proposed terminal site has some potential for production of commercial wood products and for dispersed recreational use. Thus, development of the proposed site would result in somewhat greater land-use impacts than would development of the Tewksbury alternative.

2.3.2.3 Hydrology, Water Quality, and Water Use

Surface Water

Potential surface-water impacts related to erosion, water quality, drainage patterns, surface runoff, and damage to streambanks would be similar for all overhead transmission facilities. The adverse impacts associated with construction of an underground transmission system are expected to be greater than those associated with the proposed overhead facility, mainly because of increased volume of excavated material for trenches and manholes and increased length of construction time for an underground system. Surface-water impacts could increase, particularly when the underground line would pass under surface water bodies. During operation of an underground system, there would be a potential for oil spills or leaks into surface waters.

The proposed DC and the Tewksbury alternative transmission lines would have comparable surface-water impacts. The substantially greater right-of-way clearing and soil disturbance associated with developing the eastern or western alternative routes would increase erosion potential and sediment deposition in surface water bodies to a greater extent than would be the case for the proposed route.

The proposed Sandy Pond converter terminal site contains no surface water bodies, whereas the Tewksbury alternative converter terminal site contains 3 ha (8 acres) of 100-year floodplain, of which 2.4 ha (6 acres) are vegetated wetlands. The western alternative converter terminal would be adjacent to a small wetland and a tributary stream to the North Nashua River (ER, Vol. 4); therefore, surface-water impacts for the proposed terminal site would be less than for the alternative converter terminal site.

Groundwater

Some adverse impacts on groundwater conditions, including aquifer contamination and disruption of shallow groundwater flow patterns, would be similar for all overhead design options. The groundwater impacts of the underground transmission line are expected to be greater than those of the overhead transmission option since the underground line would involve excavating a continuous trench for the entire length of the proposed interconnection. Routing detours to bypass areas that would hinder or preclude trenching operations would substantially increase the volume of materials to be excavated. Backfilled trenches would tend to serve as subsurface collector drains for groundwater at shallow depths. Contamination of groundwater resources could also result from oil spills or leaks.

There would be no significant differences in groundwater impacts among proposed and alternative converter terminal sites, although there would be slight changes in groundwater conditions for the Tewksbury alternative converter terminal site because of the filling of the 3-ha (8-acre) floodplain.

2.3.2.4 Ecology

The ecological characteristics of the alternative routes and converter terminal site are similar to those of the proposed routes and of the site for the proposed converter terminal facilities (see Section 3.4). Differences are primarily in the extent of various habitat types within each route or at each site. Of major concern are the amounts of forested habitat that would require clearing and the extent of disturbance to wetlands. Differences in numbers of flowing or standing water bodies to be crossed are of minimal concern, as these water bodies would be spanned in almost all cases. The differing amounts of open (nonforested) upland habitat are not of major concern because such habitats would only be minimally impacted by structure placement, laydown area development, and access road improvements. Additionally, such habitats can be more readily restored than can forested or wetland habitats.

Briefly, the principal differences of the overhead route alternatives as compared with the proposed route are as follows:

- Tewksbury Alternative--less forest clearing (including forested wetlands) (9.3 ha [22.9 acres] for the Tewksbury route vs. 74.1 ha [183 acres] for the proposed route), and greater wetland and floodplain displacement (due to location of the converter terminal partially in a floodplain/wetland area) (4.6 ha [11.3 acres] of wetland displacement for the Tewksbury route vs. 4.1 ha [10.2 acres] for the proposed route, and 4.2 acre-feet of floodplain displacement for the Tewksbury route vs. 3.2 acre-feet for the proposed route) (ER, Vol. 4).

- Eastern Alternative--greater forest clearing (693 ha [1,713 acres] for the eastern alternative vs. 86.2 ha [213 acres] for the proposed route), less wetlands traversed (10.3 km [6.4 mi] of wetlands to be traversed for the eastern alternative vs. 15.0 km [9.3 mi] for the proposed route), and greater erosion potential (21.1 km [13.1 mi] of terrain with centerline slopes greater than 20% for the eastern alternative vs. 9.3 km [5.8 mi] for the proposed route) (ER, Vol. 4).

- Western Alternative--greater forest clearing (716 ha [1,770 acres] for the western alternative vs. 86.2 ha [213 acres] for the proposed route), less wetlands traversed (6.1 km [3.8 mi] for the western alternative vs. 15 km [9.3 mi] for the proposed route), and greater erosion potential (22.2 km [13.8 mi] of terrain with centerline slopes greater than 20% for the western alternative vs. 9.3 km [5.8 mi] for the proposed route) (ER, Vol. 4).

Differences among these alternatives are discussed more fully in Section 4.2.2.4.

The only other alternative of concern is that involving placement of the transmission lines underground. The underground line would follow the same route as the proposed overhead system. However, because of construction and maintenance differences, there would be differing effects on ecological resources. Compared with the overhead line, the underground alternative generally would require increased clearing of vegetation, significantly more disturbance of streams and wetlands, increased potential for erosion (due to more excavated material), and increased disturbance to wildlife and vegetation (due to requirements to maintain the right-of-way of the underground system in a grassy condition). These differences are discussed in more detail in Section 4.2.1.4. The underground line could also result in the contamination of wetlands and other habitats due to oil spills or leaks.

2.3.2.5 Socioeconomics

Socioeconomic impacts caused by implementation of alternative designs would be the same as those of the proposed project, except in the case of development of an underground transmission line. The underground option could create greater disturbance (temporary and long-term) to communities along the right-of-way as a result of increased traffic, noise, and dust levels.

The Tewksbury alternative overhead route and converter terminal site would have effects similar to those of the proposed project; however, the eastern and western alternatives would have greater impacts because of the need for right-of-way expansion. For these alternatives, the acquisition of an additional 400 to 600 ha (1,000 to 1,500 acres) would necessitate relocation of 35 to 60 homes or businesses, and heavier access road demands would have potential disturbance effects on local communities.

2.3.2.6 Visual Resources

Visual impacts are minimized when structures of multiple transmission lines within a common corridor are symmetrical in terms of structural design and placement. Thus, the Applicant's selection of steel lattice H-frame structures for the proposed DC transmission line between the Comerford converter terminal and Sandy Pond Junction in New Hampshire would cause less incremental visual impact than any of the three alternative structure types considered. Overhead supports for the proposed DC transmission line between Sandy Pond Junction and the proposed converter terminal site at Sandy Pond in Massachusetts would be single-shaft, steel-pole structures (ER, Vol. 2--p. 48, Vol. 3--p. 34). The level of visual intrusiveness associated with these structures is generally considered relatively low compared with that of other structure designs of similar stature. However, this advantage would be offset to some extent since the form and line attributes of the proposed single-shaft structures would contrast with those of H-frame structures of an existing transmission line within the common right-of-way.

During construction, development of the proposed overhead DC transmission line would result in far less visual impact than would construction of the alternative underground transmission system. However, following reclamation of sites disturbed during construction, the situation would be reversed in that the incremental visual impacts of overhead transmission lines would exceed those of underground systems. Nonetheless, the appearance of the rights-of-way for underground systems would intrude on numerous landscapes since the rights-of-way must remain cleared of trees and shrubs (ER, Vol. 4--p. 80). The effect would be most noticeable in forested landscapes, particularly in areas where construction constraints would necessitate routing of the underground system outside the established rights-of-way (ER, Vol. 4--p. 86).

The potential for visual impacts for both the eastern and western alternative routes would be greater than that for the proposed route. The alternative routes are appreciably longer, encroach on substantially greater residential area, and would require considerably more right-of-way clearing than would be the case for the proposed route (ER, Vol. 4--Sec. III.C, Sec. III.D). The alternative Tewksbury route corresponds with the proposed route for about 181 km (112.5 mi). The remainder of the two routes would traverse relatively similar terrain and cultural developments. However, visual impacts would be greater for the Tewksbury alternative, primarily because the alternative route traverses a 7.2-km (4.5-mi) segment of an established transmission corridor in which paralleling transmission lines would entail support structures of six differing structural designs.

Both the proposed and alternative Tewksbury converter terminal sites are characterized by low-quality landscape views. Furthermore, both sites are relatively well screened from views by the general public. Thus, visual resources are not meaningful issues for choosing between the two converter terminal sites.

2.3.2.7 Cultural Resources

Alternative structure types (single pole and waisted) could have greater visual impact on historical sites near the right-of-way, although specific impacts have yet to be identified. Burial of the transmission line would have much higher potential for both surface and subsurface damage to archeological sites.

Among the alternative overhead routes considered, the western alternative probably has the highest potential for impacts to archeological and historic sites because its northern segment would traverse the Connecticut River Valley. Cultural resource surveys would be needed in order to effectively assess the adverse impacts, as in the case of the proposed route.

2.3.2.8 Health and Safety

Health and safety concerns generally would be similar among all overhead transmission system alternatives. As discussed in Section 4.1.8, the levels of air ions, ozone, audible noise, electric fields, and magnetic fields associated with ±450-kV DC and 345-kV AC transmission lines are within levels that have been shown to have little or (more often) no biomedical or behavioral effects on animals and humans. Therefore, no impacts would be expected from any of the overhead alternatives. Nevertheless, perceived impacts would probably be greater for both the eastern and western alternatives compared with the proposed route and the Tewksbury alternative. This difference would be due to the greater number of residential and business developments adjacent to the eastern and western alternative routes.

Worker safety issues would be similar for all overhead transmission line alternatives. Relative safety would be less for the eastern and western alternatives because those routes would be longer and because greater amounts of forest would require clearing.

The underground alternative would not have the perceived impacts associated with electric field effects, air ions, and other operational air-quality concerns. The peak magnetic field within the right-of-way of an underground line would be greater than that from an equivalent overhead line. However, because of closer spacing of underground cables, the magnetic field would decrease more rapidly (e.g., would be less at the edge of the right-of-way than the magnetic field from an equivalent overhead line). However, worker safety issues would increase because of the greater amount of construction activities required for an underground system. Also, health and safety issues would be greater because of the increased maintenance (effort and frequency) required for an underground system.

2.3.2.9 Radio and Television Interference

In contrast with electrical fields surrounding conductors of overhead transmission lines, there is essentially no electrical field surrounding cables of underground transmission systems (Bonneville Power Administration 1982). Thus, receivers adjacent to buried transmission cables are not subject to radio and television interference.

The eastern and western alternative routes would traverse more residential and commercial development than would the proposed route (ER, Vol. 4--Sec. IV.C-D). Thus, the potential for occurrences of radio and television interference would be greater along the eastern and western alternative routes. The extent of residential and commercial developments traversed by the proposed route and the alternative Tewksbury route would be relatively similar; therefore, the potential for the incidence of radio and television interference would likewise be similar.

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3. AFFECTED ENVIRONMENT

3.1 AIR RESOURCES

The principal climatic characteristics of central Massachusetts and interior New Hampshire include changeable weather, large day-to-day and annual temperature variations, evenly distributed monthly precipitation, great differences between the same season of different years, and considerable anomalies in localized climate (National Oceanic and Atmospheric Administration [NOAA] 1980).

Average annual temperatures are about 9.4°C (49°F) in the Massachusetts portion of the study area and from 7.8°C (46°F) in the south to 5.0°C (41°F) in the north in the New Hampshire portion (NOAA 1980).

Precipitation is fairly uniform throughout the year and is mainly associated with frontal passages. Although the frequency of frontal passages decreases during the summer months, increasing thunderstorm activity in the summer more than compensates for the precipitation difference. Snow cover is usually continuous through the winter (Baldwin 1974). In Massachusetts, annual precipitation is about 114 cm (45 in), and in New Hampshire ranges from 104 cm (41 in) in the south to 94 cm (37 in) in the north. Annual snowfall is just under 178 cm (70 in) in Massachusetts, and in New Hampshire ranges from 152 cm (60 in) in the south to 229 cm (90 in) in the north (ER, Vols. 1-3).

The changeability of the weather is attributable to the large number of storm tracks and the frequent migration of air masses through the region. The predominant wind direction is west, with deviations to the southwest in the summer and to the northwest during winter. Over the general area that would be traversed by the transmission line, the wind speeds range from monthly average highs of 8 to 15 km/h (5 to 9 mph) in the summer to 13 to 19 km/h (8 to 12 mph) in the winter (ER, Vols. 1-3).

Hurricanes and tropical storms occasionally affect the area, but the area is far enough inland that the destructive nature of the winds is considerably lessened. Thunderstorm days have a frequency of 20 to 30 per year; however, severe thunderstorms with attendant hail or tornadoes are rare (Baldwin 1974). Glaze and freezing rainstorms in winter make travel hazardous. At least one ice storm can be expected each winter (NOAA 1980).

The few air-quality monitors that exist in the region are usually sited near major stationary sources of pollution and, therefore, do not represent the rural setting found along the proposed transmission line corridor. Ambient air-quality data for 1983 (U.S. Environmental Protection Agency 1984) indicate that the pollutant levels of suspended particulates, sulfur dioxide, and nitrogen dioxide are well below standards in the urban areas of Massachusetts and New Hampshire, and are undoubtedly even lower in the rural areas. Carbon monoxide and hydrocarbon levels are probably well below standards in the rural areas also. However, elevated levels of ozone are frequent in the urban areas of New England (U.S. Environmental Protection Agency 1984). High levels may also occur in the rural areas along the proposed transmission line during summer due to pollutant transport into the region coupled with climatic conditions that promote ozone production (ER, Vols. 2 and 3).

3.2 LAND FEATURES AND USE

3.2.1 Geology and Topography

The proposed route lies within the New England physiographic province, a northward continuation of the Piedmont, Blue Ridge, and Valley provinces. This area is differentiated from the more southerly portion of the Appalachian range (ER, Vols. 2 and 3), in major part due to the pronounced effects of glaciation.

The geomorphology of the area is partially influenced by the underlying crystalline bedrock. The granites and metamorphic rocks form a plateaulike surface. In general, these rocks have been compressed to some degree, uplifted, and eroded to their present character (Fenneman 1938). The geomorphology also has been influenced by intense glaciation; dominating much of the surface geology are such glacial features as moraines, drumlins, kames, and eskers (ER, Vols. 2 and 3).

The New England physiographic province is divided into five distinct sections (Hunt 1967). Three of these are included within the study area--the White Mountain section in the northern portion of the study area, the New England Upland section in the central portion of the study area, and the Seaboard Lowland section in the southern portion of the study area (ER, Vol. 2--p. 73).

In general, topographic relief and land elevations decrease from north to south. Dominant land forms of the northern part of the study area are an upland plateau and the adjoining White Mountains; the latter is an extensive mountain mass with average elevations of about 580 m (1,900 ft) above mean sea level (MSL). Several lower mountain ranges extend north-south across the plateau. Central and southern portions of the study area are located within an upraised and eroded peneplain. Residual hills and low mountains (monadnocks) are relatively abundant in the upland or northern portion of the peneplain and occur with decreasing frequency in a southerly direction. The uplands of the peneplain are strongly dissected, typically by steep-sided, narrow valleys. Compared with topographic relief of the upland peneplain, land forms of the southernmost part of the study area are lower and smoother. Surface elevations typically range from 75 m (250 ft) to 150 m (500 ft) MSL.

The area along the proposed route and the proposed substation sites are within Seismic Zone 2 (Corps of Engineers 1983). This designation means that the region has light to moderate earthquake potential (ER, Vol. 2--p. 74). No structural damage would be expected from an earthquake in a Seismic Zone 2.

3.2.2 Soils

The soil conditions of New England reflect the strong influence of recent glacial events. Some of the origins of the soils are glacial till, glaciofluvial deposits, and glaciolacustrine deposits (Soil Conservation Service 1965). Soil resources relevant to the proposed project are those within a study area defined as a 16-km (10-mi) wide corridor centered on the proposed transmission line (Figure 2.1). Soil resources within this study area range in thickness from nonexistent (exposed bedrock) to very deep alluvial deposits in river valleys. In some cases, stream terraces can be seen in the river valleys.

The slopes of the soil surfaces range from flat to more than 25% in limited areas. Because of the existing vegetation cover along and within the established right-of-way, the amount of soil erosion is relatively minor. However, sand and gravel extraction activities have resulted in accelerated erosion rates in several spots along the route.

The proposed DC and AC transmission line routes would traverse a total of about 27 km (17 mi) of prime and important farmland in Massachusetts (ER, Vol. 2--Table III-28). This distance represents about 26% of the total 103 km (64 mi) of proposed transmission line route in the state. In New Hampshire, the proposed 195-km (121-mi) DC transmission line route would traverse a total of about 8 km (5 mi) of prime and important farmlands, about 4% of the New Hampshire route (ER, Vol. 3--Table III-30). Thus a cumulative total of 35 km (22 mi) of prime and important farmlands would be traversed by the proposed routes within the two states.

Some soils of the 9-ha (23-acre) converter terminal site also have been identified as prime farmlands, but the site is characterized by rock outcrops and large boulders and thus may not be well suited for farming (ER, Vol. 1, Sec. IV.C.1.b).

3.2.3 Agriculture

Land use for agricultural purposes in Massachusetts and New Hampshire has decreased markedly during the last few decades. For example, in Massachusetts the proportion of land categorized as "land in farms" decreased from 33.0% in 1950, to 17.9% in 1964, and to 12.2% in 1982 (Bureau of the Census 1984a); in New Hampshire the corresponding percentage decreases were 29.7%, 15.7%, and 8.2%, respectively (Bureau of the Census 1984b).

As shown in Table A.1 of Appendix A, the proportion of land in farms in the counties traversed by the proposed transmission line is relatively low, ranging from 13.8% for Worcester County to 5.2% for Norfolk County. However, data presented by the Applicant (ER, Vol. 2--Table III-19, Vol. 3--

Table III-18) indicate that agriculture ranks second only to forestry as a major land use in the project study area. The proportions of land in farms in these counties in 1982 were essentially unchanged from comparable 1978 data. The percentages of land in farms for 1982 decreased from those for 1978, with the exception of Worcester and Grafton counties, but all changes were less than 1% of the land in the respective counties. On the other hand, the average size of farms in all counties decreased during 1978-1982, and in some cases changes were substantial. For the most part, the effects of decreased farm size were essentially offset by corresponding increases in the number of farms (Bureau of the Census 1984a, 1984b).

Among the Massachusetts counties along the proposed route, sales from livestock production and dairy operations were major sources of agricultural income in Worcester County in 1982, while sales from crop production, especially nursery and greenhouse products, were principal sources of income for farms in Middlesex and Norfolk counties. For the New Hampshire counties along the proposed route, sales from dairy operations constituted the predominant agricultural income in Grafton and Merrimack counties; dairy products, fruits, nuts, and berries were the principal sources of income from Hillsborough County farms; and sales of agricultural products from Rockingham County farms derived primarily from dairy and poultry operations (Table A.1).

3.2.4 Forestry

As of 1977, about 59% (1.2 million ha [3 million acres]) of the land area in Massachusetts consisted of forest land. Of this, about 95% (1.1 million ha [2.8 million acres]) was classified as commercial timberland (Forest Service 1978). In New Hampshire, about 87% of the land in the state, or 2 million ha (5 million acres), consisted of forest land, and about 94% of the total forested area was classified as commercial timber land.

The predominance of forest land use in counties traversed by the proposed transmission line is illustrated in Table A.2 of Appendix A. Forest land use in New Hampshire counties substantially exceeds that for most Massachusetts counties. The proportion of total forest area for New Hampshire counties ranges from about 75% in Rockingham County to about 90% in Grafton County. For Massachusetts counties, the proportion of forest lands ranges from about 44% in Middlesex County to about 69% in Worcester County (Table A.2). For the most part, the lower percentages of forest land in Middlesex County are attributable to the intensive residential, commercial, and industrial land use in the Boston area. This is supported by forest land data presented by the Applicant (ER, Vol. 2--Table III-19) that are based on a project study area composed of only those towns within a given county that are traversed by the proposed line.

Table A.2 shows that about 90% or more of the forest land in each county traversed by the proposed route consists of commercial timberland and that most forest lands are in private ownerships.

The distribution of forest types within counties traversed by the proposed transmission line is presented in Table A.3 of Appendix A. In general, the trends in occurrence of the forest types correspond with ecosystems as delineated by the U.S. Fish and Wildlife Service (1979); i.e., forest stands of New Hampshire counties correspond with the Northern Hardwoods-Spruce forest, while forest types in Massachusetts counties represent transition to the Appalachian Oak forest.

3.2.5 Mining

Cumulative data from long-term inventories indicate that only minor quantities of the major metals (gold, silver, lead, zinc, and iron) have been extracted in Massachusetts and New Hampshire (Geological Survey 1970). The major materials extracted in the two states are essentially nonmetallic and are of relative minor economic significance. The 1984 production of minerals in New Hampshire derived primarily from sand and gravel materials, followed by more limited extraction of stone products (F.E. Compton Co. 1984). As observed during Staff reconnaissance of the New Hampshire project area (Figure 2.1), sand and gravel materials are generally poorly sorted, extraction is not extensive, and use appears oriented to local needs. Exploitation of mineral resources in the project area occurs only as scattered sand and gravel pits and granite quarries (ER, Vol. 3--p. 61).

The value of mineral production in Massachusetts is more substantial than in New Hampshire (F.E. Compton Co. 1984). Mineral resources of economic value within Massachusetts counties wholly or partially traversed by the proposed transmission lines (Figures 2.2 through 2.4) occupy a total of about 4,828 ha (11,930 acres). About 97% of this total area consists of sand and gravel deposits (ER, Vol. 2--Table III-3). Of the total surface area of economic mineral deposits (1,695 ha [4,190 acres]) in Middlesex County, only 7% occurs within towns traversed by the proposed transmission line and involves only sand and gravel deposits. About 395 ha (980 acres) of sand and gravel deposits and 15 ha (35 acres) of other mineral deposits occur in towns of Worcester County traversed by the proposed line. Only 48 ha (120 acres) of economic sand and gravel deposits occur in the town of Medway in Norfolk County (ER, Vol. 2--p. 79).

3.2.6 Natural and Recreational Areas

3.2.6.1 New Hampshire

The study area for the inventory of natural and recreational sites in New Hampshire consisted of a 6.4-km (4-mi) wide corridor centered on the proposed transmission line route. Designated natural areas include the White Mountain National Forest, which is traversed by the proposed route for about 15 km (9 mi) in the towns of Benton, Warren, and Wentworth (Figure 2.2). An additional 35 natural areas are located partially or wholly within the study area corridor, of which 19 areas are state (16), town (2), and private

(1) forests ranging in size from 10 ha (25 acres) to 400 ha (1,000 acres) (Freeman 1981). Among the larger designated natural areas adjacent to the proposed route are the Hopkinton-Everett and Blackwater reservoirs in the town of Hopkinton and Webster, respectively (Figure 2.3). Other designated areas featuring aquatic attractions include Musquash Swamp, Merrimack Fish Rearing Station, Smith Pond Bog, Contoocook River, and the Parker Natural Area (Freeman 1981; New Hampshire Office of State Planning 1983a). Other notable areas are the 440-ha (1,100-acre) Conservation Commission Land and the smaller Contoocook River Park within the towns of Bow and Concord, respectively (Figure 2.3).

Dedicated recreational areas totally or partially within the study area corridor include two state parks and seven municipal parks. The state parks are the Plummers Ledge Geologic Site in the town of Wentworth and the Wellington Beach State Park in the towns of Bristol and Alexandria. Four of the municipal parks are in the town of Manchester, with one each in the towns of Hudson, Hebron, and Haverhill (Figures 2.2 and 2.3). The most numerous recreational sites adjacent to the proposed route are municipal and school facilities developed for intensive recreation (Freeman 1981). For example, there are more than 40 athletic fields, 5 golf courses, and 2 gymnasiums adjacent to the proposed line in Hillsborough County, primarily in the towns of Goffstown, Manchester, and Bedford (Figure 2.3). Other comparable recreational opportunities or facilities within the study area corridor include water sport activities (16 sites), athletic fields (16 sites), campgrounds (23 sites), winter sport activities (4 sites), a roadside park, as well as public hunting (2) and fishing (4) areas.

The proposed route intersects several designated river and overland recreational routes. Segments of the Baker, South Branch Baker, and Contoocook Rivers intersecting the proposed route are included in the federal inventory of nationwide rivers with recreational potential (National Park Service 1982). The Baker and Contoocook are designated state recreation rivers, and South Branch Baker is a state scenic river route (New Hampshire Office of Comprehensive Planning 1977a). Additionally, intersected segments of the Ammonoosuc and Smith Rivers are state recreation corridors. Several highways intersecting the proposed route include State Route (SR) 135 and U.S. 302/SR 10, which are designated scenic highway/bike routes. Intersected scenic highways include SRs 11, 13, 25, 103, and 112 and U.S. 4; SRs 101, 102, 111, and 114 are designated bike routes (New Hampshire Office of Comprehensive Planning 1977b; ER, Vol. 3--Table III-25). The proposed route intersects the Appalachian Trail in the town of Warren (Figure 2.2).

Additional information concerning recreational resources within the proposed New Hampshire project area is presented in the ER (Vol. 3--Sec. III.C.12).

3.2.6.2 Massachusetts

Sites included in the Massachusetts statewide inventory of recreational resources are classified in four major categories--intensive recreation areas, general recreation areas, natural (conservation) areas, and historical/cultural areas (Massachusetts Office of Planning 1978). The historical/cultural areas located in Massachusetts towns traversed by the proposed transmission line route (the project study area) are discussed in Section 3.7.

The natural and general recreation areas vary considerably in size, but include the larger of the recreation areas in the state. General recreation areas are more highly developed and afford a wider range of recreation opportunities. Of the large recreation areas immediate to the proposed route, the 1,075-ha (2,660-acre) Upton State Forest provides for a variety of dispersed and trail-related recreation activities (Massachusetts Division of Forestry and Parks undated). A small portion of this state forest, as well as a small part of the Wachusett Reservoir, would be traversed by the proposed route (Figure 2.4). Reservoir shorelines provide opportunities for passive recreation activities, and the general area is a major scenic attraction (ER, Vol. 2--Sec. III.C.12).

Located in the town of Worcester (Figure 2.4), the Quinsigamond State Park is outside of the project study area but is located within 2 km (1.2 mi) of the proposed route. The park affords opportunities for swimming, boating, sailing, fishing, tennis, and picnicking (Rand McNally & Company 1985). All or portions of seven additional state parks and forests occur within 8 km (5 mi) of the proposed route.

The conservation areas within the project study area are variable in size and are primarily administered by local town governments. These areas tend to be largely undeveloped with limited opportunities for recreational use. The Applicant has identified seven such sites (ER, Vol. 2--Table III-25)--the Floyd and Bates Conservation Areas, the Whorton Plantation, and the Priest Memorial Area in the town of Groton; the Hollingsworth Conservation Area and a town forest in the town of Ayer; and the Lancaster-Cook Conservation Area in the town of Lancaster.

Intensive recreational areas are sites involving high levels of recreational activity with developed facilities for one or more specific recreational uses, such as athletic fields, tennis courts, swimming pools, and public school playgrounds. Such sites are scattered throughout the project study area, primarily in association with urban areas (ER, Vol. 2--Figures III-6.1 through III-6.12). Other publicly administered recreational sites in the project study area include Sargison and Spectacle Pond beaches, Shalan Park, and Pratt Pond; located in the towns of Groton, Lancaster, Sterling, and Upton, respectively (ER, Vol. 2--Table III-25).

The Applicant has identified several private recreational sites in the project study area (ER, Vol. 2--Table III-15). Seven sites are used by various youth organizations. Other sites include areas used by sportsman clubs (4), a hang glide-ski slope area, and a private beach area.

The proposed route intersects several designated river and overland recreation routes. Intersected segments of the Merrimack and North Nashua Rivers are designated as urban recreation rivers; the intersected segment of the Nashua River is a local scenic river (ER, Vol. 2--Table III-15). A segment of the Nashua River from below Pepperell to the Ayer State Game Farm is included in the Federal Nationwide Rivers Inventory (National Park Service 1982). The federally inventoried segment is immediately downstream from where the proposed route intersects the Nashua River. Overland recreation corridors that intersect the proposed transmission line route include three state routes (SR 113, 119, and 62) that are designated as scenic highways on standard Massachusetts highway maps.

Additional details relative to recreational resources of the Massachusetts project area are available in the ER (Vol. 2--Sec. III C 12).

3.2.7 Residential, Commercial, and Industrial

The New Hampshire study area for land use data presented by the Applicant (ER, Vol. 3--Table III-18) consists of the New Hampshire towns traversed by the proposed route (Figures 2.2 and 2.3). About 5.6% of the study area was reported as "developed" land in 1978. The developed land included areas used for residential, commercial, industrial, recreational, and other minor land use categories. It is expected, however, that the area of developed land has increased since completion of the survey cited by the Applicant. For example, results of a 1980 survey indicate that the number of housing units in New Hampshire counties traversed by the proposed transmission line route increased by percentages ranging from 35.5% to 43.3% during the 1970-1980 period (Bureau of the Census 1983).

Recent estimates of land areas used for residential purposes within towns of the New Hampshire project study area are not readily available. However, the density of housing units (number per unit area) provides some insight into residential land use. Based on 1980 data (ER, Vol. 3--Tables III-14, III-16), the average housing unit density in towns of the study area in Grafton County ranges from less than 1 to 12.4 units/km^2 (2.6 to 32.1/mi^2), thus reflecting the rural character of the county. The greatest concentration of residential land use in the New Hampshire study area is in the town of Concord in Merrimack County, with an average housing unit density of 73 units/km^2 (189/mi^2). Densities for other Merrimack towns are considerably lower. The average housing unit densities for all Hillsborough towns within the project study area are comparatively high, ranging from 32 to 58 units/km^2 (83 to 149/mi^2). In general, residential land use tends to increase with distance from the northern to the southern part of the New Hampshire study area (Figures 2.2 and 2.3).

Based on supplemental data provided by the Applicant, about 1140 residences are located within 305 m (1000 ft) on either side of the outer edges of the proposed transmission line right-of-way in New Hampshire (ER, Supplement, Sept. 29, 1986, Exhibit B). For individual towns crossed by the proposed route, the number of residences within 305 m (1000 ft) of the right-of-way edges range from zero (five towns) to a high of 338 residences in the town of Bedford. The number of residential units similarly located with respect to the right-of-way in the town of Hudson is also relatively high at 239 residences; the number for all other towns is less than 100 residential units. The Memorial Elementary School is also within 305 m (1000 ft) of the edge of the proposed right-of-way in the town of Bedford.

Employment data provide some insight to the concentrations of commercial and industrial land use in the area (ER, Vol. 3--Table III-17). Accordingly, country-wide employment for industrial and commercial activities indicate that land area used for industrial and commercial purposes is greatest for Hillsborough County and least for Grafton County. Commercial and industrial land use in Merrimack and Rockingham counties is intermediate between that for the aforementioned counties. In general, patterns of commercial and industrial land use tend to correlate with patterns of residential land use.

In Massachusetts, the project study area also consists of towns traversed by the proposed transmission line (Figures 2.3 and 2.4). Based on the Applicant's data (ER, Vol. 2--Table III-19), residential land use represents 9.7% of the total lands in the Massachusetts study area. However, the Applicant's data represent land use before 1971 and do not reflect more recent changes. For example, total housing units in Middlesex, Norfolk, and Worcester counties increased during the 1970-1980 period by 14.3%, 17.5%, and 17.5%, respectively (Bureau of the Census 1983).

Compared with New Hampshire towns, the overall residential land use is substantially greater for Massachusetts towns in the project study area (Figures 2.3 and 2.4). The only comparatively rural town in the Massachusetts study area is Dunstable, with an average housing unit density of 11.0 units/km^2 (28.5/mi^2). The average housing unit densities in Massachusetts towns of Lancaster, Sterling, Boylston, Sutton, and Upton range from 22.5 to 29.4 units/km^2 (58.3 to 76.1/mi^2); while average densities for all other towns of the Massachusetts study area exceed 45 units/km^2 (116/mi^2). The major concentrations of residential land use occur in the towns of Medway, Ayer, Millbury, Shrewsbury, and Milford, with average housing unit densities ranging from 87 to 215 units/km^2 (224.5 to 556.9/mi^2).

Data provided by the Applicant indicate about 1,960 residences are located within 305 m (1000 ft) on either side of the edges of the proposed transmission line right-of-way in Massachusetts (ER, Supplement, Sept. 29, 1986, Exhibit B). About 600 (31%) of these residential units are located in the town of Shrewsbury. Other towns with substantial numbers of residences (i.e., 100 to 200 units) similarly located with respect to the proposed right-of-way include Ayer, Shirley, Sterling, West Boylston, Grafton, and Milford. Comparable numbers of residences for the remaining towns traversed by the proposed right-of-way are less than 100 units. Schools within 305 m (1000 ft) of the boundaries of the proposed right-of-way include the Stone Environmental School, Ayer High School, Purchase Street School, and the Shepard Knapp School.

Almost half the manufacturing in the Massachusetts study area occurs in the towns of West Boylston, Shrewsbury, Grafton, and Millbury (ER, Vol. 2--p. 128). High levels of both industrial and commercial activities occur in the town of Milford, and high levels of commercial activities in the towns of Ayer and Shirley serve to accommodate demands of the Fort Devens community. Medway is primarily a residential town within commuting distance of the Boston area. Commercial land use is oriented to providing for local needs.

3.2.8 Military

No major military installations occur on or near the proposed route in New Hampshire; however, the northern portions of the proposed route as far south as Hebron, New Hampshire, are within either the Yankee One or Yankee Two Military Operations Areas (NOAA 1985a, 1985b). In northeastern Massachusetts, only Fort Devens is in the project study area. The proposed route is adjacent to Fort Devens in the towns of Ayer and Shirley (ER, Vol. 2--Figure III-6.3).

3.2.9 Transportation, Transmission, and Communication Systems

3.2.9.1 Transportation Systems

Highway and Roads

The northern portion of the proposed transmission corridor (Figure 2.2) traverses predominantly rural area in Grafton County, New Hampshire, and the highway network within the county is generally less developed than in more southerly counties of New Hampshire, where land use is more intensive (DeLorme Publishing Co. 1985). The proposed corridor intersects a single federal highway in Grafton County, U.S. 302 in the town of Bath. State routes (SR) in Grafton County that are intersected by the proposed corridor include 135, 25, 25c, 25a, 118, and 104. About 26 local roads (including streets, permanent trails, etc.) within the county also intersect the proposed corridor. In Merrimack County, the proposed corridor intersects U.S. I-89, U.S. 202 (both in the town of Hopkinton), U.S. 4 (in the town of Salisbury), SRs 11 (two places) and 13, and 32 local roads. The highways of Hillsborough County that intersect with the proposed corridor are U.S. 3 and the Everett Turnpike in Merrimack; SRs 114 (two intersects), 101, 3A (two intersects), and 111; and 26 minor roads. In Rockingham County, the proposed corridor intersects SR 102 and three local roads.

The principal highways in Massachusetts that are intersected by the proposed transmission line corridor tend to promote either direct access to downtown Boston or to channel traffic around the immediate Boston area. The principal highways in Middlesex County intersected by the proposed corridor include U.S. 3 and SR 3A in the town of Tyngsborough. Other intersects in Middlesex County include SRs 119/225, 111, and 2A, and about 22 local roads. The highway network in Worcester County is particularly well developed since the county surrounds much of the Boston area. Major highways and towns in which intersections occur are U.S. I-190, SR 117, the Union turnpike, and the Lunenburg turnpike in Lancaster; U.S. I-190 and SR 62 in Sterling; SR 170, SR 110, and SR 140 in West Boylston; U.S. I-290, SR 9, and SR 20 in Shrewsbury; U.S. I-90 in Millbury; SR 122 and SR 140 in Grafton; and U.S. I-495, SR 85, and SR 16 in Milford. The proposed corridor also intersects about 35 local roads in Worcester County. In Norfolk County the proposed corridor extends only into the town of Medway and intersects SR 109 and two local roads.

Railroads

The proposed transmission line route intersects four railroad lines in New Hampshire (DeLorme Publishing Co. 1985); all intersections involve freight lines of the Boston and Maine Corp., a subsidiary of Guilford Transportation Industries, Inc. (National Railway Publication Co. 1985). The intersections occur near Bath, Andover, and Goffstown and in Merrimack, New Hampshire. The railway through Andover is scheduled for abandonment (ER, Vol. 3--p. 147).

The Boston and Maine Corp. also operates railroad lines in Massachusetts that intersect the proposed transmission line (National Railway Publication Co. 1985); these are freight lines in the towns of Tyngsborough (1), Ayer (2), and Sterling (1) (ER, Vol. 3--Figures III-6.1, III-6.3, and III-6.7). The Boston and Maine/Massachusetts Bay Transit Authority operates a freight/passenger service line that intersects the proposed line near Shirley, Massachusetts. Conrail lines intersecting the proposed transmission line route include one freight line in each of the towns of Sterling and Milford. Also, Conrail/AMTRACK facilities include freight/passenger service intersecting the proposed line in the town of Grafton. Two additional freight lines intersect the proposed line in Grafton, one operated by the Providence and Worcester Railroad Co. and the other by the Grafton and Upton Railroad Co.

Airports

Seven airports are located at or within 8 km (5 mi) of the New Hampshire portion of the proposed transmission line route (NOAA 1985a, 1985b). Included are Lee Airport (a private facility near Goffstown) and six public airports: Dean Memorial Airport near Haverhill, Newfound Valley Airport near Bristol, Plymouth Airport near Plymouth, Country Club Airport and Skypark Campground Airport near Goffstown, and Manchester/Grenier Industrial Airport at Manchester. The last mentioned is a comparatively large airport, the only one of the seven with a control tower.

The study area for the inventory of Massachusetts airport facilities adjacent to the proposed transmission line route consisted of a corridor with boundaries at 8 km (5 mi) on either side of the proposed route. The airports nearest the proposed transmission line route include private facilities at the Larson Seaplane Base on the Merrimack River adjacent to the Massachusetts state line, the airport at the Moore Army Air Force Base at Fort Devens (which includes a control tower), and two public airports--the Shirley Airport immediate to Fort Devens, and the Sterling Airport near Oakdale (NOAA 1985b). Additional airports wholly or partially within the study area include private facilities at the Sports Center Airport near Pepperell and the Walters Airport south of Millbury, as well as public facilities, including the Groton Airport southeast of Pepperell, the Fitchfield Airport at Fitchfield, the Hopedale/Draper Airport near Milford, and Norfolk Airport near Medway.

3.2.9.2 Transmission Systems

Major links in the electric power grid of New Hampshire include two 345-kV AC transmission lines that traverse the southern part of the state in general southwest-northeast directions, linking transmission facilities of Maine and southern New Hampshire with facilities in Vermont and Massachusetts (ER, Vol. 3--p. 151). The principal north-south transmission corridor in the New Hampshire portion of the project study area includes two 230-kV AC transmission lines that extend from the Comerford substation near the Comerford Dam to the Sandy Pond Junction in southern New Hampshire, and from there to the Tewksbury substation in Massachusetts. The proposed DC transmission line parallels the existing 230-kV lines in a common corridor from the Comerford substation to the Sandy Pond Junction and then extends southerly and westerly within another established transmission line corridor that intersects the state boundary adjacent to the Merrimack River.

The northern segment of the proposed route intersects existing transmission lines at only two locations (involving three line intersections) in the town of Monroe (ER, Supplement, Sept. 29, 1986). However, the power grid in southern New Hampshire is relatively well developed, reflecting the more intensive land use patterns (NOAA 1985a, 1985b). Crossings of existing transmission lines by the proposed DC transmission line route in southern New Hampshire are as follows: one location in the town of Andover, one location in the town of Concord, three locations (five line intersections) in the town of Goffstown, two locations in the town of Merrimack, two locations in the town of Londonderry, and two locations (three line intersections) in the town of Hudson (ER, Vol. 3, Table III-40; ER, Supplement, Sept. 29, 1986).

Within the Massachusetts portion of the project area (Figures 2.3 and 2.4), the proposed DC and AC transmission line routes traverse established transmission line corridors for essentially the entire distance from the Massachusetts state line to the project terminus at the West Medway substation. Depending on the location along the route, existing transmission facilities within the corridor segments vary from one to six individual lines operating at voltages ranging from 69 kV to 345 kV (ER, Vol. 2--Figures II-5 through II-15). Electric transmission facilities identified in the towns that are traversed by the proposed DC and AC routes consist of the following:

thirty 115-kV lines, ten 345-kV lines, fifteen 69-kV lines, three 230-kV lines, and fifteen existing substations (ER, Vol. 2--p. 152). Land use maps presented by the Applicant reveal parallel transmission lines within corridor segments, as well as existing transmission lines that intersect the proposed DC and AC routes. For example, multiple line intersections occur in the towns of Dunstable, Groton, Ayer, Shirley, West Boylston, and Millbury (ER, Vol. 2--Figures III-6.4 and III-6.7 through III-6.9).

Other transmission systems in the vicinity of the proposed transmission line route include pipelines. A segment of a Tenneco natural gas pipeline in the New Hampshire towns of Londonderry, Windham, and Pelham generally parallels the proposed route (ER, Vol. 3--Figure III-3) at a closest distance of about 1 km (0.6 mi). Additionally, the proposed DC transmission line route crosses an existing gas pipeline in the town of Hudson, New Hampshire (ER, Supplement, Sept. 29, 1986). Pipeline crossings of the proposed route occur in the Massachusetts towns of Lancaster, West Boylston, and Upton in Worcester County, and in the town of Medway in Norfolk County (ER, Vol. 2--Figures III-6.5, III-6.7, III-6.11, and III-6.12).

3.2.9.3 Communication Systems

The study area for identifying air traffic communication facilities adjacent to the proposed transmission line route consisted of a corridor with boundaries at 8 km (5 mi) on either side of the proposed route. Communication facilities within the study area include two VORTAC stations in New Hampshire near Concord and Deery (NOAA 1985a), as well as nondirectional radiobeacons near Deery in New Hampshire, and at Fitchburg and Worcester in Massachusetts. Other nondirectional radiobeacons somewhat more removed from the proposed route include stations in the vicinity of Hooksett and Milford in New Hampshire and a station near Townsend in Massachusetts. Airports near the proposed line that have control towers are the Manchester/Grenier Industrial Airport in New Hampshire and the Moore Army Air Force Base in Massachusetts.

The study area for identifying obstructions to air traffic consisted of an 8-km (5-mi) wide corridor centered on the proposed transmission line route. These obstructions include communication towers for radio, television, and microwave transmissions. Four single and two group obstructions occur within the corridor in New Hampshire; seven single and one group obstructions occur within the corridor in Massachusetts (NOAA 1985a, 1985b). Most of the structures occur near urban areas in southern New Hampshire, and in the Fitchburg, Worcester, and Milford areas in Massachusetts.

3.3 HYDROLOGY, WATER QUALITY, AND WATER USE

3.3.1 Surface Water

The proposed transmission line route successively traverses the watersheds of the Connecticut, Merrimack, Blackstone, and Charles Rivers. The line would cross more than 300 surface water bodies (ER, Vols. 2 and 3), including the Ammonoosuc, Baker, Cockermouth, Fowler, Smith, Contoocook, Piscataquog, Nashua, and North Nashua Rivers. Runoff in these watersheds varies considerably on a seasonal basis, with the greatest flows in spring and the least flows in summer and fall. Snowmelt and summer thunderstorms can cause dramatic increases in streamflow. Most of the tributary creeks are intermittent in the area of the proposed route. Selected streamflow data for watersheds that would be crossed by the proposed route are given in Table A.4 of Appendix A. Reservoirs that would be crossed by the proposed line range from an isolated pond with a surface area of about 74 m^2 (800 ft^2) to the 16.8-km^2 (6.5-mi^2) Wachusett Reservoir near Worchester, Massachusetts (ER, Vols. 2 and 3).

The quality of surface water can vary considerably in response to such factors as streamflow, time of year, climate, types of material in the stream channel, groundwater inflow, and land- and water-management practices. In general, periods of low streamflow are characterized by poorer water quality than occurs during periods of high flow. Also, influent groundwater providing baseflow adds to the solution loading of the stream.

Most of the surface waters within the Connecticut, Merrimack, Nashua, Blackstone, and Charles River basins crossed by the proposed route are designated as Class B, which is the second highest quality of water, and are used for recreational activities, fish habitat, protection and propagation of other aquatic life and wildlife, and as a water supply following adequate treatment. Exceptions include several streams, lakes, ponds, and reservoirs and their tributaries that are designated as Class A and are used as public water supplies. These are Cross Brook at its two tributaries in the Blackwater River basin, three tributaries of Kimball Pond, a small unnamed pond in the Black Creek watershed, and ten streams within the watershed of Walker Pond, currently used as the public water supply by the town of Boscawen and the city of Concord, New Hampshire.

The Class A surface waters crossed by the proposed transmission line in Massachusetts include the Wachusett Reservoir and 14 other reservoirs and ponds and their tributaries in the Nashua River basin, several streams used for public water supplies in the Blackstone River basin, and the headwaters of the Charles River. A reach of about 14 km (9 mi) of the mainstream Blackstone River, from its source to the outlet of Fisherville Pond, and lower reaches of the Charles River are designated as Class C--the third highest quality of water, and are used for secondary-contact recreation only (ER, Vols. 2 and 3).

Several major surface waters within the counties through which the proposed route would pass (Figures 2.2 through 2.4) are used for public water supplies. In New Hampshire, these include the Wild Ammonoosuc River (serving Woodsville and Bath), Walker Pond (serving Boscawen and a portion of Concord), Bradley Lake (serving Andover), Penacook Lake (serving Concord and Bow), and the Goffstown Reservoir (serving Goffstown). In addition, the Contoocook and Souhegan rivers serve as auxiliary public water supplies for the cities of Concord and Nashua, respectively. In Massachusetts, the Wachusett Reservoir and the Charles River serve as public drinking water supplies for the towns of West Boylston and Milford, respectively. The Wachusett Reservoir is also a source of drinking water for the Boston metropolitan area (ER, Vol. 2--p. 88).

3.3.2 Groundwater

Groundwater in the general project area (Figures 2.2 through 2.4) is available primarily from bedrock aquifers and glacial-drift aquifers of Quaternary age. Glacial-drift aquifers in the area include till, surficial sand and gravel deposits, glacial outwash deposits, and alluvial deposits. The ability of these deposits to yield water depends on the permeability, thickness, and extent of the deposit and the amount of water stored in and recharged to the aquifers.

Water from bedrock of igneous and metamorphic origin is generally available in quantity and quality suitable for single-family domestic supplies. Water in bedrock occurs in secondary pore spaces, such as joints and fractures, which are commonly narrow and represent only a small percentage of total aquifer volume. In the study area, nearly all wells constructed in bedrock intercept some water-bearing fractures; however, bedrock well yields range from a fraction of a liter per second (or a fraction of a gallon per minute) in places where the fractures are small and poorly interconnected, to more than 6.3 L/s (100 gal/min), where they are numerous and well interconnected, as in some fault zones.

Sufficient amounts of water to supply single-family homes are available from the bedrock aquifer nearly everywhere in the Middle Connecticut River and Merrimack River basins. Unconsolidated aquifers of sand or sand and gravel that are relatively thin, narrow, and commonly capable of yielding more than 12.6 L/s (200 gal/min) to properly located and constructed wells are found in major stream valleys. A significant amount of water is stored in thick glacial till, but it is transmitted very slowly through the small intergranular spaces (pores) of the deposits. Accordingly, till is a poor aquifer and normally does not yield enough water for municipal, industrial, or commercial needs (Gay and Delaney 1980; Cotton 1975, 1976a, 1976b, 1977).

Groundwater in the middle Connecticut River and Merrimack River basins near the project area in the state of New Hampshire is generally of good chemical quality. Most of it is clear and colorless, contains no suspended matter and practically no bacteria, and is low in dissolved-solids concentration. Also, it is generally soft (0-60 mg/L) to moderately hard (61-120 mg/L). In general, groundwater from bedrock and glacial-drift aquifers is good throughout the lower Merrimack River basin near the study area in the state of Massachusetts, with dissolved solids less than 300 mg/L, and is suitable for domestic, municipal, irrigation, and livestock supplies. Reported water quality of these aquifers is a calcium bicarbonate type (Gay and Delaney 1980).

Water-supply sources for most communities within the project area consist of groundwater from private suppliers and onsite wells, although larger communities such as Concord, Manchester, and Nashua rely either on surface-water sources or a combination of surface water and groundwater to meet water-supply demands (ER, Vols. 2 and 3).

3.4 ECOLOGY

The counties containing the proposed route are within two ecological provinces (Bailey 1976; Galvin 1979). Most of New Hampshire and the western portion of Massachusetts are within the Northern Hardwood-Spruce Forest section of the Laurentian Mixed Forest province. The remainder of the area is within the Appalachian Oak Forest section of the Eastern Deciduous Forest province. Much of the information provided in the following overview of the predominant habitats and biota occurring within the area traversed by the route is derived from Galvin (1979), U.S. Department of Energy (1984), the ER (Vols. 1-3), and references cited therein.

3.4.1 Terrestrial Environment

3.4.1.1 Vegetation

Forest habitat predominates in the study area (consisting in this case of the counties through which the proposed project would be routed). Forest covers about 82% of the counties in the New Hampshire portion of the study area (ER, Vol. 3) and about 59% of the counties in the Massachusetts portion of the study area (Peters and Bowers 1977). These forests can be grouped into eight major types (see Table A.5 of Appendix A). The white and red pine forest is the most common type in the New Hampshire portion of the study area. This type becomes less prevalent in the Massachusetts portion, where oak/hickory forest becomes predominant. This change in forest type occurs within the area of change from the Northern Hardwood-Spruce Forest to the Appalachian Oak Forest section (see Galvin 1979).

The second most common forest type in the New Hampshire study area is the maple/beech/birch forest type, which is commonly known as the northern hardwood forest (Kingsley 1976). The other major forest types in Massachusetts are the white and red pine forest and the elm/ash/maple forest. The latter is the most prevalent forested wetland type in the area (Kingsley 1974).

A variety of species make up the understory and shrub layers in the forest types, and many of them are common along the edge of rights-of-way or become established within them. Such species include huckleberry, blueberry, arrow-wood, flowering dogwood, raspberry, and many others (Jorgensen 1978).

Old field and shrubland also occur throughout the study area and exemplify the habitats found within maintained rights-of-way. These habitats go through a succession from annual herbaceous plants (e.g., crabgrass, ragweed); to perennial herbaceous plants (e.g., little bluestem, goldenrod, milkweed); to small tree and shrub species (e.g., grape, buckthorn, eastern red cedar) (Jorgensen 1978).

Complete lists of the common flora in the study area are given in the ER (Vol. 2--Table III-8, Vol. 3--Table III-9).

3.4.1.2 Wildlife

The wildlife communities in the study-area counties range from those characteristic of heavily forested areas to those characteristic of areas of urban encroachment. A large number of species are found in the study area, as indicated in the ER (Vol. 2--Table III-9, Vol. 3--Table III-10). In the New Hampshire portion there are 244 bird, 39 reptile and amphibian, and 56 mammal species; in Massachusetts the numbers of such species are 208, 26, and 49, respectively. Game species and furbearers in the area include white-tailed deer, black bear, coyote, bobcat, cottontail rabbit, snowshoe hare, opossum, raccoon, red and gray fox, muskrat, mink, striped skunk, weasel, beaver, river otter, and others (Cardoza 1979; ER, Vols. 1-3).

The white-tailed deer is the most important game species in the region (Godin 1977; Halls 1980). Of prime importance to white-tailed deer is the availability of overwintering habitat, or deeryards, which provide a source of forage and shelter. There are six areas with the physical characteristics of deeryards in the New Hampshire portion of the study area. However, these areas apparently have not been surveyed to confirm use by deer.

Gamebirds in the area include wild turkey, ruffed grouse, ring-necked pheasant, northern bobwhite, and more than 20 species of waterfowl. Most waterfowl are migrants or winter residents, but the mallard, wood duck, black duck, and Canada goose nest in the area (Blodget 1983). Waterfowl numbers are not extensive because the study area is within a low-migratory-population corridor for geese and ducks (Bellrose 1976).

3.4.2 Aquatic Environment

About 300 surface waters would be crossed by the proposed transmission line (Section 3.3.1). Of these, at least 53 are known coldwater or warmwater fisheries (ER, Vol. 2--Table III-33, Vol. 3--Table III-35). Generally, most streams in New Hampshire are considered potential trout streams. However, warmer water temperatures in some streams make them unsuitable for year-round use by trout.

Both warmwater and coldwater fish communities occur in the Massachusetts portion of the study area. Existing coldwater fisheries are maintained mostly by annual stocking programs (Massachusetts Division of Fish and Wildlife 1984), but there are a few exceptions. For example, natural trout spawning is reported from Wachusett Reservoir (Halliwell 1981). Ponds and lakes in the study area are considered warmwater fisheries, except for several at higher elevations that are cold enough to support trout year-round. Newfound Lake, the largest lake in the study area, supports a two-story fishery that includes landlocked salmon, lake trout, whitefish, smallmouth bass, pickerel, and yellow perch (ER, Vol. 3). Two tributaries of the lake (Cockermouth and Fowler Rivers) support spawning runs of landlocked salmon (U.S. Fish and Wildlife Service 1982). Good to excellent trout streams have the general habitat characteristics listed in Table A.6 of Appendix A, as well as temperatures adequate to meet the requirements for trout survival and reproduction (Table A.7).

The principal warmwater game fish in the study area include chain pickerel, white perch, various sunfish, largemouth and smallmouth bass, black crappie, and yellow perch. Eastern brook trout, rainbow trout, and brown trout are the principal coldwater game fish. A number of other game forage and rough fish species occur in the ponds, lakes, and streams throughout the study area (ER, Vol. 2--Table III-9, Vol. 3--Table III-10).

Trout are stocked in some of the streams that would be crossed by the proposed transmission line (ER, Vol. 2--Table III-33, Vol. 3--Table III-35). Stocking is done to supplement natural reproduction or to provide a seasonal coldwater fishery in streams where natural reproduction does not occur. Generally, heavy trout fishing pressure necessitates constant restocking (Eddy and Underhill 1974).

Several of the rivers in the study area are, or soon will be, managed to allow reestablishment of anadromous species, namely the Atlantic salmon, American shad, blueback herring, and alewife. A fishway has been constructed at Lowell Dam and should be operational in 1986. This will allow the latter three species to ascend to the portion of the Merrimack River that is in the study area (ER, Vol. 2). A number of rivers in both the Merrimack and Connecticut River basins are targeted for Atlantic salmon and American shad reestablishment programs (ER, Vol. 3--pp. 94-95).

Detailed characterizations of the benthic macroinvertebrates of the waterbodies in the study area are not available. Since most of the water-bodies are Class A or B waters (ER, Vols. 2 and 3), it is likely that they maintain productive benthic communities composed of a diverse assemblage of invertebrate species indicative of good to pristine water-quality conditions. The few Class C waters to be crossed by the proposed transmission line are probably dominated by invertebrate species tolerant of organic enrichment or other degraded water-quality conditions.

3.4.3 Wetlands

Wetlands are systems where the water table is usually at or near the surface or where land is covered by shallow water at least periodically (Cowardin et al. 1979). Wetlands that would be crossed by the proposed line are principally marshes (vegetation dominated by grasses, reeds, rushes, sedges, and other nonwoody plants) or swamps (vegetation dominated by bushes and trees). Other wetland types present include bogs, prairies, and ponds. The transmission line corridor would cross 98 wetlands in New Hampshire and 119 wetland areas in Massachusetts. Detailed information on the wetlands is given in Appendix B.

3.4.4 Threatened and Endangered Species

The Endangered Species Act of 1973 requires a determination of the presence of endangered and threatened species and/or their critical habitats within the vicinity of a proposed federal action. The DOE Staff has consulted with, and received information from, the U.S. Fish and Wildlife Service and the New Hampshire Fish and Game Department concerning federally and/or state listed species (see letters in Appendix E from G.E. Beckett, Supervisor, New England Area, Ecological Services, U.S. Fish and Wildlife Service, February 13, 1986; and from H.P. Nevers, Federal Aid and Endangered Species Coordinator, New Hampshire Fish and Game Department, February 14, 1986). Similar correspondence was implemented by the Applicant with the Massachusetts Natural Heritage Program relative to state-listed species. A copy of the correspondence from these agencies is included in Appendix E. The following sections contain information on the endangered, threatened, and rare species that may occur within the area. This information is based upon the above mentioned consultations and pertinent reference literature.

3.4.4.1 Vegetation

No federally listed endangered or threatened plant species occur within the counties that would be traversed by the proposed transmission line (Beckett 1986).

New Hampshire has not developed an official state list of endangered and threatened plants, but the New Hampshire Natural Heritage Program, through the New Hampshire Natural Heritage Inventory, has developed a list of rare plant species (New Hampshire Office of State Planning 1984). Within 0.4 km (0.25 mi) on either side of the New Hampshire portion of the proposed transmission line, 11 species of rare plants have been reported (Brackley and Hentcy 1985).

Forty-seven plant species listed by the state of Massachusetts as rare and declining occur within the Massachusetts portion of the study area (ER, Vol. 2--Table III-10). Only one of these, the climbing fern, is likely to be present near the proposed transmission line. However, a field survey by the Massachusetts Natural Heritage Program has determined that the climbing fern does not occur in the right-of-way (ER, Vol. 2). The rare plants and their habitats are listed in Table A.8 of Appendix A.

3.4.4.2 Fish and Wildlife

A number of federally listed and state-listed threatened and endangered animal species may occur as transient individuals within the counties containing the proposed route (Beckett 1986). The species, their status, and their general habitats are listed in Table A.9 of Appendix A. In Massachusetts, none of the species listed as endangered or threatened is considered by the Massachusetts Natural Heritage Program to be near the proposed transmission route in that state (ER, Vol. 2). The Massachusetts Natural Heritage Program also has a category listing species considered to be "of special concern." The Program has determined that of the 30 species listed in this category, only the southern bog lemming is likely to be present near the proposed transmission line. It has been recorded from a wetland in Dunstable. Its habitat includes wet sedge meadows, sphagnum bogs, and (less commonly) orchards and open grasslands (ER, Vol. 2).

Of the 19 species listed by the state of New Hampshire as threatened or endangered, 11 (all birds) have been observed in the study area. These are the bald eagle, peregrine falcon, Cooper's hawk, osprey, red-shouldered hawk, northern harrier, common loon, upland sandpiper, whip-poor-will, purple martin, and eastern bluebird. No active nests of the first four species are known to occur in the study area, but some individuals of the other seven species may nest in or near some of the counties that would be traversed by the proposed line (ER, Vol. 3).

3.5 SOCIOECONOMICS

3.5.1 Institutional Setting

Local governmental units in both New Hampshire and Massachusetts consist of counties that are further subdivided into towns (which are somewhat equivalent to townships in some parts of the country). Each organized town traversed by or adjacent to the proposed right-of-way (total of 27 in New Hampshire and 17 in Massachusetts) is administrated by a town meeting/board of selectmen type of government. The chief source of local revenue is property taxes (payable directly to cities and towns), followed by revenue-sharing (primarily from the state) (Bureau of the Census 1983).

3.5.2 Population

The population density exhibits marked variation along the proposed corridor, ranging from low-density rural to moderate-density urban (see Table A.10 of Appendix A). The lowest population densities occur in Grafton County, New Hampshire, where several towns (Lyman, Benton, and Groton) contain fewer than 4 persons/km^2 (10/mi^2). (Most towns in the county have total populations of less than 1,000 persons.) The largest population concentrations are in the towns of Shrewsbury and Milford, Massachusetts, where the population density exceeds 385 persons/km^2 (1,000/mi^2), and in Concord City and adjacent towns in New Hampshire.

Growth trends for New Hampshire reflect significant acceleration during the 1970-1980 decade, especially in rural areas. By contrast, growth rates for the same period were much less in Massachusetts, with some towns even reporting modest declines. Moderate growth is projected for the period 1980-1990 in areas in both Massachusetts and New Hampshire traversed by or adjacent to the proposed transmission line route. Past trends and projections are presented in Table A.10.

3.5.3 Employment and Economics

The 1982 labor force in counties traversed by the proposed right-of-way totaled 343,247 for New Hampshire and 1,402,567 for Massachusetts. Unemployment rates for that year ranged between 6% and 7%, except for Worcester County, where it reached 9.4%; by 1984, unemployment had fallen to less than 5.0% (Bureau of the Census 1983; ER, Vol. 2--p. 127, Vol. 3--p. 114).

The primary categories of employment in the area are manufacturing and professional and related services. These two categories respectively account for an average of 27.2% and 23.4% of employment in the area, by county. The other major categories include wholesale and retail trade (18.9%) and government (15.9%) (Bureau of the Census 1983). Manufacturing jobs are chiefly in machinery, electrical products, metals, and lumber and wood products (Bureau of the Census 1985a, 1985b). Tourism is an important industry in several of the counties, especially Grafton.

Median family income was $19,837 for the four New Hampshire counties and $23,322 for the three Massachusetts counties in 1979. Income is lowest in the rural areas; in several Grafton County towns it falls below $14,000 (New Hampshire Office of State Planning 1983b; Bureau of the Census 1983).

3.5.4 Housing

In 1980, there were 249,205 housing units in the New Hampshire counties traversed by the proposed route and 945,628 in the Massachusetts counties. The former represents a significant increase over 1970, ranging between 35.5% and 43.3% by county, while modest increases (14.4% to 17.5%) occurred in the Massachusetts counties. Vacancy rates for rental units in 1980 varied between 4.5% and 6.1% in New Hampshire, except for Grafton, with 11.1%. More moderate rates (2.8% to 4.8%) were reported for Massachusetts (Bureau of the Census 1972a, 1972b, 1982a, 1982b).

In 1982-1983 there were 288 temporary lodging establishments (chiefly hotels and motels) in the New Hampshire counties along the route and 203 in the Massachusetts counties. Figures are highest in areas where tourist demand is strong, especially in Grafton and Rockingham counties, New Hampshire (Bureau of the Census 1985a, 1985b).

3.5.5 Transportation

The transportation network in the proposed project area is described in Section 3.2.9.1. The most heavily traveled roadways in the New Hampshire portion of the proposed route are in the more urban southern regions, traversed by two interstate routes (I-89 NW-SE and I-93 N-S). Average annual daily traffic (AADT) volumes for these roads range as high as 16,000 and 30,000, respectively, for Concord. Other high-volume roads (more than 10,000 AADT for some areas) in the southern towns include U.S. 3 (N-S) and 393 (E-W) and SRs 101 (NE-SW), 101A (NW-SE), 102 (NE-SW), 111 (E-W), 114 (N-SE), and 114A (NW-SE). North of Concord, traffic volumes decline substantially, generally falling below 3,500 AADT. The most heavily used roads (over 2,000 AADT in some areas) include U.S. 302 (N-SW) and SRs 3A (N-S), 10 (N-S), 11 (E-W), and 25 (N-SE) (New Hampshire Department of Public Works and Highways 1984; ER, Vol. 3--pp. 145-146, Table III-20).

Traffic flows are high in the Massachusetts counties, although volume data are not available. The area is traversed by four interstate highways: I-90 (E-W), I-190 (N-S), I-290 (E-W), and I-495 (N-S). Other major roads include U.S. 3 (N-SE) and 20 (E-W) and SRs 2 (E-W), 9 (E-W), 12 (N-S), 117 (E-W), 119 (NE-SW), and 140 (NE-SW) (Massachusetts Department of Public Works 1982-1984; ER, Vol. 2--pp. 148-149, Table III-21).

3.5.6 Public Concerns

Although few public concerns relative to the proposed project were voiced at the DOE scoping meetings held in Concord and Boston on June 4-5, 1985 (U.S. Department of Energy 1985), concerns were expressed at a hearing held in Groton, Massachusetts, on February 5, 1985 (conducted jointly by the Massachusetts Department of Public Utilities, the Massachusetts Energy Facilities Siting Council, and the Massachusetts Environmental Policy Act Unit of the Executive Office of Environmental Affairs), and in written correspondence to DOE. The primary issue raised was potential adverse health effects (both to humans and livestock); less commonly expressed concerns included visual impacts, potential increases in underground pipeline corrosion, need for power, property value effects, noise, and impacts to wildlife.

3.6 VISUAL RESOURCES

3.6.1 Visual Resources Study Area and Landscape Classifications

A 3.2-km (2-mi) corridor centered on the proposed transmission line route initially was selected for evaluation of visual resources. This selection was based on the assumption that construction of the proposed transmission line within an established right-of-way occupied by one or more existing transmission lines would not significantly degrade viewsheds from the boundary of the study area corridor. However, during field surveys, boundaries of the study corridor were expanded to encompass viewsheds from particularly sensitive areas. In other instances, the boundaries of the study corridor were narrowed in accord with landscape features that would preclude observation of the proposed transmission line.

The Applicant has identified landscapes of the study area in terms of three classes of visual quality--Distinctive, Noteworthy, and Common. Distinctive landscapes are areas of high visual quality, whereas the visual quality of Noteworthy landscapes is less, but nevertheless important. Landscapes characterized by typically inconspicuous features are categorized as Common landscapes. The classification of a given landscape is based on four landscape elements, i.e., landform, water, vegetation, and cultural or man-made modifications. The landscape quality matrix is presented in Table A.11 of Appendix A.

3.6.2 Route Landscape Descriptions in New Hampshire

Vistas along the proposed transmission line route in New Hampshire are predominantly Distinctive and Noteworthy landscape types (see Table A.11), particularly in northern portions of the study area. The following descriptions of landscapes along the proposed New Hampshire route are adapted from the ER (Vol. 8--Sec. III.B.2) and correspond with segments of the route identified by the Applicant--Monroe to Rumney (Segment A), Rumney to Goffstown (Segment B), and Goffstown to the New Hampshire/Massachusetts state line (Segment C). Towns in which the segments begin or terminate are shown in Figures 2.2 and 2.3. Detailed maps delineating the New Hampshire study area established by the Applicant are presented in the ER (Vol. 8--Figures III-2.1 through III-2.8).

Segment A: From the northern terminus of the proposed line in the town of Monroe, this segment extends south for about 60 km (37 mi) to the town of Rumney. The terrain is typical for the White Mountain Section of the New England province, i.e., rolling hills and several low mountain ranges with peak elevations ranging up to 915 m (3,000 ft). Some of the higher peaks include Jeffers, Hogsback, Sugarloaf, and Black mountains in the town of Benton. Rock outcrops such as Pond Ledge and Owls Head are prominent landscape features in the towns of Haverhill and Benton, respectively. The Connecticut River Valley is the dominant landform of the western portion of the study area in the towns of Monroe and Bath. Vegetation is typically Northern Hardwood-Spruce Forest, with stands of spruce and fir being particularly extensive in northern portions of the segment. However, interspersions of coniferous and deciduous forest stands over large areas create patterns of color that are particularly attractive during the fall. Water elements include scattered lakes and ponds, the relatively large Moore Reservoir, and rapid-flowing drainages such as the Ammonoosuc and Wild Ammonoosuc rivers. Aside from the Connecticut River Valley, cultural developments are characterized by scattered farmsteads and rural residences with small communities and highways located along valley floors. In combination, natural and cultural features comprise a high proportion of Distinctive and Noteworthy landscapes in this segment.

Segment B: From the town of Rumney, this segment extends south about 93 km (58 mi) to the town of Goffstown. The segment is transitory in that topographic relief tends to decrease and cultural development tends to increase in a southerly direction. In general, the terrain consists of scattered hills and remnant mountains, but hills and mountains are more common to the north, while topographic relief is less pronounced in the southern part of the segment. The vegetation is generally similar to that of Segment A, except that the prominence of red and white pine increases while spruce and fir are less important components of forest stands. Water elements of this segment include the relatively large Newfound Lake; numerous scattered small lakes and ponds; and the Merrimack, Contoocook, and Piscataquog rivers. South of the town of Boscawen, the natural landscape has been fragmented by agricultural and residential land use. Other cultural changes remain reasonably compatible with surrounding natural landscapes, but modifications range from residential areas along established roads to small- and medium-sized commercial areas, to the Concord metropolitan area. Compared with Segment A, Distinctive and Noteworthy landscapes are less prominent in this segment of the study area.

Segment C: This landscape segment extends south from the town of Goffstown about 40 km (25 mi) to the New Hampshire state line and is typical of the New England Seaboard Lowland section. Topographic relief generally ranges from 75 to 150 m (250 to 500 ft). Occasional monadnocks such as North and South mountains are the only prominent features of this landscape segment. The dominant white and red pine forest type frequently occurs bordering agricultural areas in relatively flat terrain. Recent development activity has occurred, transforming some rural areas into residential and commercial centers and dramatically modifying the associated landscape. Compared with Segments A and B, lakes and ponds are less common in Segment C and are typically surrounded by moderate development. The proposed transmission line would intersect and generally parallel the Merrimack River throughout this landscape segment. The river corridor has been developed into a major transportation and commercial center that tends to dominate the visual character of the river valley. In summary, this landscape segment includes more elements of Common landscape than other segments of the New Hampshire study area.

3.6.3 Route Landscape Descriptions in Massachusetts

The following descriptions of landscapes within the Massachusetts study area are adapted from the ER (Vol. 7--Sec. 3). The descriptions correspond with the framework of landscape classes discussed in Section 3.6.1 and are in accord with segments of the proposed route identified by the Applicant, i.e., New Hampshire/Massachusetts state line to Ayer (Segment A), Ayer to Millbury (Segment B), and Millbury to West Medway (Segment C). Towns in which segments begin or terminate are shown in Figures 2.3 and 2.4. Detailed maps delineating the Massachusetts study area and formally designated landscape units are presented in the ER (Vol. 7--Figure III). All Distinctive and Noteworthy landscapes in Massachusetts are recorded in the Massachusetts

Landscape Inventory, each identified by name, code designation, and location (ER, Vol. 7--p. 55).

Segment A. The proposed route traverses Common landscape throughout the entire length of this segment. The landform is predominantly gently rolling terrain, only occasionally interrupted by low hills. The Merrimack River is a major drainageway that intersects the study area, but shoreline development significantly detracts from the visual quality of the river landscape. Vegetation patterns are dominated by Appalachian Oak Forest typical of glaciated areas, consisting primarily of the elm/ash/maple and oak/hickory forest types (see Appendix A). The vegetation patterns dominated by forest are interrupted by active and abandoned farms and developed land. Much of the man-made modifications of landscapes include major highways and industrial and residential areas. However, the landscapes in Segment A are primarily rural in character, the exceptions being the considerable development between U.S. 3 and the Merrimack River and in the vicinity of the Sandy Pond substation.

Within Segment A, the Lower Nashua Valley Distinctive Landscape Unit (C1)* encroaches into the outer boundary of the study area and extends close to and parallels the proposed route for a short distance in the town of Groton. The high visual quality of this landscape unit is attributable to picturesque orchards and farms, wooded drumlins, and open high ground that affords vistas of the Wachusett Mountains to the west and monadnock mountain region of New Hampshire to the northwest.

Segment B. Distinctive and Noteworthy landscapes are traversed by, or are adjacent to, the proposed transmission line route at four locations within Segment B (see below). Otherwise, the proposed route traverses Common landscapes for virtually the entire length of the segment, and landform and vegetation elements of Segment B tend to be similar to those of Segment A. However, vegetation patterns tend to be more fragmented in Segment B, primarily due to a generally greater density of residential areas, industrial/commercial complexes, and other man-made modifications. Increased development is particularly notable in towns in the Worcester area. The proposed route intersects the Nashua River, but proximity of the Boston and Maine Railroad, Fort Devens, and a mining area detract from the visual quality of the river landscape. Other water elements include the North Nashua River and numerous lakes and ponds, many of which are virtually surrounded by residential development.

The four areas of Distinctive and Noteworthy landscapes in Segment B are the Sterling Landscape Unit (C6), the Upper Nashua Valley-Shrewsbury Ridge Landscape Unit (C2), the Nashua Valley Noteworthy Landscape Unit (C1), and the Lunenburg Noteworthy Landscape Unit (C5). The Sterling unit, located in the

*This and subsequent "unit" designations indicate Distinctive and Noteworthy landscapes identified in the Massachusetts Landscape Inventory (ER Vol. 7--p. 55).

town of Sterling, is traversed by the proposed route for a short distance, and generally parallels the route for about 3.2 km (2 mi). This unit includes both Distinctive and Noteworthy landscapes; the moderate to high visual quality of the unit derives from extensive apple orchards and open highlands that afford views of distant landscapes. The proposed route also intersects two narrow segments of the Upper Nashua Valley-Shrewsbury Ridge unit in the town of West Boylston. The unit includes both Distinctive and Noteworthy landscapes, primarily consisting of the Wachusett Reservoir and its immediate shorelines. The reservoir is a major scenic attraction. The Nashua Valley Noteworthy unit abuts the proposed route in the town of Ayer, and the Lunenburg Noteworthy unit is adjacent to the proposed route in the town of Shirley.

Segment C. Landscape features traversed by the proposed route virtually throughout the length of this segment are characteristic of Common landscapes, e.g., gently rolling topography and typical regenerating Appalachian Oak forest interspersed with ponds, streams, and wetlands; as well as considerable cleared and developed land. An exception is where the proposed route intersects a 460-m (1,500-ft) segment of a southern extension of the Grafton Distinctive/Noteworthy Landscape Unit (C3) in the town of Grafton. This landscape unit widens to the north of the route intersection and generally parallels the proposed route for about 4 km (2.5 mi). Principal features contributing to the comparatively high visual quality include picturesque dairy farms and apple orchards, as well as dispersed highland areas.

Converter Terminal Site. Within rolling topography, the general area of the proposed converter terminal site is characterized by Common landscape dominated by man-made modifications. The site is within a triangle formed by two highway routes and a branch of the Boston and Maine railway system, all within about 520 m (1,700 ft) from site boundaries at closest distance (ER, Vol. 1--Figure IV-6). Electric transmission facilities adjacent to the site include an existing substation, a transmission line extending into the area from the north, and an east-west transmission corridor immediately south of the site that is occupied by three transmission lines. Additionally, an industrial complex is adjacent to and south of the site, and a gravel mining area parallels the eastern boundary of the site.

3.7 CULTURAL RESOURCES

3.7.1 Introduction

Cultural resources primarily include archeological sites (both prehistoric and historic) and historic structures, which are protected by or qualify for protection under the National Historic Preservation Act and other federal and state laws. Pursuant to these laws, the Applicant conducted an inventory and evaluation (in consultation with the New Hampshire and Massachusetts State Historic Preservation Officers [SHPOs]) of sites that could be affected by the proposed action (ER, Vol. 2--p. 152-155; ER, Vol. 3--p. 153-157; Quinn 1985;

Talmage 1985; New England Power 1986a, 1986b). Inventory procedures and study area boundaries are described for each site category below. There are no Native American religious sites (protected by the American Indian Religious Freedom Act) or paleontological sites that would be affected by the project.

3.7.2 Regional Prehistory and History

New England prehistory begins with Paleo-Indian settlement, following retreat of the Wisconsin ice sheet after 12,000 years before present (B.P.). Subsequent prehistory is divided into Archaic (preceramic) and Woodland (ceramic) phases. Regional prehistoric overviews are presented by Griffin (1964), Willey (1966), Newman and Salwen (1977), and others. Both New Hampshire (Pillsbury 1927-1928; Squires 1956) and Massachusetts (Hart 1927-1930; Brown 1978) also possess a long and rich historical record, extending back to the 17th century A.D.

3.7.3 Archeological Sites

Archeological sites include surface and subsurface remains from prehistoric and historic periods. A literature/file inventory of previously recorded sites (including the National Register of Historic Places and the appropriate state registers) indicated that the New Hampshire towns traversed by the proposed right-of-way contain 14 archeological sites, and that 4 archeological sites lie partially on or adjacent to the Massachusetts segment (ER, Vol. 2--pp. 152-155; ER, Vol. 3--pp. 153-156).

The Applicant also undertook a field survey for previously unrecorded archeological sites in areas that would be affected by the proposed project. The survey strategy was developed in consultation with the appropriate State Historic Preservation Office (see letters in Appendix E from J.F. Quinn, Deputy New Hampshire State Historic Preservation Officer, October 30, 1985; and from V.A. Talmage, Massachusetts State Historic Preservation Officer, September 9, 1985). Survey methods included a 100% pedestrian surface reconnaissance of the right-of-way and proposed converter terminal sites, and subsurface testing of areas on the right-of-way where proposed structure locations coincide with high site potential (Office of Public Archaeology 1985; New England Power Co. 1986a).

The sites discovered in the course of the survey bring the total to 46 archeological sites (14 prehistoric and 32 historic) located on or adjacent to the right-of-way (New England Power Co. 1986c). Nineteen sites occur in New Hampshire, and 27 sites are located in Massachusetts. Eleven sites have been determined to be ineligible for the National Register of Historic Places (New England Power Co. 1986c, pp. 2-3). The remaining 35 sites have not been evaluated for National Register eligibility, but will be protected from adverse effects by a series of mitigative measures and therefore do not require testing (see Section 4.1.10).

3.7.4 Historical Structures

Although prehistoric sites may contain structures and historic sites may lack them, historic structures may be considered separately because the methods employed for inventory and impact assessment differ from those applied to other cultural resources. An initial literature/file search by the Applicant produced a total of 56 historical structures or historic districts containing structures listed on the National Register or the state registers in towns traversed by the proposed route. The structures include houses, covered bridges, churches, schools, and others (ER, Vol. 2--pp. 153-154, Table III-24; ER, Vol. 3--pp. 155-156, Table III-24).

The Applicant also conducted a more intensive project-specific survey during August-November 1985 and April 1986. The survey design (approved, with modification, by the appropriate SHPOs) entailed identification and evaluation of all historic structures located within one-quarter mile of the proposed right-of-way, and also those outside the one-quarter mile boundary but in proximity to it (Office of Public Archaeology 1985--p. 9-12; New England Power 1986a--pp. 10-11).

A total of 766 individual properties and 30 districts were inventoried within the study area (301 properties and 13 districts in New Hampshire and 465 properties and 17 districts in Massachusetts). In New Hampshire, 114 properties and all 13 districts were determined to be eligible for the National Register, while in Massachusetts, 76 properties and 5 districts were determined eligible (New England Power Co. 1986c; Talmage, 1986).

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4. ENVIRONMENTAL CONSEQUENCES

4.1 CONSEQUENCES OF THE PROPOSED ACTION

The proposed action includes numerous committed mitigative measures that are identified by category in Section 2.1.5. Each of the following discussions of environmental consequences of the proposed action assumes the adoption and effective implementation of all listed mitigative measures. Because of these mitigative measures and the fact that almost all of the proposed transmission line would be constructed within established rights-of-way and adjacent to existing transmission lines, most of the incremental environmental impacts associated with the proposed action would result from short-term construction activities that would be transitory in nature.

4.1.1 Air Quality

The greatest project-related impact to air quality would be from fugitive dust generated during clearing and construction activities. Although locally heavy at times, the dust generally would not be bothersome at distances of more than 300 m (1,000 ft) from the clearing and construction activities. At this distance, the concentration of dust would have decreased to less than one-tenth of the initial concentration (Sullivan and Woodcock 1982). During construction of the line, contractors would be required to provide dust-control measures to avoid undue impact. Watering has been shown to be an effective and inexpensive method to reduce dust. For example, one study indicated that dust releases were lowered by as much as 95% from a haul road if the road was watered twice an hour (Maxwell et al. 1982). Under normal conditions of watering, the major impact should not extend more than 100 m (300 ft) from the dust source.

Air-quality impacts from gaseous pollutants from diesel exhausts, i.e., sulfur dioxide and nitrogen oxides, would be minor and transitory because of the mobile nature of the sources. Because of this, the emission of these gases would not cause or contribute to any violations of air-quality standards. The amount of carbon monoxide and hydrocarbons released from diesel engines is also small and would not cause any violation of air-quality standards.

Ordinarily, ozone is a secondary pollutant formed by the interaction of hydrocarbons, oxides of nitrogen, and ultraviolet radiation within sunlight. In the case of high-voltage transmission lines, however, ozone is directly produced by the conductor corona of the transmission lines. Under worst-case conditions, ozone levels of about 20 $\mu g/m^3$ (10 ppb) above background have been measured under lines operating at ±400 to ±500 kV DC (Droppo 1979; Krupa and Pratt 1982). A number of field experiments have shown that ground-level ozone concentrations resulting from transmission line corona are usually indistinguishable from background concentrations (Sebo et al. 1976; Roach et al. 1978). Johnson and Zaffanella (1982) measured no detectable ozone levels above background beneath a line operating under conditions similar to those proposed for the DC interconnection. Comber et al. (1982b) estimated than an operating 1050-kV AC line may increase ozone by 5 ppb above background. The one-hour EPA standard for ozone is 120 $\mu g/m^3$ (60 ppb). Minimum levels of toxicity are reported to be about 200 $\mu g/m^3$ (100 ppb). Based on these studies, it is apparent that operation of the proposed transmission system would not result in the production of ozone at toxic levels.

In summary, local ambient air quality would be only slightly and temporarily impacted by fugitive dust emissions if mitigative measures are employed during construction. Release of gaseous pollutants would not result in significant impacts on local air quality.

4.1.2 Land Features and Use

4.1.2.1 Geology

Construction, operation, and maintenance of the proposed transmission facility would have only minor or negligible impacts on geologic conditions. Terrain changes associated with the construction of the proposed transmission lines would be confined to local landscape alterations caused by construction-vehicle traffic and leveling or grading for transmission line structure sites and access roads. Changes in landform would also occur at the proposed 12-ha (30-acre) converter terminal site, where cut and fill would be used in site preparation prior to construction of terminal facilities.

Placement of transmission structures on sloping areas could produce localized slope failures and resulting landslides. These areas are confined to stream crossings, steeper slopes, and dissected uplands of major river valleys. Examples of such areas include some banks of the Ammonoosuc River near Bath, the Fowler River near Alexandria, and the Merrimack River near Merrimack, all in New Hampshire, and the Wachusett Reservoir in the town of West Boylston, Massachusetts.

A seismic risk map indicates that the study area is in a region expected to sustain minor earthquake damage (Corps of Engineers 1983). The transmission facilities, including structure footings and substations, should be designed with a safety factor to account for earthquake loadings. Seismic activity of low or medium intensity would have little or no effect on the transmission line system. Although the historical record indicates minor seismic activity in the general project area, this does not preclude the occurrence of a major earthquake (intensity of 7 or higher, Richter scale), which would likely cause severe structural damage to the facilities.

Construction of structure foundations, access roads, and substations would result in the consumptive use of sand and gravel resources. These resources might have to be imported from outside the right-of-way, since surface materials in the right-of-way consist primarily of clay-rich till. However, sand and gravel resources are of local importance only and supplies would not be unduly strained by construction needs.

4.1.2.2 Soils

Project-related impacts on soil resources include consideration of important farmlands as identified in the Farmland Protection Policy Act (Public Law 97-98, December 22, 1981). The 298 km [185 mi] of proposed transmission line routes in Massachusetts and New Hampshire would traverse a cumulative total of 35 km (22 mi) of prime and other farmland of statewide importance (Section 3.2.2). At an average structure spacing of 183 m (600 ft), spanning the 35 km (22 mi) of prime and other important farmland would require about 193 structures. Based on published data (Scott 1981), the calculated total cumulative area of important farmland that would be disturbed or inaccessible to operators of farm implements around 193 H-frame structures would range from 1.6 ha (3.9 acres) to 3.2 ha (7.7 acres). The affected area is somewhat overestimated since some important farmlands would be spanned and some single-pole structures would be used in transmission line construction. Some additional important farmlands would be disrupted to facilitate project access, but for the most part, existing access within the established transmission line corridors would be adequate for project development. Because of the limited area involved, project-related impacts on prime and other important farmlands would be of minor consequence.

The major impact on soils would occur during the construction period. Vegetation clearing and construction activities would increase the potential for soil erosion. Much of this erosion would occur in areas with a steep slope and/or highly erodible soil. The grades of many of the slopes along the proposed route equal or exceed 15%. Soils in areas with steeper slopes have more potential for soil erosion. If access roads are not properly located, graded, and maintained, concentrated runoff could occur, resulting in gulley erosion.

Site preparation for the proposed converter terminal construction site would create one of the more significant sources of accelerated erosion. The greatest erosion potential would exist during and following vegetation clearing, as well as during initial phases of leveling the 9-ha (23-acre) converter terminal site. Leveling of the site would involve cut-and-fill procedures whereby earth materials would be borrowed from the southwestern corner of the site to raise the surface elevation of other portions of the site. Erosion from the steeper slopes (12.5%) would diminish in accord with progress of site leveling operations. During site grading, temporary drainage ditches, sedimentation basins, hay bales, and plastic siltation fencing would be used to prevent runoff from attaining sufficient velocity to transport large volumes of sediment off the site (ER, Vol. 1--p. 70).

Upon completion of leveling operations, the entire converter terminal site would be graded to a 2% slope. Permanent drainage ditches and culverts would be installed to prevent runoff from flowing onto the site (ER, Vol. 1--p. 70). Also, measures would be implemented to ensure that sediment in runoff from the site would be deposited before the runoff reaches nearby surface waters. After final grading, the entire converter site would be surfaced with 7.6 cm (3 in) of crushed rock, thereby further reducing erosion potential.

Existing soils would be disrupted and/or displaced during the leveling of the 12-ha (30-acre) converter terminal site, grading and excavations at structure construction sites, and construction of access roads. However, the cumulative area of affected soils would be relatively limited since much of the required access has been previously developed during construction of existing transmission lines within the common right-of-way. Furthermore, excavations for structure foundations would entail minimal sacrifice of soil resources, particularly in upland areas. For example, the cumulative area for H-frame structure foundations would generally be less than 0.02 ha (0.04 acre) per 1.6 km (1 mi).

For the most part, excavated spoil materials at the converter terminal and access road construction sites would be used for fill. Any excess excavated spoil material that would be unsuitable as topsoil dressing would be removed from the converter terminal site (ER, Vol. 1--p. 73). At transmission line structure construction sites, the excess excavated spoil would be spread over areas adjacent to the structures. Distribution of the spoil materials would be such as to prevent interference with established drainage patterns (ER, Vol. 3--p. 47).

4.1.2.3 Land-Use Impacts

Agricultural Resources

Based on analysis of aerial photographs, the centerlines of the proposed transmission lines are estimated to traverse tracts of agricultural lands for a cumulative distance of 13.5 km (8.4 mi) in New Hampshire (ER, Vol. 3--p. 200) and 11.7 km (7.3 mi) in Massachusetts (ER, Vol. 3--p. 188), a combined distance of 25.2 km (15.7 mi). Given an average spacing interval of 183 m (600 ft) between structures, spanning this combined distance would entail construction of about 138 structures. Calculations based on published data (Scott 1981) indicate that the total cumulative area around 138 two-pole (H-frame) structures that would be inaccessible to operators of farm machinery ranges from 1.1 ha (2.8 acres) to 2.2 ha (5.5 acres). The inaccessible area would be even less since single-pole structures would be used along some segments of the proposed line. Furthermore, some tracts of agricultural land would be spanned, and use of pasturelands would be essentially unaffected by structures. Thus, the actual area withdrawn from agricultural production would be of minor consequence. Prime and unique farmland acreage affected by the proposed action is discussed in Section 4.1.2.2.

The proposed project also would entail some short-term impacts on agricultural resource areas. For example, some agricultural land could be temporarily unavailable for use during local construction. Construction activities could be scheduled to minimize damage to annual crops during the growing season; however, perennial crops such as orchards and nursery trees would be subject to damage regardless of the season of construction. Soils along temporary access routes and at construction sites would be subject to varying degrees of compaction, depending on soil properties and compaction loading; thereby causing corresponding reductions in crop yields for several subsequent years (Asplundh Environmental Services 1981). Restoration of productivity would depend on tillage practices and natural factors such as freeze-thaw cycles and soil fauna activity. None of these impacts are regarded as significant.

Forest Resources

Project-related impacts on forest resources would be relatively minor since virtually all of the proposed transmission lines would be located within established corridors in which most of the vegetation is controlled at heights compatible with operation of one or more existing transmission lines. An exception to this is a 1.3-km (0.8-mi) right-of-way that would extend from the Comerford converter terminal to an established transmission corridor in the town of Monroe, New Hampshire. This corridor would be cleared to a width of 61 m (200 ft). The only other forest removal required in New Hampshire would entail clearing a 23-m (75-ft) belt within an established 13.7-km (8.5-mi) transmission corridor from Sandy Pond junction to the state line. From the New Hampshire-Massachusetts boundary to the proposed converter terminal immediate to the Sandy Pond substation, cleared portions of the established transmission corridor would be widened by 23 m (75 ft) for 13 km (8.1 mi) and by 18 m (60 ft) for 6.6 km (4.1 mi). Cleared portions of the established 58-km (36-mi) transmission corridor between the Sandy Pond and Millbury substations would be widened at several locations. However, all such clearings within this corridor would be of limited extent and involve a total of 6 ha (15 acres) of forest vegetation (ER, Vol. 2--Table III-32).

The most extensive right-of-way clearing would occur within the established 25.9-km (16.1-mi) transmission corridor between the Millbury and West Medway substations. Cleared portions of the right-of-way would be increased by widths ranging from 24 m (80 ft) to 30 m (100 ft). Aside from right-of-way clearing, a 15-ha (36-acre) tract would be cleared to accommodate construction of the proposed converter terminal and two alternating current connector lines in Massachusetts.

In summary, the proposed project would result in withdrawal of about 146 ha (361 acres) from the forest resource base. For perspective, about 60% of the land area in Massachusetts and 86% of the land area in New Hampshire is forested (Kingsley 1976). Additionally, the aforementioned 147 ha (364 acres) withdrawn from the forest resource base represents less than 0.06% of the forest lands in Massachusetts and New Hampshire towns traversed by the proposed transmission lines (ER, Vol. 2, Table III-19; Vol. 3, Table III-18).

Mining Resources

Mining activities represent a very minor land use in the vicinity of the proposed project facilities. For example, the proposed transmission lines would traverse sand and gravel extraction sites for a total cumulative distance of 2.4 km (1.5 mi). Mining activities are not encouraged in the established transmission corridor within which the proposed lines would be constructed (ER, Vol. 2--p. 168); however, where feasible, excavations that would neither interfere with locations of structures nor jeopardize the structural and operational integrity of the proposed lines would be permitted.

Recreational Resources and Natural Areas

The proposed line would be developed within an established transmission corridor, thus all or portions of recreational resources and natural areas within the corridor already are traversed by one or more existing transmission lines. Users of such recreational resources are exposed to views of the lines and experience impacts of a visual nature. The adverse visual effects related to existing lines would be incrementally increased by development of the proposed line (see Section 4.1.6).

Project-related construction would not encroach on any major and intensively developed recreational areas, but some small portions within the established transmission corridor have been developed for recreational use. For example, a segment of the corridor in the town of Bedford, New Hampshire, is part of a golf course, and a boat launch facility and swimming beach are within the corridor in the towns of Shrewsbury-Grafton, Massachusetts (ER, Vol. 2--Table III-40). Other private developments have encroached on the edge of the transmission corridor at several locations; these developments include swimming pools and playground facilities. Users of developed recreational facilities within the corridor could be temporarily inconvenienced by project construction, but the only long-term impact would be visual in nature. Users of portions of the Upton State Forest and Wachusett Reservoir sites would also be exposed to views of the proposed line.

The proposed route intersects eight river segments in New Hampshire (see Section 3.2.6) and four river segments in Massachusetts that are identified as official or potential recreational resources by various agencies or organizations. Project construction likely would not interfere with river recreation, but river travelers would be exposed to views of the proposed line as well as one or more adjacent existing lines at several locations. Eleven scenic highways, six bike routes, and the Appalachian Trail intersect the proposed line (see Section 3.2.6). Project-related construction could temporarily interfere with use of these recreational routes, but the only long-term effect would be visual in nature.

In general, the level of potentially adverse impacts on recreational resources due to the proposed project is relatively low, since the long-term adverse effects on recreational resources would essentially be limited to incremental visual impacts; i.e., the visual intrusiveness of the proposed transmission line would exacerbate the visual intrusiveness of existing lines within the transmission corridor.

Residential, Commercial, and Industrial Areas

With exception of a 1.3-km (0.8-mi) segment located on existing utility property, the proposed transmission line would be developed within established transmission line corridors that have existed for 15 or more years (ER, Vol. 2--p. 194, Vol. 3--p. 206). In some towns, the transmission corridors are incorporated in town zoning district maps and land-use plans. No residential homes or business establishments occur in the transmission corridor; however, the corridor is encroached on at several locations. Two hard-topped parking lots associated with an industrial park extend into the corridor in the town of Bedford, New Hampshire (ER, Vol. 3--p. 208), and a truck-trailer storage facility occupies part of the corridor in the town of Shrewsbury, Massachusetts (ER, Vol. 2--Table III-35). These facilities could be altered during project-related construction. Urban residential areas would be crossed by the proposed transmission lines for a cumulative distance of about 1.9 km (1.2 mi) within nine towns in Massachusetts (ER, Vol. 2--Table III-35). These and other residential areas, as well as commercial and industrial developments adjacent to the transmission corridor, would be subject to increased levels of noise and dust during construction of the proposed project.

Construction impacts related to development of the proposed converter terminal in Massachusetts would primarily affect scattered residential units along roads surrounding the converter terminal site. The proposed route traverses the Fort Devens Military Reservation for about 2,160 m (7,100 ft) and some adjacent residential units could be affected by construction activities. However, since the proposed line would be developed within an established transmission corridor, the overall effects on residential, commercial, and industrial development would not likely reach unacceptable levels.

Transportation Facilities

Development of the proposed project would involve crossing about 210 major highways and local roads. Some local damage to roadbeds could occur due to movement of heavy vehicles and transport equipment. During line-stringing operations, temporary overhead guard structures would be erected at intersections of the proposed line and transportation routes. Motorists would be subjected to temporary increased levels of noise and fugitive dust at construction sites adjacent to the proposed line, and construction-related vehicles could cause short-term interference with local traffic patterns on routes adjacent to construction sites. However, construction would be scheduled so as to disperse activities along the entire proposed route, thus avoiding concentrations of construction activities (ER, Vol. 2--p. 197). Impacts on railroad facilities would likely be minimal. The Applicant would be committed to coordinate proposed construction activities with appropriate railroad officials to minimize interference with scheduled railway traffic (ER, Vol. 2--p. 201, Vol. 3--p. 214).

Conductor clearances over highways and railways would comply with the current National Electrical Safety Code. The Federal Aviation Administration (FAA) would be notified of the proximity of the proposed line to the Dean Memorial and Newfound Valley airports in New Hampshire, and the Moore Army Airfield and Shirley Airport in Massachusetts. Any issues whereby development of the proposed line would interfere with aeronautical facilities or navigable air space would be resolved though coordination with appropriate authorities.

Transmission Facilities

The proposed transmission line would intersect a total of 33 other electrical transmission lines (ER, Vol. 2--p. 203, Vol. 3--p. 214). The Applicant will coordinate with affected utilities during the design and construction of facilities, and the use of temporary guard structures during construction would avoid or minimize adverse effects associated with transmission line intersections (ER, Vol. 2--p. 203).

Pipelines intersecting the established transmission corridor (see Section 3.2.9.2) have been grounded to control electrical effects from existing AC transmission lines, thereby preventing excessive corrosion of the pipelines. The principal causes of corrosion on pipelines are natural and stray earth currents. Under normal conditions, AC and DC transmission lines create negligible currents in the earth and are not potential sources of pipeline corrosion. In general, pipelines are coated and connected to rectifiers for cathodic protection to prevent corrosion. The primary potential proximity effect of a transmission line on an intersecting pipeline is that occasional high current surges from lightning striking a transmission line could go to ground in proximity to a pipeline and damage the rectifiers (ER, Supplement, Sept. 29, 1986). This effect is prevented by a physical separation between grounded parts of the transmission line and the pipeline.

The Applicant proposes to meet all code requirements for separation between grounded parts of the proposed transmission lines and pipelines, and would comply with all transmission line proximity requirements of intersecting pipeline operators (ER, Supplement, Sept. 29, 1986). Thus, pipelines adjacent to or intersecting the proposed route would not be affected by operation of the proposed transmission line system.

As originally designed (ER, Vol. 8), the Phase I ground electrode would have been expanded to accommodate Phase II DC operation. The proposed expansion was an issue of concern, particular to several pipeline companies. Their concerns related to the potential for pipelines (and other linear underground steel structures) to be damaged from electrolytic corrosion or structure coating disbonding caused by ground currents from normal system imbalance or monopolar operation. Electrolytic corrosion occurs in areas were DC currents discharge from the pipeline. Structure coating disbonding can occur in areas where current enters a pipeline. Damage can result even during short periods of system imbalance. Elaborate mitigative measures would have been required to prevent damage from the proposed expanded ground electrode. Such measures would have included a system of rectifiers and cathodic protection to ensure compliance with Federal Pipeline Safety Regulations 49 CFR Part 191-192, as well as 49 CFR Part 195 for hazardous liquid pipelines. As the system was originally proposed with an expanded ground electrode, the variable nature of ground currents from (1) normal two-wire current imbalance flowing through the ground, (2) two-wire operation at half capacity with net ground return, and (3) one-wire operation at half capacity with full current flow through the ground in either direction would make mitigative measures for protection from a ground electrode both difficult and expensive. To eliminate concerns relative to pipeline protection, the Applicant now proposes to use an aboveground dedicated metallic return conductor that would carry all current imbalances or return current (ER, Supplement, Sept. 29, 1986). This would eliminate any potentially damaging discharges of large electric currents into the ground.

Communication Facilities

Project-related impacts on existing communication systems would likely be minimal. Communications for the proposed project involve an existing shared microwave system. Internal equipment at existing stations would be modified, but no additional access routes or station sites would be required (ER, Vol. 1--p. 68).

Other Land-Use Impacts

Development of the proposed project would entail establishing 25 to 35 construction laydown and staging areas at intervals along the proposed route (ER, Supplement, Response No. 7, September 27, 1985). An area of about 0.5 to 1.0 ha (1 to 2 acres) would be required for each laydown and staging site. Additionally, no more than 11 larger construction laydown and staging sites would be required (Reilly 1986). These larger sites would range in size from 2 to 5 ha (5 to 12 acres) and would generally be more removed from the right-of-way than the smaller sites. Because the exact number and location of these sites have not yet been determined, specific potential land-use impacts can not be evaluated. However, following construction of the proposed project, the laydown and staging areas would be reclaimed and restored to conditions similar to those existing prior to construction. Thus, meaningful effects on long-term land-use patterns would be unlikely.

4.1.3 Hydrology, Water Quality, and Water Use

4.1.3.1 Surface Water

Construction and operation of the proposed project would result in some adverse impacts on surface-water conditions. The majority of these impacts would be short-term and limited to the period of construction. Of greatest concern are impacts involving erosion of disturbed construction areas, with subsequent increases in turbidity and sedimentation of rivers, creeks, and wetlands in the area. Removal of trees, brush, and ground cover during construction would expose soils to increased erosion, particularly along shorelines and backshore areas, and movement of construction vehicles and equipment might accelerate the transport of disturbed soils to nearby waterways. The magnitude of potential erosion impact would depend on the steepness of the slope, timing of construction, and amount of ground cover removed (Section 4.1.2.2). At stream and river crossings, construction vehicles and equipment could contribute to siltation by disturbing stream banks and creek bottoms. Siltation increases water turbidity and decreases dissolved oxygen content. The use of erosion control measures described in Section 2.1.5.3 would minimize any potential erosion impacts and the potential of contamination of surface water bodies.

Water quality could be degraded by release of oils, greases, fuels, and herbicides; improper management of wastes during operation and maintenance of construction equipment; spilling of oil from substations; and release of domestic wastes generated by construction workers. Such contamination could cause a short-term, but potentially severe, reduction in water quality. During periods of high runoff, impacts to surface-water quality could be temporarily severe in affected areas. However, such impacts would be minimized by the proposed mitigative measures (Section 2.1.5.3).

Surface runoff along the transmission line right-of-way would be increased because of removal of vegetation and ground cover. This could result in reduced evapotranspiration and interception, as well as decreased permeability of the ground surface. However, the area within the right-of-way (about 15 km^2 [6 mi^2]) would be small relative to the total area of the affected watersheds. Therefore, the effects of surface runoff from the right-of-way would primarily be reflected by increased flows in the smaller local drainageways. Major drainage patterns and streamflow regimes in the principal drainageways would be essentially unaffected, except for a tributary of Roaring Brook in the town of Monroe, New Hampshire, that would likely be diverted a short distance in order to construct a transmission line angle structure (Walker 1986). In addition, temporary diversions of water might occur along access roads and around construction sites. Local surface drainages might be temporarily or permanently altered by access roads and construction activities. Most of these impacts would be short-term, but even permanent alterations should cause only minor local impacts.

Culverts would generally be used to cross ephemeral streams flowing during construction; however, fording of some streams and passage of construction vehicles and equipment across small wetlands would likely be required. The placement of culverts across streams, the fording of streams, and the construction conducted alongside the stream could result in damage to or collapse of localized portions of streambanks. Mitigative measures would be taken to minimize these potential impacts. Most culverts installed during project construction would be left in place to facilitate access for transmission line and right-of-way maintenance (Walker 1986).

4.1.3.2 Groundwater

Construction activities associated with the proposed project could result in some adverse impacts on groundwater conditions in the study area. Areas of greatest concern are where shallow glacial-drift aquifers occur and where perched water tables exist. In some places, clay-rich till separates the glacial-drift aquifer and a perched groundwater table from deeper aquifers. Excavation for structure foundations might penetrate the impervious clay-rich layer and provide a channel for connection with the underlying aquifers. This could cause perched water to drain into lower aquifers or deeper glacial drift aquifers. Penetration of impervious layers might increase recharge of aquifers buried under clayey layers that currently limit recharge. Hydraulic interconnection between aquifers could also result in contamination of glacial-drift and deeper aquifers with pollutants contained in the perched water. Careless and excessive application of herbicides during right-of-way maintenance could result in the percolation of herbicides to shallow glacial-drift aquifers, potentially contaminating water pumped from this aquifer. Although the potential for such impacts exists, the extent and magnitude would be minor if state and company guidelines regarding herbicide use around sensitive areas (such as wells) are followed (see Table B.1).

Compaction of soils and subsequent disruption of shallow groundwater flow patterns might occur on access roads and around structure sites during construction. Groundwater flow patterns also would be disrupted in areas where dewatering was required during construction due to a high groundwater table.

4.1.4 Ecology

Impacts to biota from construction and operation of Phase II facilities within New Hampshire and Massachusetts would be similar to those discussed for Phase I (U.S. Department of Energy 1984); however, the overall extent of impacts would be less because Phase II would be constructed largely within established rights-of-way. Therefore, much of the following discussion on ecological impacts is based on analyses from Phase I (and reported herein where applicable), accompanied by site-specific information contained in the Applicant's ER. Where appropriate, additional and/or more updated information has been added to more thoroughly address potential impacts. The potential impacts to biota, in particular migratory birds, as a result of hydroelectric development in Quebec, Canada, associated with Phase II contract sales are summarized in Section 4.1.4.5 and discussed in full in Appendix C.

4.1.4.1 Terrestrial

Vegetation

Vegetation would be affected by clearing along selected areas of the proposed right-of-way and at the site of the proposed converter terminal. Clearing would include (1) cutting and disposal of trees and (2) grubbing and disposal of stumps (ER, Vol. 1). The latter would be applicable primarily for the converter site and for areas in the right-of-way where access roads and transmission line structures would be located. Effects on vegetation from clearing operations would be similar to those typical of logging operations (U.S. Department of Energy 1984).

Right-of-way clearing would entail cutting of large mature trees and removal of potentially tall-growing trees. Damage to shrub and herbaceous species would be minimized to the extent possible. Vegetation beneath the transmission line conductors would be limited to low-growing shrubs and herbaceous species, as well as tree species of low-height potential. Removal or selective trimming of some danger trees outside the right-of-way would also be required. The amount of clearing that would be required is discussed in Section 4.1.2.3. Altogether, about 135 ha (330 acres) of right-of-way would be cleared. This area would consist of the general forest types shown in Table 4.1. Relative to total forest resources in the study area, this loss of forested area would be negligible.

Dust generated by construction traffic and equipment operation could be deposited on adjacent vegetation, affecting photosynthesis and plant growth,

Table 4.1. Forest Types and Areas to Be Cleared for the Proposed Right-of-Way

Forest Type	Composition	Area Cleared (ha)[a]
Hardwood	≥ 80% hardwood species	54.5
Hardwood/softwood	51% to 80% hardwood species	38.3
Softwood/hardwood	51% to 80% softwood species	25.7
Softwood	≥ 80% softwood species	13
Plantations	Assorted planted species	3.9

[a] 1 hectare (ha) = 2.47 acres.

Source: ER, Vol. 2--Table III-32, Vol. 3--Table III-34.

as well as making the vegetation less palatable to livestock and wildlife (Dvorak 1977). However, the relatively minor amount of anticipated disturbance, accompanied by mitigative measures to control dust, would render such impacts negligible.

Following initial clearing, and subject to easement agreements, vegetation in the right-of-way would be controlled by a combination of mechanical and chemical methods. Only herbicides and application methods approved by the U.S. Environmental Protection Agency and approved for right-of-way use by state pesticide boards would be used. Herbicides would be selectively applied at the base or stump (2,4-D, Picloram, Triclopyr, or equivalent) or on the foliage (previously mentioned herbicides plus Fosamine, Glyphosate, or equivalent) of undesirable species. The maintenance program is designed to suppress tree growth while encouraging the growth of shrubs, grasses, ferns, and other mature plants that do not exceed safe heights (ER, Vols. 2 and 3).

Vegetation treatment would involve selective treatment of stump sprouts during the dormant season after the first growing season following clearing. Two years later there would be a second selective application, and subsequent treatments would occur over a three- to five-year cycle (ER, Vols. 2 and 3). This would maintain cleared areas in a vegetative community dominated by shrubs, low-growing trees, and herbaceous plants similar to those occurring on existing portions of the right-of-way. Generally, hardwood species would be more likely to reinvade cleared areas than would coniferous species. This is because some hardwoods have stump sprouts or root suckers, hardwoods generally are faster growing, and conifers compete poorly in dense stands of bracken fern and blueberry that often invade after clearing (Galvin 1979; Leak et al. 1969). Shrub species occurring in forested areas normally form a significant component of new rights-of-way, as do herbaceous species typical of both forested and open areas (Holewinski 1981).

Although operation of the proposed transmission line would produce electric fields and generate air ions, ozone, and oxides of nitrogen, recent studies indicate that such phenomena would have no significant effect on right-of-way vegetation that is properly controlled (Griffith 1977; Minnesota Environmental Quality Board 1982; Banks et al. 1982a; Droppo 1981; Krupa and Pratt 1982). McKee et al. (1978) observed leaf tip damage, with tissue injury and death in the terminal parts and higher parts of the plants, at electric field strengths of 20 to 50 kV/m. However, this affected less than 1% of the plant tissue. No effects were observed at field strengths below 20 kV/m. Maximum field strengths expected for the proposed DC line would be in the 20 to 30 kV/m range and for the proposed AC line would be less than 7 kV/m. Maximum values would occur less than 5% of the time (see Section 4.1.8). Endo et al. (1979) found no effects from high voltage direct current on growth, yield, or chemical composition of wheat after exposure to 70 kV/m. Enhanced plant growth rate has been observed by Krueger et al. (1963) and Wachter and Widmer (1976) from exposure to positive and negative air ions. McKee et al.

(1978) emphasized that plant damage due to normal tissue drying typically exceeds that induced from even high-intensity electric fields.

In conclusion, operation of the proposed transmission lines would not be likely to cause appreciable adverse impacts to vegetative resources other than those subject to periodic right-of-way maintenance.

Wildlife

Impacts to wildlife that could result from construction of the proposed Phase II system include (1) loss and alteration of habitat with subsequent loss or alteration of carrying capacities for wildlife populations and (2) disturbance of wildlife by noise and human activity. Habitat loss is a major cause of wildlife population declines (Forsythe and Gard 1980; Fredrickson 1980). Some wildlife associated with the forested areas to be cleared would be affected by the project, but the habitats that would be affected are not critical or highly unique for any wildlife species in the area (U.S. Department of Energy 1978). Since the forested areas to be cleared represent a very small fraction of those types of areas occurring in the counties to be traversed by the proposed line, continued survival of local wildlife populations would not be threatened.

It is unlikely that construction activities would result in any significant impact to local wildlife species. Construction activity would likely disturb wildlife for only a brief period (days) in any given area (except perhaps at the proposed converter terminal, which would be constructed over a period of three years [ER, Vol. 1]). Affected wildlife should return to normal behavior patterns upon cessation of construction activities. This is especially applicable to wildlife currently utilizing the shrub/grassland and wetland habitats on the existing rights-of-way.

Relatively mobile species that inhabit or utilize areas to be affected by construction would be displaced to adjacent areas, where they may find suitable habitat. However, this would depend on the existing carrying capacity of the adjacent areas. This could subject displaced species to greater competition for habitat or food resources. If a given species is at its carrying capacity, then the total number of individuals would likely be reduced (Dvorak et al. 1978). Because the forest habitat to be lost is only a small percentage of that occurring in the study area, it is anticipated that the unaffected forest areas could support displaced individuals. Smaller or less mobile species might be destroyed by construction activities.

Wildlife in adjacent areas (both forested and existing rights-of-way) may also be displaced or disturbed during construction by the level of human activity and noise at the construction sites (ER, Vol. 1). This would apply to animals within auditory or visual range of construction activities. Heavy machinery (the anticipated source of most noise) produces just under 90 dB at 16 m (52 ft), with noise intensity decreasing at the rate of 6 dB per doubling of distance (U.S. Environmental Protection Agency 1974). Values between 50 and 90 dB can cause annoyance (Cheremisinoff and Cheremisinoff 1977). Thus, in theory, animals within 2,000 m (6,500 ft) of construction might be somewhat disturbed by noise from heavy machinery. In actuality, trees and other barriers (e.g., hills) would cause a loss of energy in sound waves, so the effective range of annoyance would be reduced. The consequences of noise (or visual) distractions to animals are not well documented, so it is difficult to predict how much impact these sources would actually have on the local fauna (Soholt and Bynoe 1982), but it is expected to be small. Nevertheless, if reproductive habitat is temporarily abandoned, a localized impact to the following season's wildlife populations might result (U.S. Department of Energy 1978).

Clearing would result in the loss of only a small fraction of the forest habitat in the study area (Section 4.1.2.3). However, the types of habitat lost versus the types of habitat created are important considerations when assessing the overall impact of clearing operations. Also, regardless of the habitat type cleared, some adverse impacts may occur to wildlife populations until vegetation is restored (U.S. Department of Energy 1978). In particular, concern would exist over potential impacts to migratory birds (as well as their nests and eggs) that would be vulnerable to clearing operations. Protection of these species from impacts associated with right-of-way clearing may be required under the Migratory Bird Treaty Act, as amended, 16 USC 703-711 (50 CFR 10.13). Mitigative measures to ensure compliance with the Migratory Bird Treaty Act are suggested in Section 4.1.10.4.

A number of investigators have examined the impact of clearing and right-of-way management on wildlife (e.g., Arner 1977; Asplundh Environmental Services 1977; Carvell and Johnston 1978; Galvin and Cupit 1979). Generally, right-of-way maintenance results in the presence of wildlife species that prefer open habitat with few large trees. These species are often those characteristic of early stages of plant community succession, such as are found in abandoned farm fields or in areas of postfire regeneration. More than 50 species of wildlife in the region frequently inhabit early successional stages of vegetation (U.S. Department of Energy 1978). Maintenance of a clearcut strip in an area of extensive forest offers a more diverse habitat than pure forest stands and supports a greater diversity of wildlife (Mayer 1976; Johnson et al. 1979; Geibert 1980; Cavanaugh et al. 1976; Kroodsma 1982). Thus, the creation of forest edge should enhance habitat for species typical of open or edge areas, but it would be somewhat detrimental to species that are more restricted to forest habitat. This would result either through competitive interactions with edge-inhabiting species or through habitat reduction. However, the proposed transmission lines would be located within existing transmission corridors. Thus, the creation of forested edge would not affect wildlife to the extent that it would if a new corridor was constructed through forested habitat.

Following all clearing (selective and nonselective), the corridor would be maintained primarily by selective application of herbicides. It has been shown that wildlife use of rights-of-way and herbicide use are compatible (Carvell and Johnston 1978; Asplundh Environmental Services 1977). The available data indicate that proper use of herbicides in right-of-way management does not pose a toxicological threat to wildlife individuals or populations. The planned use of herbicides along the proposed route would be similar to that in the existing rights-of-way and should not threaten wildlife. The Applicant is committed to apply herbicides in accordance with Massachusetts and New Hampshire regulations.

Although the primary impacts to wildlife would result from alteration of habitat in the right-of-way, there are potential impacts from the presence of the line--collisions of birds with structures or conductors and electrocution of birds. Raptors and waterbirds are particularly sensitive to such problems (Stalmaster and Newman 1978; Swensen 1979; Erwin 1980; Liddle and Scorgie 1980; Burger 1981).

There are documented studies of bird mortality from collision with conductors or structures (Avery et al. 1978; U.S. Fish and Wildlife Service 1978), but the proposed transmission line would not be tall enough to pose a serious threat to birds in migratory flight. In general, migratory flight occurs at altitudes in excess of 100 m (300 ft) above the ground surface (U.S. Fish and Wildlife Service 1978; Lincoln 1979). However, waterfowl landing or taking flight could strike components of a line passing over or immediately adjacent to an open body of water. Species such as starlings, red-winged blackbirds, and shorebirds that fly fast at low altitudes and in tight flocks also are vulnerable to collisions (Meyer and Lee 1981). Since most structures for the 450-kV DC line would be only 4.6 to 9.1 m (15 to 30 ft) above existing 230- and 345-kV AC line structures, the incremental risks of collision would be minimal.

There is general agreement in most published studies that bird losses to overhead wires are not biologically significant (Beaulaurier et al. 1984; Meyer and Lee 1981; Stout and Cornwell 1976). Nevertheless, some concern for collision potential may be warranted. For transmission line corridors carrying more than one power line, the wires can be a major obstacle. This is especially true for panic-stricken flocks of birds or for birds flying in inclement weather (Jaroslow 1979). The most lethal of four study areas analyzed by Andersen-Harild and Bloch (1973) was one containing 12 wires at eight different levels. An average of nine dead birds per day per 10 km (6.2 mi) of power line was recorded. Several corridor sections in Massachusetts would contain more than 20 wires positioned at a minimum of five different levels ($\geq$ 12 m [40 ft] height differential from lowest to highest wire) (ER, Vol. 2--Figures II-6 through II-15).

Electrocution can occur when an animal makes contact with two energized conductors or with one energized conductor and a shield wire or grounded part of the support structure. Historically, this has been a problem only with large raptors (such as eagles). Minimum clearances between conductors on the proposed line (> 3 m [10 ft]) would ensure that such a possibility does not exist. Spark discharges to wildlife or livestock under the line are also unlikely because maximum voltage buildup (0.8 kV) in a well-insulated individual beneath the line is not expected to be sufficient for such occurrences (Johnson 1982a). Spark discharges occur at levels of about 5 to 7 kV (see Section 4.1.8.2).

Other impacts to wildlife stemming from transmission line operation (e.g., air ions, magnetic, and electric field effects) would be similar to effects on human health and safety as discussed in Section 4.1.8.

4.1.4.2 Aquatic

Construction activities (especially construction of access roads) involving stream crossings would be the principal sources of potential impacts to aquatic biota. The potential impacts would include (1) changes in water temperatures resulting from removal of riparian vegetation, (2) habitat destruction or modification resulting from instream construction activities, and (3) downstream increases in turbidity and sedimentation resulting from erosion and stream sediment displacement at the construction site. These impacts can be expected, in varying degrees, for every stream crossing affected by construction of an access road or some near-stream vegetation clearing. The severity of impact resulting from such construction would depend upon several factors, such as (1) season of construction, (2) stream size, (3) corridor width to be cleared, (4) construction procedures, and (5) existing habitat quality (Dehoney and Mancini 1982). Generally, the smaller streams would have the greatest potential to be impacted because they have less ability to assimilate (dilute) introduced solids and are more affected by removal of riparian vegetation. Ephemeral stream channels also may be disturbed, especially in late summer, when they are not easily detected (Irland 1985). Overall, ponds and lakes (including reservoirs) should not be directly impacted because all attempts would be made to route lines to avoid such aquatic systems or to span them. Currently, only Whittier Pond in Hopkinton and an unnamed pond of a tributary of Musquash Brook in Hudson may have structures or foundation pads placed at the edge or, possibly, extending into them.

Stream temperature alteration is reported to be one of the most significant impacts resulting from clearing of riparian vegetation (Herrington and Heisler 1973). For the proposed project, however, only a short linear distance would be cleared for the proposed line and/or access road at any stream crossing, and it is doubtful that significant thermal increases would occur. In addition, results of several studies indicate that low-growing vegetation can effectively shade smaller streams (Brown 1979; Fredricksen 1971-1972). Case histories of rights-of-way in New York have shown that impacts on stream temperatures were negligible (Holewinski 1981).

Disturbance of instream habitat can have an immediate and localized impact on aquatic biota, but turbidity, and especially sedimentation, can result in greater and more widespread biological impacts. Because of their relative immobility, eggs and larvae of fish and macroinvertebrates would be most adversely affected by increases in siltation and turbidity. Adult fish would likely vacate the area and avoid many of the activities associated with stream crossing construction; however, instream construction activities could interfere with spawning migrations (Dehoney and Mancini 1982; Busdosh 1982), and increased siltation could disrupt fish reproduction by covering potential spawning grounds (Karr and Schlosser 1978). The locations where access road stream crossings would most probably be required (e.g., streams less than 3 m [10 ft] wide), coupled with the physical characteristics often chosen for the crossing areas (e.g., gravelly riffles), essentially coincide with the habitat used by the salmonids for spawning. Shelton and Pollock (1966) found that when only 15% to 30% of gravel interstices were filled with sediments, 85% mortality of salmon eggs occurred. There are 112 streams less than 3 m (10 ft) wide along the proposed route (ER, Vols. 7 and 8). Since much of the proposed route coincides with existing rights-of-way, access used for construction or maintenance of the existing lines may also be used for the proposed lines. However, it can be assumed that new access roads will be required across some streams and that some existing access will require upgrading. In such situations, streams could be subjected to the above-mentioned impacts.

After construction of the line, fish could be impacted as a result of improper design characteristics, such as improperly designed culverts. Installation of improper culverts and use of unsuitable (unstable) fill material could lead to complete washout of a stream-crossing embankment. This results in the most severe incidences of erosion stemming from highway development and is responsible for the greatest percentage of fish passage problems (Dryden and Stein 1975). Improperly sized culverts can eliminate fish species from a stream through blockage of migration, particularly upstream spawning runs, and spawning downstream of the blockage may be hampered by overcrowding--forcing fish to spawn in marginal areas, avoid the system, or not spawn at all (Dryden and Stein 1975). Additionally, improperly stabilized banks and improperly sized culverts may cause long-term erosion.

During operation of the transmission line, aquatic systems may be impacted from maintenance activities, primarily vegetation control. However, required vegetation control near stream crossings should be infrequent and of a much lower degree of activity than would occur during construction. For example, instream disturbances would not be required and only selected trees might have to be removed or trimmed. Vegetative control near streams might temporarily increase streambank erosion due to the activity of men and machinery. Impacts would be similar to those discussed for construction. The accidental release of toxicants (e.g., gasoline, lubricants, and herbicides) could cause the most impacts during operation.

Fisheries can be impacted by human activity (e.g., off-road vehicles) that hinders revegetation and thus prolongs erosion and related perturbations to streams (Galvin 1979). However, such potential impacts are not expected to increase as a result of the proposed project because public access via access roads or the transmission line rights-of-way is already well established.

As mentioned, the smaller streams would have the greatest potential to be impacted. The majority of these streams are potential coldwater trout streams (Section 3.4.2). However, only about eight streams less than 3 m (10 ft) wide have been documented as containing spawning trout populations (ER, Vol. 7--Table III-3, Vol. 8--Table III-3). Approximately 25 other small streams are documented to contain trout, but they are mostly stocked. Even some of the streams with spawning trout are supplemented by stocking. Only in a very few instances could spawning populations be affected, and impacts would be offset by subsequent stocking. Additionally, disruption of activities such as migration would only be temporary because stream disturbances would not be expected to last more than a few days, whereas fish migration occurs over a period of days to weeks (Geen et al. 1966).

The likelihood of long-term impacts to aquatic ecosystems from the proposed transmission line facilities would be small. Although impacts resulting from construction (e.g., erosion and subsequent increases in turbidity and sedimentation) may occur, they would be localized, short-term, and reversible. Stream recovery (return to near the original biological and physical conditions that existed prior to construction) is often estimated to occur within a year and as rapidly as six weeks (Dehoney and Mancini 1982). The potential for significant adverse impacts would be minimized if the mitigative measures committed to by the Applicant are properly implemented.

4.1.4.3 Wetlands

Assessment of Impacts

In response to Executive Orders 11988 (Protection of Floodplains) and 11990 (Protection of Wetlands), DOE Rules and Regulations (10 CFR 1022) require that a floodplain/wetland assessment be prepared which: describes the project, discusses the effects of the project on floodplains and wetlands, and identifies alternatives including mitigating measures. This assessment is provided in Appendix B, and the results are summarized here.

Although construction activities would avoid wetland areas where possible, all such areas cannot be avoided. Therefore, some adverse impacts, primarily temporary, would occur during construction, stringing operations, and following construction. These impacts, discussed in more detail in Appendix B, would be minor and largely reversible. Long-term impacts to a minimum amount of wetlands would occur from structure placement and access roads. This has been conservatively estimated to preempt a maximum of 7.7 ha (19 acres) out of 214.9 ha (531 acres) of wetland habitat within the Phase II rights-of-way (ER, Vols. 7 and 8). The minor amount of floodplain habitat to be affected by structure placement and access roads would have a minimal amount of impact to terrestrial biota, similar to that previously discussed

(Section 4.1.4.1). This evaluation is based upon mitigative measures recommended by DOE staff and committed to by the Applicant to minimize wetland/floodplain impacts (see Sections 2.1.5, 4.1.10.4, and Appendix B).

Statement of Findings

DOE finds that no practicable alternative to locating a portion of this proposed action in floodplains and wetlands is available, consistent with the policy set forth in E.O. 11988. The components of this floodplain statement of findings are contained in Appendix B, and the action conforms to applicable state or local floodplain protection standards.

4.1.4.4 Threatened and Endangered Species

Section 3.4.4 identifies consultative and coordinative efforts carried out by DOE and the results of these efforts.

Vegetation

There are no plant species on the federal list of threatened and endangered plants that are likely to occur along the proposed transmission line corridor (see Section 3.4.4.1). Plants considered rare to the study area have been found in the vicinity of the proposed route. However, these species either occur in habitats that would be generally avoided by construction (e.g., wetlands) or have been determined not to occur on the proposed right-of-way.

Fish and Wildlife

A number of state and federally listed threatened and endangered species of fish and wildlife could be affected by the transmission line (see Table A.9 in Appendix A). The major potential for impact is associated with clearing of forest habitat for the right-of-way and, for birds, the potential of collisions with the structures. All of the species listed in Table A.9 are wide ranging, with populations extending throughout at least New England, albeit sparsely. Therefore, loss of a minor fraction of available habitat is unlikely to result in a reduction in numbers of these protected species; in some instances, more preferred habitat would be established. Also, as discussed for birds in general (Section 4.1.4.1), the potential for impact related to wire strikes is negligible.

4.1.4.5 Environmental Impacts from Hydroelectric Generation in Canada

Impacts to migratory birds and other wildlife in Canada attributed to hydroelectric development there are beyond the scope and requirements of the EIS. Nevertheless, several commenters on the draft EIS expressed concern that the proposed action might have significant adverse environmental effects outside the United States, particularly in the James Bay region of Quebec, Canada. Therefore, the applicant and Hydo-Quebec (a provincial agency) jointly submitted a supplement to the ER describing the Canadian environment in question and addressing the historical and proposed effects of hydroelectric development within the La Grande Riviere system on James Bay, particularly in relation to migratory birds (ER, Supplement, Jan. 15, 1987). That document is included in this EIS as Appendix C.

The DOE has obtained copies of the pertinent scientific literature upon which the information and conclusions in Appendix C are based. The DOE has independently assessed the information contained in those documents, and concurs with the conclusions presented in Appendix C. Briefly stated, these conclusions are as follows: (1) no noticeable effects on the use of the reservoirs by migratory birds are expected (see p. C-8), (2) changes in river flow associated with Phase II contract sales would be negligible (see pp. C-30 through C-34), (3) no changes in physical or biological parameters in James Bay related to Phase II contract sales would be expected (see pp. C-38 through C-50), (4) hydroelectric development to date in the James Bay region has not had any significant effect on migratory bird populations, and (5) no significant adverse effects on migratory bird populations in the James Bay region related to Phase II contract sales are expected (see pp. C-49 and C-50).

In the remainder of this section, the applicability of the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. 4321 et seq. to the environment outside the United States is discussed, and the rationale for determining that, in this case, NEPA does not require an analysis of the James Bay region is presented. As noted earlier, NEPA requires that federal agencies give appropriate weight to factors affecting the human environment in their decision-making process. In this connection, federal agencies are required to prepare statements on proposals for major federal actions significantly affecting the quality of the human environment.

Executive Order 12114, entitled Environmental Effects Abroad of Major Federal Actions, was issued on July 4, 1979 (44 Fed. Reg. 1957). This Executive Order represents the exclusive and complete determination by the Executive Branch on the procedural and other actions to be taken by federal agencies to further the purposes of NEPA with respect to the environment outside the United States, its territories and possessions. The major federal actions included under this Executive Order are as follows:

1. Those actions significantly affecting the environment of the global commons outside the jurisdiction of any nation.

2. Those actions significantly affecting the environment of a foreign nation not participating with the United States and not otherwise involved in the action.

3. Those actions significantly affecting the environment of a foreign nation which provide to that nation specified products or physical

projects which would be prohibited or strictly regulated in the United States.

4. Those actions significantly affecting natural or ecological resources of global importance designated for protection under the Executive Order by the President. For resources protected by international agreement binding on the United States, the Secretary of State may designate such resources for protection under this Executive Order.

The Executive Order also designates a series of specific exceptions to its provisions, including actions not having a significant effect on the environment outside the United States as determined by the federal agency.

In making its determination whether an action will have a significant effect on the environment outside the United States, the Department of Energy may adopt all or part of existing environmental analyses, including those prepared by foreign countries or international organizations, when it believes that these analyses are adequate in scope and content to make a determination.

In the present case, the major federal action is to grant a Presidential Permit for the construction and operation of an electric transmission line that will cross the international borders of the United States. The applicant for the Presidential Permit proposes to construct and operate transmission lines and related facilities wholly within the United States. These activities do not fall under the jurisdiction of Executive Order 12114 because none of the four specified activities stated above is the subject of the proposed action:

1. The proposed action does not have a significant adverse effect on the global commons outside the jurisdiction of any nation. Thus the Executive Order does not apply.

2. The export of electric power to the United States from Canada is the reason the applicant needs to construct the proposed facilities. Thus, Canada is involved in the proposed action, and the Executive Order does not apply.

3. The proposed action does not involve the export to Canada of any product or physical project. Thus, the Executive Order does not apply.

4. Neither the President nor the Secretary of State has designated any of the relevant natural or ecological resources to be subject to protection under the Executive Order. Thus, the Executive Order does not apply.

Although, in this instance, DOE has determined that NEPA does not require an analysis of the environmental effects outside the United States, it nevertheless assessed the information presented in Appendix C. DOE has determined that the information submitted was adequate in scope and content for DOE to assess any incremental effects the proposed action might have on the James Bay region. Based on this information and other references, DOE concluded that the proposed action would not result in any significant incremental adverse environmental impacts in the James Bay region. Therefore, even if the Executive Order was applicable to the proposed action, the action nevertheless would be exempt under the terms of the Executive Order. This environmental analysis, together with a discussion of the on-going and extensive environmental monitoring programs and regulatory procedures applicable to the James Bay region that are administered by the Government of Canada, is presented on pages C-12 through C-27 of Appendix C.

4.1.5 Socioeconomics

The construction phase of the proposed project would have minor short-term impacts on the local economy, housing, and transportation. The project would create local short-term employment opportunities, but would not have significant impact on the unemployment rate. Construction activities would occur during 1987-1990 and would result in a peak work force of about 550 people. The Applicant estimates that 30% to 40% of the work force would be hired locally (ER, Vol. 2--p. 193, Vol. 3--p. 205). Minor short-term benefits to the local economy would result from project expenditures on equipment, services, and payrolls.

The influx of construction workers would increase short-term demand for temporary lodging; however, since the work force would be distributed in small units (2 to 20 persons) along the proposed route (ER, Vol. 2--pp. 192-193, Vol. 3--p. 204), housing shortages would be unlikely. Residential property values would probably not be affected, given the established presence of multiple transmission lines on the right-of-way. Although sample size was small, Lamprey (1986) found no significant difference in the values of adjacent properties before and after the addition of a transmission line to an existing right-of-way.

Movement of heavy equipment and trucks on access roads during construction activities could adversely affect local traffic flows and increase local levels of noise and of fugitive dust. This might be mitigable to some extent through judicious choice of routes and prior notification (ER, Vol. 2--p. 193, Vol. 3--p. 205).

4.1.6 Visual Resources

4.1.6.1 Visual Impacts Analysis Criteria

The methods for establishing the study area and evaluating the visual quality of the existing environment in terms of landscape types are discussed in Section 3.6. The following methodology is oriented toward assessing potential visual impacts related to the proposed project.

The DOE Staff has reviewed the Applicant's methodology for evaluating visual impacts associated with the proposed project, as presented in the ER (Vol. 7--Sec. III.C.2.c, p. 104; Vol. 8--Sec. III.C.2.c, p. 108). In view of the comprehensive nature of the methodology and the generally low level of project-related impacts anticipated, a detailed description of methodology is not presented here. However, some discussion of terminology and analytical procedures is necessary for comprehension of project-related impacts addressed in Section 4.1.6.2.

Initial analytical procedures included establishing vantage points within project study areas from which the proposed transmission facilities could be observed. Vantage points were identified from available data sources and general field surveys and were recorded as "Inventoried Assessment Points" (IAPs). Each IAP was investigated through field reconnaissance and map analysis. In instances where the project-related visual impacts could be ranked as no or minimal impact, the appropriate ranking was recorded and no further analyses were undertaken. In the event that the visual impact at a given IAP exceeded the minimal level, the IAP was designated as a "Visual Assessment Point" (VAP) and the impacts were further evaluated by four types of analyses (ER, Vol. 7--p. 105). Results of evaluations for a given VAP were assigned one of five relative ratings to reflect the degree of impact--i.e., low, low-moderate, moderate, moderate-high, or high. These rankings, as well as the no or minimal impact rankings for IAPs, are used in the following descriptions of project-related visual impacts.

4.1.6.2 Visual Impacts of Corridor Segments and Building Sites Within Project Study Areas

The following discussions of project-related visual impacts correspond with the sequence of segments within project study areas established in Sections 3.6.2 and 3.6.3. In all cases, construction activities and equipment related to the proposed project would result in short-term adverse visual impacts.

New Hampshire

Segment A--IAPs established within this 60-km (37-mi) landscape segment included 102 sites, of which 24 were identified as VAPs. The highest rating of impact assigned was moderate for each of eight VAPs. Given the development plans for the proposed line, the overall visual impact for this segment would be rated as low. The low rating would largely be due to the densely forested, hilly to low mountainous terrain that would screen and obstruct views of the proposed line, as well as limit viewing distances. Furthermore, this segment of the study area is primarily rural in character with limited areas of urban and commercial development; thus, the number of viewers would be comparatively low. The proposed line would parallel two existing transmission lines for all but about 1.3 km (0.8 mi). The visual effects related to the proposed line would be incremental to those of the two existing lines for virtually the entire length of the segment.

Segment B--Analysis of this 93-km (58-mi) segment of the study area resulted in the evaluation of 158 IAPs, of which 21 were identified as VAPs (ER, Vol. 8--p. 132). The highest level of assigned visual impact was rated at moderate-high impact, involving four VAPs; the associated impact areas include highway and bike route crossings (U.S. 202, SRs 9/103 and 11), Whittier and Pillbury ponds, and the village of Groton, including an adjacent road (ER, Vol. 8--Table III-10). The overall impact level for this segment was rated as low-moderate visual impact. Assessment sites in the northern portion of this segment tend to correspond with natural landscapes, recreational areas, and road crossings. To the south, assessment points tend to correspond with residential areas and thus would involve a greater number of viewers. The proposed line would parallel two existing lines; thus, the visual effects related to the proposed line would be incremental to those of the existing lines throughout this segment of the study area.

Segment C--A total of 151 IAPs were established within this 42-km (26-mi) landscape segment, of which 26 were identified as VAPs. The highest project-related level of visual effects is rated at moderate-high impact, and involves four VAPs. The associated impact areas include the Kennedy Hill farm, SR 114 (paralleled and crossed), the Terrell Hill and Back River Road crossings, and areas adjacent to the Back River Road. This landscape segment recently has undergone extensive residential and commercial development. Subdivision and roadside residences constituted 68 of the established IAPs. In view of the visual effects related to existing transmission lines paralleling the proposed route, the scattered distribution of large residential and commercial structures, the fragmented patterns of vegetation, and the low landscape quality of this segment, the incremental increase in visual impact related to development of the proposed line would generally be of minor consequence.

Massachusetts

Segment A--Within this 19.6-km (12.2-mi) segment of the Massachusetts study area, a total of 42 IAPs were established, of which only seven were later designated as VAPs. Given the development of the proposed line, the overall assessment for the segment is a low-moderate visual impact rating (ER, Vol. 7--p. 121). The highest impact rating assigned was moderate-high for the State Route (SR) 119/225 crossing of the proposed route. Two moderate ratings were assigned, also involving highway crossings (U.S. 3 and SR 40). Widening the cleared portion of the existing right-of-way within this segment and development of the proposed transmission line would incrementally increase the visual impacts associated with the existing transmission line presently occupying the right-of-way. However, the vegetation and rolling to hilly terrain would tend to limit viewing distances and otherwise obstruct views of the two lines.

Segment B--Assessment of this 58-km (36-mi) segment entailed establishing 144 IAPs, of which 40 were identified as VAPs. The overall assessment of the segment was rated as low-moderate visual impact (ER, Vol. 7--p. 122). The proposed route would parallel existing transmission lines for all but 0.8 km (0.5 mi) near the Millbury No. 3 substation. Thus, compatibility ratings for the proposed line would tend to be moderate or moderate-high; these rankings are equivalent to relatively low visual impacts. Most visual impact areas in this segment are related to residential developments and highway crossings. About 6% of assessment points in the segment involve ratings of moderate-high visual impacts; the impact areas include the Wachusett Reservoir, a National Historic Monument, three residential-commercial areas, and four highway crossings.

Segment C--A total of 73 IAPs were established along this 26-km (16-mi) segment, of which 17 were identified as VAPs. Only two of these VAPs rated moderate-high impact levels, i.e., the Janock and Carp Road subdivision and the SR 85 crossing. Five moderate impact ratings were assigned, variously involving local streets and/or state and federal highways. Vegetation clearing would create greater potential for viewing the right-of-way in this segment, but the proposed line would parallel existing transmission lines throughout the segment. Thus, the resulting impact would be incremental. The overall assessment for this segment is rated a low-moderate visual impact (ER, Vol. 7--p. 124).

Converter Terminal Site--Site clearing and development of the proposed terminal facilities would drastically alter the character of the site. However, the proposed terminal site is bounded by wooded rolling topography on the northeast, north, and most of the west side of the site. The site is otherwise surrounded by gravel pits, an industrial site, the Boston and Maine freightline and yarding area, and transmission facilities and rights-of-way. Thus, the development of the proposed terminal would be of minor consequence with respect to visual resources.

Construction Laydown and Staging Areas

An estimated 25 to 35 small areas of 0.4 to 0.8 ha (1 to 2 acres) each, as well as 11 larger areas of 2 to 5 ha (5 to 12 acres) each, would be developed at various intervals along the proposed transmission line segments to serve as construction laydown and staging areas (ER, Supplement, Response No. 9, Sept. 29, 1985). Development of these areas and the related construction activity would degrade the quality of local landscapes. Since locations of staging areas are not normally identified prior to initial construction, the related visual impacts are currently unknown. However, following project construction, the staging areas would be reclaimed and restored to conditions similar to those existing prior to construction (ER, Supplement, Response No. 7, Sept. 27, 1985); thus, no significant long-term visual impacts would be expected.

In summary, the overall visual impacts for both the New Hampshire and Massachusetts portions of the proposed transmission lines are ranked as low-moderate (ER, Vol. 7--p. 125, Vol. 8--p. 135).

4.1.7 Cultural Resources

The proposed action would have no adverse effects on significant archeological sites or historic structures (i.e., those determined to be eligible for the National Register of Historic Places) (Adamovich 1986; Talmage 1986). However, the proposed action could have adverse effects on 35 archeological sites located on or adjacent to the right-of-way that have not been evaluated for National Register eligibility; these impacts would be avoided by implementation of the protective mitigative measures outlined in Appendix E in the December 12, 1986, letter from Bradley H. Spooner to Valerie A. Talmage.

4.1.8 Health and Safety

Health and safety issues related to the operation and maintenance of the transmission lines would center around potential effects from electric and magnetic fields, air ions, induced current and/or spark discharges, audible noise, ozone production, and use of herbicides. Potential effect on cardiac pacemakers is also an issue of concern. Both DC and AC transmission lines would be constructed in conjunction with the proposed project. Because of differences in the electrical characteristics of the two systems, potential health and safety issues for AC and DC lines are discussed separately. Additionally, since most of the proposed DC line would be routed within existing AC corridors, a discussion of potential combined effects of AC and DC operation is also included. Unless noted or otherwise obvious, stated values include contributions from existing transmission lines.

4.1.8.1 DC Effects

Information presented in the Phase I EIS (U.S. Department of Energy 1984) supports the conclusion that operation of the DC line would generally have negligible effects on health and safety. Information published since that time does not alter the conclusions reached in that document. Much of this newer information is summarized in the ER, Vol. 5a (New England Hydro-Transmission Corp. and New England Hydro-Transmission Electric Co. [NEHTC and NEHTEC] 1985a). A pertinent summary of the potential adverse effects of DC transmission lines is presented in the following subsections.

Electric and Magnetic Environment

The electric field associated with a high-voltage DC transmission line is produced by the electric charges on the separate positive and negative conductors (lines) and by the space charge generated by corona (Bracken 1979a, 1979b; Johnson and Zaffanella 1982). Charges on the transmission line produce a static electric field; the field produced by the space charge is highly variable. The intensity of the electric field--measured in volts (V) or kilovolts (kV) per unit distance--is greatest at the conductor surfaces and decreases rapidly as one moves away from the conductor, vertically or horizontally. In the absence of corona, the electric field is composed only of the static electric field; whereas during intense corona, the space charge can be several times that of the static field (ER, Vol. 5a).

Corona (the partial breakdown of air into charged particles) begins to occur when the surface voltage gradient on the conductors exceeds the threshold or onset value of the surrounding air. When the electric field intensity at the HVDC conductor surface exceeds approximately 2500 kV/m (on a smooth and clean conductor), corona can result. If the conductor has water droplets on it, corona can be produced with surface voltage gradients as low as 700 to 1000 kV/m. Transmission lines are designed to control levels of corona activity, but the onset of corona is influenced by numerous factors, including atmospheric elements, design parameters of the line, and condition of the conductors. Because field intensity at the conductor surface is dependent upon the smoothness of the surface, corona tends to be increased by nicks, scratches, and adhering dust particles, insects, ice, snow, or water droplets. Corona levels for DC systems are highest when surface irregularities occur on the conductor (which may occur during foul weather), although certain effects of corona are probably highest in fair weather (audible noise and radio/television interference) (ER, Vol. 5a). When corona occurs, ion pairs are generated in the air near the conductors, with a net movement of like charges away from each line. At distances away from the conductors the space charge tends to be carried on aerosols rather than small ions. This occurs because the small-ion density decreases from diffusion, recombination, movement to earth, and attachment to aerosols. Because of their charge, ions and aerosols move under the influence of an electric field, as well as the influence of the wind (ER, Vol. 5a).

HVDC lines also create a static magnetic field and an AC magnetic field. The static magnetic field is produced by the current flowing through the conductors; whereas the AC magnetic field occurs from AC current voltage at harmonic frequencies of 60 Hz being introduced onto the DC line by the conversion process from AC to DC (ER, Vol. 5a). At ground level under the proposed line, the static magnetic field produced by the line would be less than the earth's magnetic field and would decrease with distance from the line (Ill. Inst. Technol. Res. Inst. 1976; Hill et al. 1977). The AC field is so small that it can be ignored (Sheppard 1979).

During corona, photons emanating from the conductor surface may strike neutral atoms in the air. These energized atoms may then lose electrons, which when accelerated in the local electric field, may collide with neutral oxygen molecules, causing dissociation and reassociation into ozone molecules (Hill et al. 1977).

Audible noise is created by the breakdown of air molecules during corona. In HVDC systems, electric discharge is greater from the positive electric pole than from the negative pole. Hence, more audible noise is generated by the positive conductor. The negative conductor generally does not produce audible noise. During rain, the large number of raindrops on a conductor can produce corona currents large enough to change the corona mode into a nonaudible type. Peak audible noise levels under HVDC systems, therefore, generally occur during fair weather, snowfall, or early rainfall (Hill et al. 1977; Johnson and Zaffanella 1982).

Potential Hazards from an Operating High-Voltage Direct Current (HVDC) Transmission Line

There is a sizable literature on the health and safety aspects of operating transmission lines (Sheppard and Eisenbud 1977; Phillips et al. 1979; Lee et al. 1982; Algers and Hennichs 1983; Carstensen and Griffin 1983; Hauf 1982; Sheppard 1983a, 1983b; Charry 1984; Reilly 1984; American Institute of Biological Sciences 1985). However, most studies deal with AC systems. These studies have indicated that biological systems can be affected by exposure to electric and magnetic fields and to air ions, provided that intensities and duration of exposure are of sufficient magnitude. However, a level of exposure at which hazardous effects might occur has not been demonstrated. Additionally, the available data have not demonstrated dose-response or a time-course relationships. The maximum electric and magnetic field strengths of HVDC systems are not of sufficient magnitude to elicit harmful, pathological effects, although nonpathological effects may be elicited (U.S. Department of Energy 1984). Maximum intensities of the electric fields associated with the HVDC environment are reached infrequently (only during periods of maximum corona activity) and decline rapidly with distance from the electrical conductors. Moreover, human and livestock use of the right-of-way is usually periodic and of short duration (minutes to hours). Consequently, exposure to maximum field intensities is expected to be infrequent. The following discusses in more detail the health and safety concerns relevant to the proposed Phase II DC transmission line.

Proximity Effects. Coupling of an electric field with an organism creates the potential for shock hazard (Banks et al. 1982b; Sheppard 1983a, 1983b; U.S. Department of Energy 1984). Electric shock results from the passage of electric current through the body between two points of unequal voltage. Shocks may result from a steady-state flow of current or a transient, spark discharge (e.g., a carpet shock of static electricity). Under an operating transmission line such spark discharges might occur if a grounded human or animal contacted a large, stationary metal object that is well insulated from ground (e.g., a vehicle or watering trough). Hill et al. (1977) measured steady-state currents of up to 175 μA from 61 m (200 ft) of fence (with highly insulated wooden posts) paralleling an operating ±600-kV DC transmission line. This compares with generally accepted levels of 15,000-20,000 μA as providing a margin of safety for operating electrical fences (Dalziel and Burch 1941; Minnesota Environmental Quality Board 1982; Sheppard 1983a). At any rate, utilities metallically ground fences within rights-of-way as a standard practice. On an operating test line similar in structure and operation to the DC portion of the proposed interconnection, Johnson and Zaffanella (1982) estimated the highest current collected on a school bus to be about 40 μA. This is well below the general threshold of perception for DC current of 600 μA (Barthold et al. 1972) and below the National Electric Safety Code limit of 5,000 μA established for contact currents due to electric fields on the largest anticipated truck, vehicle, or equipment under a transmission line.

Tests beneath operating HVDC transmission lines have shown that carpet-like spark discharges can occur for persons accumulating about 10 kV of potential (Sheppard 1983a). The estimated maximum (occurring less than 5% of the time) accumulated potential is 20 kV, based on an investigation using a test line with design and operating characteristics very similar to the proposed line (Johnson and Zaffanella 1982). These voltage levels would be likely only for well-insulated individuals near the point of maximum conductor sag during summer fair weather. Shocks associated with voltages of this magnitude are considered annoying but not harmful (Sheppard 1983a). Johnson and Zaffanella (1982) reported that occasional shocks occurred while persons were active beneath a ±450-kV DC line similar to that proposed by the Applicant.

Under worst-case conditions for DC systems, spark-discharge shocks might be at levels considered annoying or objectionable. It is anticipated that such conditions would be rare and that most spark-discharge shocks would occur at or below minimally perceivable levels. Even though annoying spark-discharge shocks might occur occasionally, they would not likely result in pathological responses. The spark-discharge shocks would be no worse than commonly experienced carpet shocks (~ 5 mJ). The predicted levels are well below (safety factor of 2000) levels associated with a 10-J hazardous shock (Sheppard 1983a).

Fuel ignition can occur when objects differing in potential by about 5 to 7 kV come in contact (Hill et al. 1977). For a DC test line similar in nature to the proposed DC line, estimated worst-case voltage induced on a large school bus was 0.07 kV, during dry snowfall (Johnson and Zaffanella 1982). Levels of about 0.7 kV might be expected for worst-case summer fair weather conditions, but are still 7 to 10 times below the voltage threshold for fuel ignition (ER, Supplement, Sept. 29, 1986). Again, these voltage levels were likely less than 5% of the time, in summer fair weather conditions, near the point of maximum conductor sag, and if the vehicle was well insulated from ground. However, it would be prudent to ensure that large vehicles not be refueled beneath operating lines unless the vehicles are well grounded.

Electric Field Effects. Electric fields of the magnitude that occur in HVDC transmission-line environments have been alleged to cause a variety of physiological and behavioral effects in humans and other animals. There have been several reviews of the literature on the biological effects of electric fields, including Banks et al. (1982a), Sheppard (1983a), DOW Associates (1980), and Minnesota Environmental Quality Board (1982). Findings of studies in this area have been diverse, ranging from no evidence of effects to the attribution of many effects due to exposure to electric fields. Because of the diversity of findings and experimental designs, as well as paucity of reproducible results, it is difficult to provide definitive predictions of effects of transmission line electric fields.

Johnson and Zaffanella (1982) measured the electric field under a "Project UHV" test line, which is similar in design and operation to the proposed DC line. Their results indicated that maximum electric field intensities in excess of ±30 kV/m could be expected at mid-span ground level during some weather conditions (Table 4.2). However, these maxima occur infrequently (less than 5% of the measurements), with field intensity declining rapidly as one moves from the centerline of the system and as one moves away from the point of maximum conductor sag.

For the proposed Phase II DC line, the median electric field strength at ground level during fair weather under the positive conductor is calculated to be in the range of 8 to 17 kV/m, with calculated fair weather extremes of -20 kV/m under the negative conductor and 24 kV/m under the positive conductor. During foul weather, the median electric field strengths at each conductor would range from 9 to 26 kV/m, with a maximum around 30 kV/m. Maximum foul weather electric field strengths at the right-of-way edge are calculated to be 9 and -9 kV/m, with median intensity calculated at 7.6 and -7.6 kV/m (ER, Supplement, Sept. 29, 1986). Median electric field intensity at the right-of-way edge during fair weather may be as low as ±1 kV/m (ER, Vol. 5a). The earth's natural average fair weather electric field strength is about 0.1 to 1.5 kV/m, with an intensity as high as 15 kV/m during thunderstorms (Chalmers 1967).

Electric fields within the right-of-way for the proposed DC transmission line would have intensities within the range of those reported to elicit physiological responses in experimental animals. Effects of exposure to field intensities below 60 kV/m have been subtle--e.g., improved performance in rats (Mayyasi and Terry 1969), increased brain wave activity in anesthetized rats (Lott and McCain 1973), improved performance of human subjects in fine motor skills (Carson 1967), and altered body serotonin levels in mice (Mose and Fischer 1970; Mose et al. 1971; Fisher 1973). Fischer (1973) observed a 50% increase in spontaneous activity of mice exposed to positive and negative electric fields of 24 kV/m for 10 days, with an accompanying increase in food

Table 4.2. Electric Fields (kV/m) Under the Project UHV Test Line Operating at ±450 kV DC[a]

		Negative Side						Positive Side					
		-50 m[c]		-25 m[c]		Worst Position[d]		Worst Position[d]		+25 m[c]		+50 m[c]	
Weather	N[b]	50%	95%	50%	95%	50%	95%	50%	95%	50%	95%	50%	95%
Fair (winter)	14,073	-2	-5	-5	-8	-12	-15	+8	+11	+3	+6	+1	+4
Fair (summer)	16,100	-1	-3	-8	-12	-17	-26	+19	+29	+4	+8	+2	+5
Snow	9,003	-3	-7	-5	-12	-12	-23	+10	+17	+4	+10	+2	+5
Fog	411	-1	-2	-4	-8	-13	-26	+12	+24	+6	+11	+3	+5
Frost	1,590	-5	-10	-8	-15	-13	-23	+12	+20	+6	+13	+5	+6
Freezing rain	1,129	-5	-8	-12	-16	-27	-32	+23	+29	+10	+17	+2	+7
Rain	1,581	-1	-4	-11	-15	-30	-34	+29	+32	+14	+6	+2	+7

[a] Electric fields were monitored continuously; measured under point of minimum conductor height of 11 m (37 ft); 50% = median value and 95% = absolute value below which 95% of the measurements occurred.

[b] Number of records per weather condition.

[c] These positions represent distances from centerline between positive and negative conductors; distances approximate the distance to edge of right-of-way above Sandy Pond (50 m) and below Sandy Pond (25 m) from centerline.

[d] Highest absolute values were obtained at about -6 and +9 m from centerline during winter months and about -9 and +12 m in later months.

Source: Based on curves presented in Johnson and Zaffanella (1982).

consumption (10%) and water consumption (13%). An oxygen consumption increase of 14% was noted from an 8-day exposure. From a 15-day exposure to positive and negative electric fields of 5 kV/m, Fischer (1973) found a 1000% increase in spleen plaque production, a 17% increase in spleen weight, a 58% increase in spleen cell count, and a 264% increase in hemagglutination. These responses have been elicited in laboratory situations involving continuous or repeated exposure to constant levels of electric field intensity over periods of days to months. However, there is no evidence that these levels are harmful; also, such elevated electric fields would not exist near the line for extended periods of time (e.g., more than 10 days).

Several investigations have shown little or no significant effects from electric fields at levels that would be expected from operation of the proposed DC line. Biogenic amines in rat brains exposed to positive and negative electric fields of 3 kV/m for 2, 18, and 66 hours did not exhibit altered neurotransmission (Bailey and Charry 1984). No effects on the course of respiratory disease in rats were observed from an 11-day exposure to positive and negative electric field strengths ranging from 0.1 to 6 kV/m (Krueger et al. 1974). Fam (1981) observed no effect on number, survival, or weight of mice progeny of parents exposed to 340 kV/m for 90 days. The exposed mice also showed no difference in body weight (females) or growth rate. No histologic effects to any organs were noted. There were some mixed effects between males and females for blood counts and chemistry, but observed variations were small. Under no conditions would static fields reported as affecting blood pressure and heart rates (60 kV/m) by Krivova et al. (1973) occur. Subtle behavioral and physiological effects would be transient and difficult to perceive.

It is not expected that humans or livestock would be continuously exposed to electric fields from the proposed DC line during normal circumstances. Electric field intensities under the operating DC line would vary with time and with distance from the centerline (Table 4.2). Highest exposure levels would be restricted to an area in the proximity of either electric conductor near the point of maximum conductor sag. All electric fields would be at or near ambient levels at a distance less than 150 m (500 ft) from the centerline. Also, it does not appear likely that persons or livestock would remain continuously in the areas of highest exposure for even a number of hours. Thus, biological responses that could potentially be induced would not present a health hazard.

In conclusion, although biological effects have been reported for electric field intensities associated with power transmission, it is improbable that the fields associated with the proposed DC systems would compromise the health and welfare of the local population or farm livestock.

Magnetic Fields. The magnetic field at ground level due only to the proposed DC line is calculated to be 0.34 gauss (G), decreasing to 0.059 G at the edge of the right-of-way (ER, Vol. 5 Supplement). Magnetic field intensities drop rapidly with distance from the centerline and from the point of maximum sag (Lee et al. 1982). These values are less than the earth's magnetic field of 0.6 G. In general, the literature indicates that the static magnetic fields associated with operating transmission lines do not pose a hazard to human health and welfare (Bracken 1979a, 1979b; Minnesota Environmental Quality Board 1982; Sheppard 1983a). Harmful effects have not been documented in laboratory studies at field strengths of 1,000 G (Tenforde 1981) or in studies of people occupationally exposed to magnetic fields (Marsh et al. 1982).

There is also an expressed health concern related to the biological significance of AC harmonic magnetic fields that would be derived from currents that the DC magnetic field would induce within an organism. Maximum estimates of the magnitude of this within the right-of-way are 0.34 mG for the segment between Monroe and Hudson and 0.27 mG for the segment between Hudson and the state line. At the edge of the right-of-way, the maximum values would range from 0.0041 mG at the eastern edge of the Londonderry to Hudson segment, 0.040 mG at the eastern edge of the Hudson to the state line segment, and 0.021 mG for the remainder of the DC line. Realistic values within the right-of-way are 0.20 mG from Monroe through Hudson, 0.16 mG from Hudson to the state line, 0.0025 mG on the eastern edge of the Londonderry to Hudson segment, 0.024 mG on the eastern edge of the Hudson to state line segment, and 0.012 mG along the edge for the remainder of the DC line right-of-way. These values can be compared to average AC harmonic magnetic field background levels in residences that range from 0.7 to 1.0 mG (ER, Supplement, Sept. 29, 1986). Wertheimer and Leeper (1979; 1982) report a 7-mG value under distribution lines near residences. Magnetic field strength produced by a color TV or microwave oven at 0.9 to 1.2 m (3 to 4 ft) is 50 mG, while for a copy machine the field is 1800 mG (ER, Supplement, Sept. 29, 1986).

The body current levels induced by harmonic AC magnetic fields would be significantly less than levels necessary to influence tissues or organs. Depending upon the organ, the levels required are on the order of 1.0 mA/m^2 (Tenforde 1986). This can be compared to expected peaks within the right-of-way of 0.00043 mA/m^2, 0.00005 mA/m^2 at the edge of the right-of-way, 0.0045 mA/m^2 in Wertheimer and Leeper's (1979, 1982) studies, 0.032 mA/m^2 from a color TV or microwave oven, and 1.15 mA/m^2 from a copy machine (ER, Supplement, Sept. 29, 1986).

A magnetic field would also result from the operation of the dedicated metallic return conductor. However, because of the physical location of the return conductor in relation to either pole, the net magnetic field generated during contingency conditions is expected to be less than the magnetic field generated during normal operation. Thus, the dedicated metallic return conductor should not pose public health or safety problems.

Air Ions. No established exposure limits exist for air ions; therefore, assessment of the impacts from the proposed transmission line must rely on the large body of literature addressing the biological effects of air ions (Sulman 1980; Sheppard 1983a; Charry 1984). It has been suggested that air ions are biologically active because of their charge and chemical form. The most widely acknowledged mechanism for biological effects from air ions has been termed the "serotonin hypothesis". Serotonin is a neural transmitter that is important in sleep regulation, vasoconstriction, and smooth muscle stimulation. It is hypothesized that air ions alter serotonin levels in exposed organisms, producing abnormal effects (Krueger 1972).

Maximum ion densities for both polarities under the proposed DC line and at ground level are expected to be less than 2×10^5 ions/cm^3 during foul weather and less than 1×10^5 ions/cm^3 during fair weather. Under conditions of low corona, clear conductors, and fair weather, ion levels will be on the order of 2×10^3 ions/cm^3 (ER, Vol. 5a). This approaches ambient levels, which are in the range of several hundred to several thousand ions/cm^3. Ion densities for the Project UHV test line, which operates under conditions similar to the proposed DC line, are given in Table 4.3. The values are quite similar to those calculated for the proposed line. The calculated median ion density at the edge of the proposed DC right-of-way is less than 3×10^3 ions/cm^3 under all weather conditions (ER, Vol. 5a). Maximum ion density for rain conditions on the Monroe cross-section in New Hampshire (where the DC

Table 4.3. Ion Densities Near the Project UHV Test Line Operating Under Conditions and Parameters the Same as for the Proposed Transmission Line

Weather Conditions	Density[a] (10^3 ions/cm^3)	
	Negative Ions	Positive Ions
Fair (winter)	3	3
Fair (summer)	140	140
Snow	10	20
Wet snow	40	50
Fog	20	50
Frost	30	20
Freezing rain	150	150
Rain	140	220

[a] Median value calculated from electric field and ion current measurements at point of highest density during operation at ±450 kV and a minimum conductor height of 11 m (37 ft). Values are at ground level and under respective conductors.

Source: Johnson and Zaffanella (1982).

line near the Comerford Phase I converter terminal is totally on utility property) would be 1.7×10^4 ions/cm^3. In more typical cross-sectional portions of the line, the maximum value at the edge of the right-of-way would be 1.23×10^4 ions/cm^3 (ER, Supplement, Sept. 29, 1986).

Humans and other animals exposed to 10^3 to 10^6 ions/cm^3 have experienced increased and improved motor activity, improved escape behavior, improved learning, decreased reaction times, and altered moods (Sheppard 1983a; Charry 1984). Similar ion concentrations have led to altered serotonin levels in selected organs and fluids of humans and other animals. Subtle respiratory and circulatory effects in laboratory animals and humans have been attributed to exposure to ion concentrations between 10^3 and 10^9 ions/cm^3. Animals challenged with microorganisms have experienced both increased and decreased death rates under additional exposure to air ions (Krueger et al. 1970, 1972, 1974). Burn victims, weather-sensitive persons, and asthmatics have reportedly benefited from exposure to air ions (DOW Associates 1980; Sulman 1980; Charry and Hawkinshire 1981; Sheppard 1983a). Additional findings on biomedical responses of man and animals to air ions are given in Table 4.4. In most instances, ions have not been observed to produce any influences on respiratory activity, heart rate, mental state, performance, symptomatology (e.g., headaches, sore throats), pulse rate, blood pressure, or skin resistance. Only rarely have effects been reported, and then generally with mixed effects. Effects, when reported, are small in magnitude and within limits of normal variability.

Maximum ion concentrations below the New England DC interconnection would fall within the the lower range of values associated with subtle effects upon biological systems (compare Tables 4.3 and 4.4). These effects would be difficult to perceive outside the laboratory setting because they are within the range of normal physiological and psychological responses to environmental variation. Furthermore, the periods of highest ion concentrations would be transient and highest ion concentrations would only occur in localized areas. For example, maximum ion concentrations would occur during such periods as intense rain storms or periods of high dust levels (i.e., when foreign objects would be adhering to the conductors). Furthermore, highest ground-level ion concentrations would occur under the point of maximum conductor sag, and factors such as changes in wind direction can change ion concentrations at any point significantly within a period of seconds (ER, Vol. 5a). Under worst-case exposure scenarios, individuals could experience small transient alterations of physiological and behavioral parameters. These effects would not represent a health hazard and would disappear with the cessation of exposure, leaving no residual effects. Air ions would be sufficiently dispersed that exposure outside the right-of-way would result in effects of even lower magnitude, if at all. Due to the combination of the small area of maximum ion concentrations; natural movements of wildlife, livestock, and humans; and variations in air ion concentrations at any point caused by weather influences (e.g., wind); it would be extremely coincidental for animals (including humans) to be exposed to maximum ion concentrations for

Table 4.4. Biomedical Responses to Air Ions

Air Ion Dose	Subject	Response	Source
$\pm 9.0 \times 10^3/cm^3$ for 1 day	Humans	No effect on mental performance or physiological response	Albrechtsen et al. (1978)
± 2.0 to $+3.0 \times 10^4/cm^3$ for 1.5 h	Humans	Decreased sociability, increased tension, increased fatigue, no change in anxiety and aggression	Charry and Hawkinshire (1981)
$-2.7 \times 10^3/cm^3$ for 4 to 2 weeks, 8 h/day	Humans	Perceived increase in environmental comfort, reduced headaches, reduced nausea and dizziness by some workers	Hawkins (1981)[a]
$-1.5 \times 10^4/cm^3$ for 45 min	Humans	No effects on EEG alpha or reaction time	Hedge and Eleftherakis (1982)
$-1.9 \times 10^5/cm^3$ for 3 h	Humans	Change in heart, rectal temperature, perceived exertion, systolic blood pressure; no change in skin temperature, sweat rate, minute ventilation, diastolic blood pressure	Inbar et al. (1982)[b]
$\pm 8.0 \times 10^3/cm^3$ for 5 h	Humans	No effect on mood	McGurk (1959)
$\pm 1.0 \times 10^5/cm^3$ for 2 h	Humans	No effect on tension-anxiety, depression-dejection, anger-hostility, fatigue-inertia, confusion-bewilderment	Sigel (1979)
$\pm 2.0 \times 10^4/cm^3$ for 25 min	Humans	Slight decline in reaction time and flicker-fusion; slight increase in finger-tapping	Slote (1961)
$\pm 5.0 \times 10^5/cm^3$ for 3 min	Rats	Increased heart rate; no effect on respiration	Bachman et al. (1965)
$\pm 8.0 \times 10^4/cm^3$ for for 3 weeks	Rats	Increased neurophysiological arousal in EEC, slightly lowered CNS arousal (+ ions only), significant decrease in brain (- ion); decreased EEG slow wave activity with slight increase in amplitude (+ ions) or slight decrease in amplitude (- ions)	Lambert et al. (1981)[c] Olivereau et al. (1981)

Table 4.4. Continued

Air Ion Dose	Subject	Response	Source
$5.0 \times 10^5/cm^3$ for 66 h	Rats	No effect on spontaneous motor activity	Bailey and Charry (1984)
$\pm 3.0 \times 10^4/cm^3$ for 15 min	Humans	Slight increase in lung function; no histamine threshold	Osterballe et al. (1979)
$-1.0 \times 10^4/cm^3$ for 2 months, 6 h/day	Humans	No effects on blood pressure, respiration, glucose, blood cell count, urinary serotonin, a 50% reduction in blood serotonin	Sulman et al. (1978)[d]
$-1.5 \times 10^4/cm^3$ for 3 to 24 days	Rats	27% reduction in ulceration	Deleanu et al. (1965)
± 3.0 to $4.0 \times 10^5/cm^3$ for 30 days	Mice	25% increase in mortality of animals with respiratory disease	Krueger and Levine (1967)
± 1.0 to $2.0 \times 10^5/cm^3$ for 6 to 10 days	Mice	5% to 23% increase in mortality of animals with respiratory disease	Krueger et al. (1970)
$\pm 5.0 \times 10^3/cm^3$ for 14 to 15 days	Mice	26% increase in mortality rate of animals with respiratory disease	Krueger and Reed (1972)
$\pm 2.0 \times 10^4/cm^3$ for 14 to 16 days	Mice	No change in mortality rate of animals with respiratory disease	Krueger and Reed (1972)
$\pm 5.0 \times 10^5/cm^3$ for 14 to 16 days	Mice	23% lower incidence in mortality of animals with respiratory disease	Krueger and Reed (1972)

[a] Greater impacts resulted from changes in temperature and relative humidity alone.

[b] Greater changes have been observed from ordinary exercise and from psychological variables.

[c] Changes observed are within limits of normal physiological variability.

[d] Serotonin reduction is within normal physiological limits and comparable to ordinary changes induced by dieting.

more than a very brief period (minutes to hours). Additionally, during conditions that can result in highest ion concentrations (e.g., storms), most animals would avoid open areas such as under transmission lines.

Overall, test results on ion effects indicate that (1) there is no dose-response relationship between ion concentration and electric field and magnitude of response, (2) there is no time-course relationship between length of exposure and degree of response, and (3) none of the responses due to ion exposure exceed ranges that are observed to be typical or normal of biological variability. Thus, it can be concluded that long-term exposures to air ions have not produced any apparent biologically harmful or adverse health effects.

Exposure to Audible Noise and Ozone. Recommended standards for noise proposed by the U.S. Environmental Protection Agency (1974) are 45 dB(A) ($L_{eq(24)}$ or L_{dn}) as an indoor level below which there is no reason to believe that public welfare will be jeopardized, and 55 dB(A) ($L_{eq(24)}$ or L_{dn}) as the corresponding outdoor level, each identified to provide a margin of safety.* Maximum predicted noise levels under the DC line are 46 dB(A) under the positive conductor and 42 dB(A) at the edge of the right-of-way (ER, Supplement, Sept. 29, 1986). Johnson and Zaffanella (1982) measured noise levels under the Project UHV test line ranging up to 33 dB(A) (below which 95% of the measured values occurred). Noise levels would fall off rapidly as distance from the lines increased; noise intensity decreases at the rate of 6 dB per doubling of distance (U.S. Environmental Protection Agency 1974).

There are insufficient data to quantitatively relate audible noise emissions to impacts to wildlife. Deer and elk have been observed using transmission line rights-of-way despite the presence of audible noise (Lee and Griffith 1978). Wildlife use of transmission line rights-of-way under a variety of weather conditions implies that audible noise has a negligible impact upon wildlife activities. The low level of audible noise that would be emitted by the proposed transmission line is unlikely to deter wildlife from using habitat in the vicinity of the right-of-way.

Experiments with animals and humans indicate a range of effects from ozone exposure at 100 to 1000 ppb. Effects include altered pulmonary function, pain upon breathing, morphological changes in pulmonary tissue, biochemical changes, alterations of genetic material, and increased susceptibility to bacterial infections (U.S. Environmental Protection Agency 1978; National Research Council 1977). The Project UHV test line generated no ozone

*A = A-weighting = weighting of the entire audio-frequency spectrum of audible noise by a single number expressing an overall sound-energy level; L_{eq} = equivalent sound level = mathematically time-averaged level of a fluctuating noise; L_{dn} = equivalent day-night sound level = variation of L_{eq} that allows for penalizing noise intrusions at night when people are more sensitive to noise.

that could be measured above background (Johnson 1982a, 1982b). Measurements in laboratories and near transmission lines have also shown the level of oxidants produced by DC lines to be near the detection limits (Droppo 1981; Krupa et al. 1980). Levels of ozone produced are less than a few parts per billion, while ambient levels are in the range of 10 to 100 ppb (U.S. Department of Health, Education and Welfare 1970; U.S. Environmental Protection Agency 1973; Coffey and Stasiuk 1975). The National Primary Ambient Air Quality Standards for photochemical oxidants are 120 ppb (maximum 1-hour concentration, not to be exceeded on more than 1 day per year) (U.S. Environmental Protection Agency 1979). Ozone production generally occurs during foul weather, which coincides with the times of lowered background levels of ozone (ER, Vol. 5a). Therefore, no adverse health effects are expected from ozone produced by the proposed transmission line.

Cardiac Pacemakers. DC electric fields are not expected to interfere with the functioning of cardiac pacemakers worn by individuals in the right-of-way. These fields would be 100 times lower than necessary to cause reversion to asynchronous operating mode (Frazier 1980).

Overall conclusions regarding the potential health effects of DC transmission line operations can be inferred from epidemiological studies conducted in association with operating DC lines. Nolfi and Haupt (1982) and Haupt and Nolfi (1984) reported that the prevalence of symptoms and other health indices were not systematically different between people that live near or far from the Pacific Intertie. While they could not conclude that there are no power line health effects; they could conclude that any health effects were not meaningful. Martin et al. (1983) investigated Minnesota Dairy Herd Improvement Association records to determine potential effects from the DC transmission line in Minnesota. Comparison of herds located varying distances from the line revealed that there were no statistically significant changes in dairy herd performance parameters associated with the line: no significant association was found between 305-day lactation milk production and distance from the line, 12-month rolling herd milk production increased at all distances from 1975 to 1982, herd size increased moderately from 1975 to 1982 at all distances, quality and efficiency measures showed no differences, and rate of culling for reproductive problems and abortion incidence were were not related to distance. In a separate analysis of health and safety issues related to DC transmission lines, no impacts were anticipated from the proposed Mead-Phoenix ±500 kV DC line, which, like the Phase II system, would also be routed along AC rights-of-way (U.S. Department of Energy 1986).

4.1.8.2 AC Effects

Potential health and safety effects of AC lines were not addressed in the Phase I EIS (U.S. Department of Energy 1984) because no AC lines were to be constructed in conjunction with that project. A moderate amount of research has been conducted on AC effects, and the results are summarized in the ER, Vol. 5b (New England Hydro-Transmission Corp. and New England Hydro-

Transmission Electric Co. [NEHTC and NEHTEC 1985b]). The information in that document supports the conclusion, and DOE Staff concurs, that no health and safety concerns would result from operation of a 345-kV AC line. A pertinent summary of the effects of AC operation is presented in the following subsections.

Electric and Magnetic Environment

Operating, high-voltage, alternating-current (HVAC) lines produce electric and magnetic fields and corona (Lee et al. 1982). Corona from such lines does not produce long-lived air ions. There is little movement of the ions away from the conductor since they are alternately repelled from and attracted to the conductor as the voltage on the conductor alternates polarity. Secondary effects of AC corona include production of audible noise, ozone, and nitrogen oxides (Comber et al. 1982a, 1982b). For a given transmission line configuration, electric field strength depends on line voltage, and magnetic field strength depends on line current. Both vary with distance from the conductors.

Potential Hazards from an Operating High-Voltage Alternating Current (HVAC) Transmission Line

As previously mentioned, most studies on the health and safety aspects of operating transmission lines have dealt with AC systems (or aspects associated with them). Biological systems have been found to be affected when field intensities and duration of exposure are of sufficient magnitude. However, as with HVDC systems, the maximum electric and magnetic field strengths associated with HVAC systems are not of sufficient magnitude to elicit harmful, pathological effects, although nonpathological effects may occur. Maximum intensities of the fields associated with the HVAC environment occur infrequently over the course of a year and decline rapidly with distance from the electrical conductors. Additionally, exposure to maximum field intensities is expected to be infrequent due to periodic and generally short duration use of rights-of-way by humans and livestock. The following discussion details the health and safety concerns relevant to the proposed Phase II AC transmission lines.

Proximity Effects. Risks of pathological shocks under the proposed 345-kV AC line would be extremely low. Maximum transient and steady-state currents would be expected to be about half those shown in Table 4.5 for operating 765-kV AC lines assuming similar line configurations. No direct physiological hazards have been associated with such shocks (Keesey and Letcher 1970), and there have been no documented cases of human injuries due to electric charges or induced currents from 345-kV AC lines in the United States (ER, Vol. 5b).

Electric Field Effects. In New England, typical maximum electric field strengths at ground level under 345-kV AC transmission lines are 7 kV/m. For

Table 4.5. Shock Currents from 765-kV AC Transmission Lines and Currents Affecting Humans[a]

Type of Current	Shock Received by Contact with a Vehicle	Shock Effects
Steady-state (current)	Theoretical: 0.1-7.5 mA[b] Probable: 0.003-0.12 mA	Perceived: >0.5-2 mA Startling: > 1 mA
	Highest Measured Value: 3.5-4 mA	Objectionable: >2 mA Release Currents[c] >5 mA suspected for small child <10.5 mA for average adult female >16 mA for average adult male
Transient (energy released)	Theoretical: 0.02-65 mJ[b] Probable: 0.003-1 mJ	Perceived: >0.1 mJ Annoying: >0.5-1.5 mJ Painful to lethal: 250-25,000 mJ

[a] Maximum electric fields of 9 kV/m.

[b] Calculated for worst-case conditions in maximum electric field. Worst-case conditions are: vehicle completely insulated from ground; human completely grounded and having negligible resistance to electric current.

[c] Current above which contact cannot be voluntarily broken.

Source: Scott-Walton et al. (1979).

the proposed 345-kV AC lines, the maximum electric field strength at ground level is calculated to be 6.6 kV/m in the right-of-way and 1.8 kV/m at the edge of the right-of-way (ER, Vol. 5b). Electric fields of these intensities are at levels for which biological responses have been reported or inferred (Michaelson 1981; Sheppard 1983b; U.S. Department of Energy 1983). As with the DC system, electric field intensities would vary with position, and the maximum ground level intensities would be encountered only in a small portion of the right-of-way (less than 5%). Recent review of the large body of literature on exposure to AC fields has revealed no evidence of harmful effects from intermittent exposure to field intensities below 10 kV/m (Michaelson 1981; Sheppard 1983b; U.S. Department of Energy 1983).

Field and laboratory studies have generally shown minimal or no impacts from power-frequency electric field strengths of 30 kV/m or less. Exposure to an AC electric field strength up to 20 kV/m did not cause stress or affect health (Hauf 1974; Rupilius 1976). No effects on growth or reproduction of cattle, horses, sheep, and swine pastured under a 765-kV AC transmission line right-of-way with an electric field strength up to 12 kV/m were observed (Amstutz and Miller 1980). Studies on another 765-kV AC line showed no effect on cow milk production (Williams and Beiler 1979). No differences in fertility were noted between cattle pastured near a 400-kV AC line and those pastured in a control area (Hennichs 1982). Rogers et al. (1982) observed no reluctance by cattle to graze under an 1100-kV AC line, although they spent less time under the line when it was energized. This suggests a behavioral effect from the 12-kV/m electric field and/or from the audible noise related to corona activity. Phillips et al. (1981) reported mixed results related to incidence of malformed offspring for swine exposed to 30 kV/m, but no evidence of this for small laboratory animals. Hackman and Graves (1981) concluded that an electric field strength of 30 kV/m was not stressful. Neuroendocrine levels (related to stress) in rats did not significantly change from exposure to 100 kV/m for a few hours to a few days (Quinlen et al. 1985). Quantitative tests for stress were negative for people exposed to 20 kV/m (at 50 Hz) for 5 hours (Hauf 1982; Amon 1977). Beyer et al. (1979) found no change in cortisol content of blood in humans exposed to 10 to 20 kV/m for 1.5 hours.

Continuous exposure to the electric field in the proposed right-of-way is unlikely because it is improbable that humans or other animals would remain in the right-of-way for more than a few hours. Outside the right-of-way, the AC electric field intensities would fall below 2.0 kV/m, and fall below the earth's natural average fair-weather electric field (less than 1.5 kV/m) within a short distance from the right-of-way. Sheppard (1983b) has identified 1.0 kV/m as a reasonable criterion level for protection of public health for long-term exposure to AC fields.

In conclusion, although biological effects have been reported for levels of electric field intensities associated with AC transmission lines, it is improbable that the fields associated with the proposed AC system would compromise the health and welfare of the local population or livestock.

Magnetic Fields. The proposed 345-kV AC lines would produce maximum ground-level magnetic fields of 0.28 G in the right-of-way and 0.085 G at the edge of the right-of-way (ER, Vol. 5b). These values are less than the AC magnetic field of 1 to 5 G produced near several home appliances (Miller 1974; Gauger 1985). There is no basis to conclude that a 60-Hz magnetic field of the magnitude comparable to that of the proposed 345-kV AC transmission lines would cause any biological effects to man or other animals. Laboratory tests present conflicting reports at magnetic field strengths and frequencies 100 and 10 times those of the proposed AC transmission lines, respectively. Epidemiological data on effects of magnetic fields on increased risks of cancer are so weak that epidemiology is not a sufficient test to detect any effects. Studies of the health of electric field workers (an employment sector that would be among those most exposed to magnetic fields) have not indicated any suggestions of increased cancer risks (ER, Supplement, Sept. 29, 1986). U.S. and Soviet research groups have recommended levels of 200 to 300 G for occupational or extended exposures and 20,000 G for short (several minutes) exposures (Llaurado et al. 1974). It can be concluded that magnetic field effects associated with the proposed HVAC transmission lines will be innocuous.

Air Ions. Air ion densities are not of concern for AC transmission lines. As the voltage on the conductor alternates polarity (at the rate of 60 times per second), charged molecules are alternately attracted and repulsed and thus remain near the conductors.

Exposure to Audible Noise and Ozone. Calculated maximum noise levels under the operating 345-kV AC lines would be about 60 dB(A) in heavy rain conditions (ER, Vol. 5b). Generally, the AC lines would generate audible noise during rain or fog. Expected noise levels at the edge of the right-of-way would be ≤ 45 dB (fair weather), 48 dB (when conductors are wet from fog or light rain), and 56 dB (heavy rain) (ER, Vol. 5b). Generally, background levels of audible noise in rural areas are about 35 to 45 dB(A) during fair weather (U.S. Environmental Protection Agency 1974). During heavy rain, background levels of audible noise would increase 10 to 15 dB(A) because of rain (ER, Supplement, Sept. 29, 1986). Thus, audible noise would be expected to be at or slightly above normal background along the edge of the right-of-way during fair weather or light rain or fog. The same conclusion would hold for periods of heavy rain when background noise levels would be greater. Also, the public typically would be indoors during heavy rain. In summary, the discernable noise levels would generally be below those considered annoying because noise levels fall off rapidly as distance from the lines increases. Noise intensity decreases at the rate of 6 dB per doubling of distance (U.S. Environmental Protection Agency 1974).

The lack of anticipated impacts due to ozone production related to the HVDC line also applies to the proposed HVAC transmission lines.

Cardiac Pacemakers. Operation of the 345-kV AC lines could result in maximum AC fields in the range that could induce reversion to asynchrony. Most pacemaker manufacturers have successfully designed them to avoid electromagnetic field problems (ER, Vol. 5b), but some cardiac pacemakers can revert in electric fields of 2 kV/m (Moss and Carstensen 1985; Butrous et al. 1983). Conditions resulting in prolonged reversion are extremely unlikely, but the risks associated with intermittent reversion could cause fainting (Moss and Carstensen 1985). Apparently no accidents have resulted from exposure of a pacemaker patient to an AC transmission line (Scott-Walton et al. 1979; Lee et al. 1982; World Health Organization 1984). Although the combination of circumstances that would lead to an accidental event is extremely rare (ER, Vol. 5b), it is, nonetheless, probably unwise for persons with sensitive pacemakers to work for extended periods in the right-of-way of the AC lines.

4.1.8.3 Combined Effects of DC and AC Transmission Lines

Most of the proposed DC transmission line would share a right-of-way with a 115-, 230-, or 345-kV AC line. The previously presented information has implied that the proposed DC and AC lines would have negligible effects on health and safety. Nevertheless, some concern may still exist as to whether the combined effects of DC and AC lines operating side by side would have effects greater than expected from either line alone. However, information summarized below strongly implies that combined operations of DC and AC lines would not have adverse health and safety effects.

The highest calculated audible noise level at the edge of the right-of-way would be 55 dB(A) during heavy rain. This is only 1 dB(A) above the calculated audible noise level for the corresponding right-of-way with only the existing AC line.

Shielding of the earth's magnetic field (whose strength is almost twice as high as that of the proposed DC line's magnetic field) is seldom done in experimental studies. Thus, it is reasonable to conclude that studies on the effects of AC magnetic fields--previously concluded to have no health effects at levels expected from the proposed 345-kV AC lines--have in actuality assessed the combined effects of an AC line and the earth's field. Several recent studies have indicated that the magnitude and orientation of a DC magnetic field can affect the responsiveness of isolated tissues or animals to superimposed AC electric and magnetic effects. Blackman et al. (1985a, 1985b) observed that certain combinations of DC magnetic fields, in conjunction with ELF electric and magnetic fields, can enhance calcium efflux within certain amplitude-frequency combinations: (1) 0.38 G and 15-Hz electric fields enhanced calcium efflux, (2) 0.38 G and 30-Hz showed no enhancement, (3) 0.19 G and 15-Hz showed no enhancement, (4) 0.253 G and 30-Hz enhanced calcium efflux, and (5) 0.7 G and 30-Hz enhanced calcium efflux. Exposure to 1.0 to 1.5 G, 60-Hz magnetic field in combination with a net DC magnetic field of 0.27 G reduced pharmacological activity of morphine on perception of pain and spontaneous locomotor activity in mice (Miller et al. 1985). Liboff et al. (1985) reported a 0.4-G, 60-Hz magnetic field superimposed on a 0.26-G DC magnetic field affected timing discrimination in rats. However these effects are reversible, returning to normal following cessation of exposure (equivalent to moving away from the right-of-way). Also there were no observed pathological effects. Thus, the meaningfulness of these observations to human health and safety is questionable. Additionally, under normal operating conditions for the proposed DC line, the resultant static magnetic field (earth's plus that of the DC line) would be close to or within limits of local variations of the static magnetic field found naturally at the earth's surface. Thus, the combined magnetic effects of AC and DC lines should have no health effects of concern.

There is little movement of small air ions away from an AC conductor. Therefore, an AC line will contribute little to the air ion concentration at ground level. Thus, air ion effects would be similar (negligible) to that previously discussed for the DC line. Additionally, ion concentrations at the the edge of the right-of-way would be less on the AC side (or on either side where the DC line is situated between AC lines) than at the edge of the right-of-way if only the DC line would be present.

There are no data indicating, nor is there reason to believe, that combined effects of DC and AC electric fields would affect health and safety. As stated in the ER (Vol. 5 Supplement, Oct. 30, 1985), a DC electric field is constant over time and does not capacitively induce currents within objects, but rather causes objects to accumulate charges at their surfaces. This should in effect shield the object from influences of the externally applied DC field.

On the basis of the information above, coupled with the lack of any observed effects from existing shared DC/AC rights-of-way, there is no reason to conclude that any adverse health or safety effects would result from the siting of the proposed DC line within AC rights-of-way.

4.1.8.4 Herbicide Use in Right-of-Way Management

The Phase I EIS (U.S. Department of Energy 1984) concluded that herbicide use would not be a health or safety concern. Vegetation maintenance practices for the proposed Phase II project would be similar to that of Phase I, as well as other New England Electric System (NEES) lines. Therefore, no health and safety effects from Phase II maintenance would be expected. A pertinent summary of herbicide use is presented in the following discussion.

Except for the first 1.3 km (0.8 mi), most of the proposed transmission line would be constructed in existing right-of-way that is currently maintained by NEES. A 2.9-km (1.8-mi) segment between Millbury and West Medway, Massachusetts, is maintained by Boston Edison Company in a manner similar to NEES. Current right-of-way management practices would be maintained along these rights-of-way (ER, Vols. 2 and 3). Selective applications of herbicides would be used to retard the development of tall-growing vegetation that might compromise the integrity and safety of the power transmission system. The Applicant would only use herbicides that are registered with the U.S. Environmental Protection Agency and the states of New Hampshire and Massachusetts and approved for use in right-of-way management. The herbicides currently used by NEES are listed in Table 4.6.

Herbicides would only be applied by means of selective spray application by workers using hand-held application tools; there would be no broadcast application. Areas near public water supplies, open waters, springs, wells, homes, or roadsides would be managed by manual removal of undesirable vegetation, use of certain herbicides, or use of only specific herbicide application techniques. Herbicide applications would follow a prescribed schedule beginning with selective spraying of stumps of all hardwood species during the first dormant season after clearing. Two years later, a second selective application would occur, with subsequent applications on a 3- to 5-year cycle.

Table 4.6. Current Herbicide Usage by NEES Companies

Herbicide	Active Ingredients	Dilution	Average Application Rate (gallons of active ingredient per acre of ROW)	Type of Application[a]
Krenite	Fosamine	1.5 gal herbicide to 98.5 gal water	0.44	High-volume foliar[b]
Krenite	Fosamine	14-20 gal herbicide	0.30	Low-volume foliar[c]
Garlon 3A	Triclopyr	1 gal herbicide to 99 gal water	0.36	High-volume foliar
Garlon 3A	Triclopyr	10 gal herbicide to 90 gal water	0.13	Low-volume foliar
Garlon 3A	Triclopyr	50 gal herbicide to 50 gal water	<0.01	Cut stump
Garlon 4	Triclopyr	25 gal herbicide to 75 gal light oil	0.03	Low-volume basal and cut stump
Tordon 101	Picloram & 2,4-D	1 gal herbicide to 99 gal water	0.41 (0.08 Picloram and 0.33 2,4-D)	High-volume foliar
Tordon 101	Picloram & 2,4-D	14 gal herbicide to 86 gal water	0.15 (0.03 Picloram 0.12 2,4-d)	Low-volume foliar
Tordon 101 & Garlon 3A	Picloram, 2,4-D & Triclopyr	0.5 gal each herbicide to 99 gal water	0.28 (0.03 Picloram, 0.12 2,4-D and 0.13 Triclopyr)	High-volume foliar
Tordon 101 & Garlon 3A	Picloram, 2,4-D & Triclopyr	7 gal each herbicide to 86 gal water	0.46 (0.07 Picloram, 0.29 2,4-D and 0.10 Triclopyr)	Low-volume foliar

Table 4.6. Continued

Herbicide	Active Ingredients	Dilution	Average Application Rate (gallons of active ingredient per acre of ROW)	Type of Application[a]
Tordon RTU	Picloram & 2,4-D	Undiluted herbicide	<0.02 (0.01 Picloram and 0.01 2,4-D)	Cut stump
Roundup	Glyphosate	1 gal herbicide	0.12	High-volume foliar
Roundup	Glyphosate	7 gal herbicide to 93 gal water	0.12	Low-volume foliar

[a] Three application methods are used. Foliar treatments are applied to the leaves of the target tree sprouts or seedlings. Basal treatments are applied to the lower 8 to 18 in of a tree's stem. Cut stump treatments are applied to the cut surface of a tree's stump. These application methods are all selective and are applied only to target plants. They suppress tree growth while encouraging the growth of shrubs, grasses, ferns, and other low-growing plant species.

[b] High-volume foliar treatments utilize a relatively low concentration of herbicide mixed with water. They are applied with hand-held nozzles attached to hydraulic spray equipment. This method is usually performed in areas of relatively high stem density and areas where access is difficult.

[c] Low-volume foliar treatments utilize a relatively high concentration of herbicide mixed with water. They are applied with powered backpack equipment. This method is usually performed in areas of relatively low stem density and areas where access is not difficult.

Source: Supplemental response from Vern R. Walker to Anthony Como (DOE, ERA), 9 October 1985.

Herbicides can be toxic to living organisms and many are considered somewhat toxic to humans (Norris 1981; Gangstad 1982; U.S. Department of Energy 1983, 1984). Human health risk from herbicide application depends upon the acute and chronic toxicity of the compound, duration of exposure, pathway of exposure, and concentration of the compound to which one is exposed. Based on worst-case assessment, the U.S. Department of Energy (1983) has estimated the maximum possible dose to a 50-kg (110-lb) individual exposed to 2,4-D occupationally or via environmental dispersion of the herbicide. Table 4.7 summarizes the results of that assessment scaled to NEES's current application rate of about 2.2 kg/ha (2 lb/acre). Estimated safety margins for use of 2,4-D as proposed by the Applicant range from maximum doses of 100 to 20,000 times less than the threshold level of 20 mg/(kg·day) for chronic effects to the reproductive system. The other herbicides proposed for use by the Applicant are generally less toxic to mammalian systems than 2,4-D (U.S. Department of Energy 1983, 1984).

Herbicide use has been found to be environmentally acceptable as practiced by the Forest Service in the Northeast. This program involves the treatment of 18,200 ha (45,000 acres) with a variety of herbicides, including 2,4-D, Picloram, and Krenite for road and trail management, recreational development, and other uses (Forest Service 1978). This conclusion was partially based upon 25 years of herbicide use by the Forest Service with no known health problems in Forest Service personnel, applicators, or local residents.

Several alternatives to vegetative management using herbicides exist. These include manual, mechanical, and biological control methods (U.S. Department of Energy 1983). However, the most readily acceptable alternatives are manual or mechanical vegetation control. These methods are much more labor-intensive and expose workers to increased risk of injury from accidents in tool, equipment, and brush handling. In Oregon, the Bonneville Power Administration has recorded a 5-year average injury rate of 5 injuries per 200,000 person-hours in brush-cutting activities (U.S. Department of Energy 1983--p. 205). No chemical toxicity injuries were reported among workers over this same time period. Vegetation management using herbicides substantially reduces health and safety risks for workers while slightly increasing the risks of toxic effects to the public, principally via erosion and spill events.

In conclusion, the herbicides proposed for use in the rights-of-way have low degrees of toxicity to humans and other animals, and their application according to label directions and in conjunction with appropriate mitigative measures would ensure their safe use. Extensive experience with toxic herbicides has shown that these potentially hazardous materials can be used safely if appropriate precautions are implemented (Barnes 1975; Buffington 1974; Gangstad 1982; U.S. Department of Energy 1983).

Table 4.7. Maximum Worst-Case Doses [mg/(kg·day)] and Associated Safety Factors for Potential Routes of Exposure to 2,4-D Proposed for Use by the Applicant for Right-of-Way Management

Item	Handling Herbicides During Application	Drinking 2 L of Water from 10-cm-deep Stream on Right-of-Way	Consuming 0.5 kg of Fish from 10-cm-deep Stream on Right-of-Way	Consuming 0.5 kg of Meat from Deer Found on Right-of-Way	Consuming 0.5 kg of Berries Collected on Right-of-Way
Maximum dose[a]	0.050	0.090	0.022	0.0010	0.12
Safety factor[b]	400	222	909	20,000	167

[a] Worst-case estimate of maximum dose to a 50-kg (110-lb) person.

[b] Based on a threshold level of chronic ingestion of 20 mg/(kg·day) of 2,4-D for initiation of effects to reproduction.

Source: Modified from U.S. Department of Energy (1983--Table 7-12).

4.1.9 Radio and Television Interference

The term "radio noise" is used in reference to any undesirable disturbance of the radio frequency spectrum, which ranges from 3 kHz to 30,000 MHz. Operational high-voltage transmission facilities contribute to radio noise that can interfere with radio and television reception, particularly the AM broadcast bands (535-1605 kHz) and the lower television broadcast bands (Channels 2-6 at 54-88 MHz) (U.S. Department of Energy 1984). The degraded reception is referred to as radio interference (RI) or television interference (TVI). The FM broadcast range from 88 MHz to 108 MHz is unaffected by pulsative-type noise (General Electric Company 1982).

RI and TVI associated with operational transmission lines result from corona discharge and gap sparking. The latter is generally caused by defective or loose fittings and can be remedied by routine maintenance. Corona (the partial breakdown of air into charged particles) begins to occur when the surface voltage gradient on the conductors exceeds the threshold or onset value of the surrounding air. Transmission lines are designed to control levels of corona activity, but the onset of corona is influenced by numerous factors, including atmospheric elements, design parameters of the line, and condition of the conductors. Corona activity is also influenced by the kind of transmission system. For example, corona activity associated with AC systems increases during foul weather, reaching a maximum during heavy rain. In contrast, corona levels for DC systems are highest when point sources occur on the conductor (which may occur during foul weather), although certain effects (audible noise and RI/TVI) of corona are probably highest in fair weather (ER, Vol. 5a).

Some evidence indicates that DC RI is of a lesser nuisance level than AC RI (Bonneville Power Administration undated). Subjective evaluations by test individuals have shown that the tolerance level for DC RI corresponds with a broadcast signal-to-noise ratio (SNR) of about 10 to 1. In terms of equivalent dB levels (above 1 μV/m, hereinafter implied), the RI at the receiving antenna must be 20 dB below the broadcast signal for acceptable reception. Bracken has reported that a differential of 17 dB results in entirely satisfactory AM reception (U.S. Department of Energy 1984). However, the SNR for acceptable reception involving AC transmission systems is variously reported as 15 to 1, ranging up to 25 to 1. Accordingly, the AC line RI must be 23.5 to 28 dB below the broadcast signal strength for satisfactory reception (Bonneville Power Administration undated). The Applicant proposes that an SNR of about 20 dB for AC transmission lines would result in satisfactory reception quality (ER, Vol. 5--p. II-20), as opposed to the 23.5 to 28 dB noted above.

The preceding attributes of RI and TVI associated with DC transmission systems were included as considerations in evaluating RI and TVI related to Phase I development of the New England/Hydro-Quebec ±450-kV DC transmission line interconnection (U.S. Department of Energy 1984). Based on a relatively conservative prediction equation, it was estimated that the fair weather RI at the edge of the right-of-way would be 41 dB. Since the design parameters of the currently proposed Phase II transmission facilities are similar to those of the Phase I development (ER, Vol. 4--p. 76), it is assumed that the fair weather RI at the edge of the right-of-way for the proposed Phase II DC line would likewise be about 41 dB. Given an SNR equivalent to 17 dB, reception at receiver units located at the edge of the right-of-way would be satisfactory for all broadcast signals exceeding 58 dB. Radio broadcast signals for primary service areas typically exceed 70 dB; thus, RI related to the proposed Phase II DC line would be unlikely to cause complaints relative to radio reception. Complaints of TVI would also be unlikely, as indicated by evaluation of potential TVI related to the Phase I DC line (U.S. Department of Energy 1984).

The Applicant has reported calculated RI levels at the edge of the right-of-way for the proposed AC transmission lines (ER, Vol. 5--p. II-18). For a frequency of 1 MHz, the calculated RI is 68 dB or less during heavy rain, 60 dB or less during wet conductor conditions, and 43 dB or less during fair weather conditions. However, RI levels decrease rapidly with increasing distance from the line. At 30 m (100 ft) from the edge of the right-of-way, the RI level drops to 49 dB or less during heavy rain, 40 dB or less during wet conductor conditions, and 23 dB during fair weather conditions. Given a SNR equivalent of 20 dB for satisfactory radio reception and a 70 dB radio broadcast signal for the primary service area, AM radio reception at the edge of the right-of-way of the proposed AC lines should be satisfactory, except during wet conductor or heavy rain conditions (ER, Vol. 5--p. II-20). At distances exceeding 30 m (100 ft) from the edges of the right-of-way, radio reception within the primary service area should be satisfactory during all weather conditions. The level of interference associated with commercial television frequencies is considerably lower than that associated with the AM radio broadcast band. Thus, the incidence of TVI should be of minor consequence. The physical presence of transmission facilities may cause scattering, reflecting, or reradiation of primary television broadcast signals, thus resulting in the phenomenon referred to as ghosting (General Electric Company 1982). Ghosting can be alleviated by modifications of antennas.

The proposed DC transmission line would be constructed within a common right-of-way in parallel with one or more existing AC transmission lines. Thus, the potential RI and TVI levels at the edges of the common right-of-way would be influenced by any "combined effects" resulting from concurrent operation of the existing AC and the proposed DC transmission lines. The Applicant has calculated RI levels for various segments of the transmission corridor (ER, Vol. 5 Supplement, Oct. 30, 1985). The results indicate that operation of the DC line during heavy rain conditions would alter RI levels at edges of the rights-of-way, ranging from slight increases (generally 3 dB or less) to actual decreases in RI levels in some cases. However, such changes are relatively minor, and the combined effects of AC and DC line operations would not appreciably affect the potential for RI adjacent to the right-of-way. Current evidence indicates that operation of the DC line would be unlikely to cause TVI problems beyond the edges of the right-of-way (ER, Vol. 5 Supplement, Oct. 30, 1985).

4.1.10 Recommended Mitigative Measures

The Applicant has committed to a broad spectrum of mitigative measures that would minimize adverse environmental impacts resulting from the construction, operation, and maintenance of the proposed project. Those measures are outlined in Section 2.1.5. Listed below are additional measures that the DOE Staff recommends be incorporated into the Applicant's mitigative program for the proposed project.

4.1.10.1 Air Quality

Additional measures that should be considered to reduce excess fugitive dust and audible noise include the following:

- *Construction and vehicular activities should be curtailed on dry, windy days in areas prone to excessive dust generation; or as an alternative, access roads in those situations should be watered, as necessary, to minimize the generation of fugitive dust (especially in developed areas).*

- *Vehicle speed should be controlled on unpaved access roads.*

- *Construction equipment should be properly maintained and properly operated.*

4.1.10.2 Land Features, Hydrology, Water Quality, and Water Use

Additional mitigation measures beyond those committed to by the Applicant that would be warranted under certain conditions include the following:

- *Before the project is started, erosion and sedimentation plans should be formulated for all sensitive areas that would be affected by project construction and/or operation activities. Such areas would include erosive upland soils on steep slopes and areas in or near wetlands, streams, or other water bodies where water quality considerations would be particularly important. Preparation of erosion and sedimentation plans should be coordinated with appropriate federal, state, and local agencies to ensure identification of sensitive areas and the adequacy of mitigative features of the proposed plans.*

- *Construction vehicles and equipment should not be operated when unfavorable weather and sensitive site conditions could result in unacceptably excessive wind or water erosion.*

- *Whenever feasible, topsoil materials should be salvaged from construction sites, stockpiled, and used for top dressing of disturbed surfaces following completion of construction.*

- *Refueling of construction vehicles, storage of construction materials, disposal of waste materials, and any other handling of potentially contaminating materials should be prohibited near surface water bodies. Fuels, chemicals, oils, greases, solid wastes, and other materials needed at construction sites should be stored and handled in a manner designed to prevent spills.*

- *Storage and maintenance yards should not be located near watercourses.*

- *Temporary toilets should be self-contained, and land-stabilization measures should be provided where required to protect the quality of surface water and groundwater.*

4.1.10.3 Land Use

- *Forest vegetation on steep ravines should not be cleared if the height of the spanning conductors is sufficient to preclude jeopardizing the operational integrity of the proposed lines.*

- *As necessary, temporary fences, gates, cattle guards, etc. should be installed to control and minimize disturbance to livestock during project construction and operation.*

- *To the extent practicable, construction activities should be scheduled to minimize damage to standing crops and limit interference with authorized land use operations.*

- *Appropriate federal, state, and local agencies should be consulted as necessary to refine construction procedures in accord with site-specific conditions to further ensure that land-use impacts related to the design, construction, and operation of the proposed transmission facilities would be minimized.*

- *Provisions for screening the proposed transmission facilities should include considerations for minimizing the length of the transmission line segments visible from a given vantage point. This could involve establishing plantations of low-growing trees across or within the edge of the right-of-way in strategic areas. In some places, feather cutting of existing vegetation (i.e., only tall trees removed) within the inner edge of the right-of-way may be effective.*

4.1.10.4 Ecology

Many of the committed and suggested mitigative measures to minimize impacts to land, forest, and hydrological resources would effectively reduce potential impacts to ecological resources as well. The following mitigative measures are designed more specifically to protect fish, wildlife, and their habitats and should be considered for use by the Applicant:

- *To ensure compliance with the Migratory Bird Treaty Act and to provide additional protection for other bird species of concern (e.g., raptors), the following steps should be taken: (1) obtain a list of migratory birds protected by the Act from the Department of the Interior; (2) determine if protected migratory birds (and raptors) or their nests exist in the areas to be cleared for the rights-of-way (this would include consultation with appropriate state and local officials to identify any locations of migratory birds); and (3) if protected birds (and raptors) or their nests or eggs are present, consult with the Department of the Interior for appropriate precautions to be taken.*

- *No debris resulting from periodic vegetation management should be placed within the high water mark of any water body. If tree tops and slash are not disposed of within 8 m (26 ft) of perennial and intermittent streams, the potential for formation of debris dams would be reduced (Lynch et al. 1985).*

- *Erosion gullies and depressions found on the rights-of-way that carry water from heavy rains should be filled with brush from clearing operations (Ulrich 1976). This would trap sediments and eventually stabilize such areas.*

- *Construction and clearing operations in streams (e.g., for access roads) should be restricted during salmonid nesting and spawning periods. [For brook and brown trout (major game species of concern) this is during late summer to early fall. Such restrictions could be lifted if it can be satisfactorily demonstrated that natural reproduction does not occur in the stream or that nesting or spawning activities do not occur within the particular section of stream to be crossed.]*

- *Prior to the disturbance of gravel stream bottoms, the potential of the area for use as a spawning site should be determined, and if present, be avoided wherever practicable. Local fishery experts should be consulted in this matter. In this manner, more sensitive habitats may be identified and protected.*

- *During the spring thaw period or during extended periods of unusually heavy rainfall, access roads should be closed to heavy construction vehicles and equipment to minimize unacceptable environmental damage.*

4.1.10.5 Socioeconomics and Cultural Resources

- *The Applicant should select construction-phase access routes so as to minimize adverse impact to local traffic flows and other disturbances to communities along the right-of-way. Communities should be given prior notification of impending construction activities on their portion of the corridor.*

- *The Applicant should comply with the cultural resources mitigative measures that are outlined in the December 12, 1986, letter from Bradley H. Spooner to Valerie A. Talmage (reproduced in Appendix E). These measures should be undertaken both in Massachusetts and New Hampshire.*

4.1.10.6 Health and Safety

- *During construction or maintenance, efforts should be made to identify structures along the right-of-way that should be grounded or to notify owners if ungrounded structures are identified. If a resident seeks assistance or guidance concerning grounding, the Applicant should have the structure or equipment grounded for the owner if the structure is existing at the time the transmission line is installed, or provide information on grounding in the case of a new or proposed structure. The Applicant should send, no later than mid-1989, information on possible electromagnetic interference with cardiac pacemakers to practicing physicians in Massachusetts that are listed with the Massachusetts Medical Society as cardiologists or cardiosurgeons.*

4.2 CONSEQUENCES OF ALTERNATIVES TO THE PROPOSED ACTION

4.2.1 Alternative Designs

4.2.1.1 Air Quality

No noticeable differences in air quality would occur due to differences in structure design, conductor spacing, or other overhead design changes. Placement of the line underground would eliminate potential air quality changes that could occur with overhead transmission line operation (e.g., ozone increases). However, air-quality changes related to overhead transmission line operation were not determined to be significant (Section 4.1.1). More intensive construction activities associated with the installation of an underground system could increase fugitive dust and engine emissions over that expected for construction of an overhead system.

4.2.1.2 Land Features and Use

Geology and Soils

Alternative overhead lines with different types of structures, conductor sizes, and configurations (ER, Vols. 2 and 4), including the ±450-kV DC transmission line, the 345-kV AC line, and double-circuit 115-kV AC lines, would have similar geologic and soil impacts. Potential erosion due to soil disturbance during construction and maintenance could initiate geological instability, such as landslides, slumping, and mass wasting near sloping areas, such as at stream crossings.

The geologic impacts of an underground transmission line would be greater than for alternative overhead lines since more extensive terrain excavation, grading, and related cable-laying and backfilling activities would be required. Trenching for the 298-km (185-mi) underground line would require excavation of 0.78 to 1.1×10^6 m^3 (1.0 to 1.4×10^6 yd^3) of material, depending on whether it is a DC or AC facility. The amount of excavated materials would likely be substantially greater because of detouring to avoid areas ill-suited for trenching, such as wetlands and exposed or shallow bedrock. The underground line alternative would also necessitate removal of unused excavated material from the site for disposal and transport to the area of about 0.2 to 0.3×10^6 m^3 (0.24 to 0.4×10^6 yd^3) of thermal sand for the trenches. The longer construction time for the underground line would increase the time excavated material would be exposed to the elements, and therefore would increase the potential for erosion. Contamination of soils from oil spills or leaks could occur during the operational of an underground line. Mitigative measures described in Section 2.1.5 could be taken to minimize potential geologic and soil impacts.

Land Use

Land-use impacts associated with the alternative structure designs would not meaningfully differ from those discussed in Section 4.1.2.3, which includes considerations of the proposed steel lattice H-frame structures. However, structure design does influence land use, depending on the land use involved. For example, structure design is a negligible consideration with respect to use of pastureland, since livestock would graze areas adjacent to and within the base of structures. In the case of agricultural croplands, however, the area within the structure base, as well as additional area around the base, would be unavailable for production due to the area required for maneuvering farm machinery. In general, cropland unavailable for production around four-legged structures is two or more times greater than that for the two-legged H-frame structures (Scott 1981). The use of single-pole structures would entail even less land area. In view of the limited cropland along the proposed route and the fact that cropland would be spanned wherever practical (ER, Vol. 3--p. 204), use of any of the alternative structures would not meaningfully alter project-related land-use impacts.

The construction of either of the alternative DC or AC underground transmission systems would result in extensive land-use conflicts. Excavation of trenches for the underground systems would disrupt land-use patterns along the entire length of the proposed route. For example, some agricultural cropland and pasture would be dissected to the extent that the tracts would not be of feasible size for agricultural management. The excavation, extensive earth moving operations, transport of materials to construction sites, and offsite disposal of excess excavated materials would contribute to relatively intense construction activities. Thus, levels of fugitive dust, construction noise, and construction traffic would impact residential, commercial, and industrial land use to a greater extent than would be the case for construction of an overhead transmission system. Interference with use of local transportation routes would also be relatively severe.

Following construction of either the DC or AC underground transmission system, reclamation of disturbed areas would tend to promote restoration of some preconstruction land-use patterns. However, some land-use constraints would prevail throughout the operation of the underground system. The right-of-way overlying the buried cables would be maintained free of trees and shrubs (ER, Vol. 4--p. 84). Furthermore, permanent roads would be constructed to access facilities along the entire length of the underground system (ER, Vol. 4--Sec. VI.B).

4.2.1.3 Hydrology, Water Quality, and Water Use

Surface Water

All overhead line designs considered would have similar surface-water impacts relative to water erosion, potential reduction in water quality, altered drainage patterns, increased surface runoff, and damage to river-banks. The adverse impacts associated with construction of underground transmission lines would be greater than for any of the overhead transmission line alternatives. This is because there would be more extensive terrain excavation, grading, and backfilling for trenches and a longer construction time for underground transmission facilities. In addition, the underground cable would require boring of sleeves at highway and railroad crossings, and river crossings would require cut and fill, jetting, boring, or tunneling (ER, Vol. 4). These construction activities could cause contamination of surface water, particularly during periods of high surface runoff. Contamination could also result from oil leaks or spills. Surface-water impacts could be minimized by the proposed mitigative measures discussed in Section 2.1.5.3.

Groundwater

Potential adverse impacts on groundwater conditions, including aquifer contamination and disruption of shallow groundwater flow patterns, would be similar for all overhead design options. The groundwater impacts of the underground transmission line would be greater in comparison with overhead transmission lines since the underground line would require more extensive excavation. Groundwater contamination could occur as a result of oil leaks or spills during operation and maintenance of an underground line.

4.2.1.4 Ecology

The nature and extent of impacts associated with any overhead design alternatives would be similar to those discussed for the proposed designs (Section 4.1.4). Overall, construction of an underground system would have greater adverse impacts to terrestrial biota. The right-of-way initially would have to be completely cleared of vegetation, and after project completion would have to be maintained in a grassy condition. Large and more mobile wildlife would be affected similarly to what was discussed for an overhead system. However, smaller and less mobile species (e.g., small mammals, reptiles, and amphibians) would be destroyed in greater numbers due to the extensive amount of clearing, trenching, and construction activities that would occur with installation of an underground system. Conversely, potential for bird strikes associated with overhead line designs would be eliminated with an underground system (except in localized areas near transition facilities, converter terminal sites, and AC substations). However, the impact associated with the proposed design relative to bird strikes was concluded to be negligible (Section 4.1.4.1).

An underground system would more adversely affect aquatic systems and wetlands, especially when construction could not be rerouted around such areas. Habitat impairment would occur within the immediate area of construction. Impacts associated with increased suspended solids and sedimentation would occur in areas removed from the construction sites (e.g., downstream in the instance of stream crossings). Hydrologic impacts could also result from trenching activities within a wetland. Increased potential for erosion due to trenching activities could also impact aquatic systems and wetlands located adjacent to construction areas. With use of proper mitigative measures and construction techniques, adverse impacts to aquatic and wetland systems would mainly be confined to the period of construction plus the time needed for habitat recovery. Recovery rates are usually less than one year, but in some cases have been observed to require up to five years or more. Potential maintenance-related impacts would also be greater for an underground system, since retrenching would be required.

During the lifetime of the project, the area covering an underground line would have to be maintained free of woody vegetation. This probably would not greatly affect animal species with a wide range of habitat requirements or wide-ranging habits, but would limit the diversity of smaller, less mobile species that inhabit forested edge or shrub habitats more commonly associated with overhead transmission line systems. There would also be the potential for oil leaks or spills that could adversely impact habitats and associated biota. A large leak in a wetland would be especially damaging.

4.2.1.5 Socioeconomics

Impacts generated by alternative designs would be the same as those projected for the proposed action, except in the case of a buried AC or DC transmission line. Burial of the transmission line would create both temporary and, to a lesser extent, long-term disruption of traffic flows and increased noise and fugitive dust levels. There could also be some short- and long-term loss of agricultural production. However, high construction and maintenance costs might have positive effects on the local economy.

4.2.1.6 Visual Resources

Two existing transmission lines occur within the segment of the proposed DC transmission line route for which the use of alternative structure designs have been considered (Section 2.2.3.4). Among other factors, compatibility of line and form between features of the landscape is conducive to visual harmony. Thus, the structure designs of the existing transmission lines within the common corridor are relevant to the design of the proposed and alternative structures for the DC transmission line. The two existing transmission lines are supported by lattice-type structures. Among structure designs considered, the proposed steel lattice H-frame is more visually compatible with the structure of the existing transmission lines and therefore would be least intrusive in local landscape settings. At the other extreme, the steel lattice, waist-type structures would be most disruptive with respect to landscape quality.

During the construction period, activities associated either with a DC or AC underground transmission system would result in a greater level of visual impacts than for construction of an overhead transmission system. The visual impacts also would probably be more enduring, since the construction period for the underground system would likely be more extended. Excavations along the entire length of the proposed line, extensive earth-moving operations at construction sites, and a high level of construction activity would severely degrade the quality of affected landscapes. Views from residential and commercial areas would be strongly affected, and users of recreational sites and routes adjacent to construction sites would be subject to visual impacts that would strongly detract from recreational experiences.

Following reclamation of disturbed areas associated with construction of an underground system, the visual impacts would be relatively minor compared with those associated with overhead transmission lines. A principal source of visual impacts associated with underground systems derives from the need to maintain the right-of-way overlying the buried cables free of tree and shrub vegetation (ER, Vol. 4--p. 91). Thus, the right-of-way would cause disruptive visual contrast, particularly in forested landscapes.

4.2.1.7 Cultural Resources

Use of alternative structure types (single pole and waisted) could have long-term visual impacts on some cultural resource sites (specifically, historical sites) incrementally greater than those of the existing right-of-way and transmission lines (Section 4.2.1.6; ER, Vol. 4--p. 77). Other alternative designs would have the same effects on cultural resources as the proposed project, with the exception of transmission line burial, which could cause significant impacts to archeological sites due to surface and subsurface disturbance during construction and maintenance (ER, Vol. 4--p. 91).

4.2.1.8 Health and Safety

Health and safety effects for overhead transmission system alternative designs would be comparable to those described for the proposed route (Section 4.1.8). Potential impacts associated with operation of overhead transmission lines (e.g., electric field, air ions) would be reduced or eliminated with an underground system. However, an increase in herbicide use could be expected as a result of more intensive maintenance requirements for an underground system. Nevertheless, when handled and applied properly, herbicides can be used safely. Construction-related accidents would be potentially greater for an underground system because of increased installation activities.

4.2.1.9 Radio and Television Interference

Given the proposed design parameters, spacing, and heights of conductor bundles, neither the proposed nor alternative structures could appreciably influence radio and television interference. This is because interference phenomena essentially derive from corona discharges from surfaces of activated conductors. Faulty or dirty insulators and loose conductor fittings may also contribute to radio and television interference. Neither the alternative DC nor AC underground system would influence radio or television reception, since there is essentially no electrical field around cables of an underground transmission system (Bonneville Power Administration 1982).

4.2.2 Alternative Routes and Converter Terminal Sites

4.2.2.1 Air Quality

Expected air-quality impacts along the Tewksbury, eastern, or western alternative routes would be identical to those expected for the proposed route.

4.2.2.2 Land Features and Use

Geology and Soils

The Tewksbury alternative DC transmission line would traverse about 9.5 km (5.9 mi) of potentially erodible soils compared with about 8.7 km (5.4 mi) crossed by the proposed DC transmission line. About 9.3 km (5.8 mi) of slopes greater than 20% would be crossed by either route (ER, Vol. 4). No significant differences in potential geologic and soil impacts related to development of these two routes would be expected. The eastern and western alternative DC transmission lines would traverse about 21.1 km (13.1 mi) and 22.2 km (13.8 mi) of terrain with centerline slopes of 20% or more, respectively (ER, Vol. 4). In addition, the eastern and western alternative lines would require more access road construction and land clearing would be more than eight times greater than that required for the proposed DC lines (ER, Vol. 4). This would result in greater soil erosion potential along the eastern and western alternative routes as compared with that for the proposed DC transmission line route.

Land Use

Land-clearing requirements for the proposed DC transmission line route would exceed those for the alternative DC Tewksbury route (ER, Vol. 4--Table IV-2). The differential of about 73 ha (180 acres) would essentially result from widening the cleared portion of an established transmission line corridor within which the proposed DC line would be constructed. The potential impacts on other land-use categories would be relatively similar for the proposed and alternative Tewksbury routes. Thus, the impacts on existing land-use patterns would not be a significant issue in choosing between the two routes.

Adopting either the eastern or western alternative DC routes would result in relatively severe land-use conflicts. Development of the eastern alternative DC route would entail acquiring about 641 ha (1,585 acres) for right-of-way (ER, Vol. 4--Table IV-4). About 441 ha (1,090 acres) of additional right-of-way would have to be acquired for the western alternative DC route (ER, Vol. 4--Table IV-6). In either case, local land-use patterns would be appreciably disrupted. Land clearing for each of the alternative routes would exceed 688 ha (1,700 acres), areas over eight times greater than for the proposed DC route. The principal land-use impacts associated with the two alternative DC routes would result from disruption of established residential and commercial land use. Development of the eastern alternative route would entail relocation of 40 to 60 residential units and business establishments. An estimated 35 home and business sites would be displaced from the right-of-way for the western alternative DC route (ER, Vol. 4--Table IV-6).

The wetland or swamp forest portion of the alternative Tewksbury converter terminal site represents passive land use. The remainder of the site is used for transmission line rights-of-way and related substation facilities (ER, Vol. 1--Sec. V). Some of the utility facilities would be relocated; however, development of the alternative converter terminal would not involve significant issues relative to active land use.

4.2.2.3 Hydrology, Water Quality, and Water Use

Surface Water

The proposed DC transmission line would cross 209 streams and rivers and 12 lakes and ponds, compared with 191 streams and rivers and 10 lakes and ponds for the Tewksbury alternative route (ER, Vol. 4). The two lines would have comparable potential impacts to surface-water resources. There are no surface-water data available for the eastern and western alternative routes; however, based on the areas to be disturbed (Section 4.2.2.2), the potentially adverse surface-water impacts for the proposed route would likely be less severe than those for the two alternative routes. The types of surface-water impacts are discussed in Section 4.1.3.1.

Groundwater

Some adverse impacts on groundwater conditions, including aquifer contamination and disruption of shallow groundwater flow patterns, would be similar for the proposed route and the alternative routes. Any differences in impacts would likely be insignificant between the proposed and alternative routes. More detailed discussions on groundwater impacts of the proposed route are given in Section 4.1.3.2.

4.2.2.4 Ecology

Terrestrial

The nature of impacts to vegetation and wildlife along the alternative routes would be as described in Section 4.1.4.1. Selection of the Tewksbury alternative would necessitate clearing of about 73 ha (180 acres) less forest than would selection of the proposed route, but would require more relocations of existing lines, which would increase construction activities and related disturbances. The eastern and western alternatives would require more clearing than the proposed route: 693.3 ha (1,713 acres) and 716.3 ha (1,770 acres), respectively (ER, Vol. 4). However, these differences are unlikely to significantly alter impacts, because any routing alternative would require clearing of only a small percentage of the forest resources in the study area. The potential impacts to terrestrial fauna would be proportionally related to differences in forest areas cleared among the alternative routes, but the significance of the impacts relative to the study area would be minimal.

Aquatic (Including Wetlands)

Environmental consequences for aquatic and wetland biota along the alternative corridors would be of the same nature as described for the proposed route (Section 4.1.4.2 and Appendix B). Impacts to streams would be comparable, as they would be spanned in almost all cases. A greater expanse of wetlands would be crossed by the proposed route (15 km [9.3 mi]) than by the eastern (10.3 km [6.4 mi]) or western (6.1 km [3.8 mi]) alternatives. However, relocations and improved access needs for the alternative routes could affect these differences. Also, both the eastern and western alternatives have about twice the expanse of slopes of over 20% than the proposed route (ER, Vol. 4). This could increase the potential for erosion-related impacts to streams and wetlands.

The Tewksbury alternative would require clearing of 4.8 ha (11.9 acres) of wetlands compared with 3.4 ha (8.3 acres) for the proposed route, with an accompanying wetland displacement of 17.3 acre-feet compared with 10.2 acre-feet and a floodplain displacement of 20.2 acre-feet compared with 3.2 acre-feet. This would result primarily from the affected floodplain and wetland areas occurring at the alternate Tewksbury converter terminal site (ER, Vol. 4).

Threatened and Endangered Species

No plant taxa included or proposed for inclusion in the federal listing of threatened or endangered species are known to occur along the alternative routes (Crow 1982). As for the proposed route, rare taxa of plants might occur but would be unlikely to be impacted (Section 4.1.4.4). Impacts to threatened or endangered wildlife would be equally unlikely.

4.2.2.5 Socioeconomics

Socioeconomic impacts of the Tewksbury alternative would be similar to those of the proposed project. Development of either the eastern or western alternative routes would result in comparatively severe impacts because of the acquisition of new right-of-way. The Applicant estimates that the eastern alternative would require an additional 641 ha (1,585 acres) of expanded right-of-way, necessitating relocation of 40 to 60 homes and businesses. It is also anticipated that access road construction would be more substantial for this alternative route, thus creating a potential for increased levels and disruption of traffic flow, noise, and fugitive dust in local communities along the right-of-way (ER, Vol. 4--pp. 60-62).

The western alternative would require 441 ha (1,090 acres) of expanded right-of-way and relocation of about 35 homes and businesses. As in the previous case, higher access road demands would have potential disturbance effects (traffic flow, noise, and dust) on adjacent communities (ER, Vol. 4--pp. 69-71). It is also possible that the significant visual impacts projected for the northern segment (from the Comerford converter terminal and Wilder substation) (see Section 4.2.2.6) could have some impact on property values in the Connecticut River Valley, although the relationship between transmission line construction and property values remains problematic (Kinnard and Stephens 1965; Vredenburgh 1974; U.S. Department of Energy 1983).

4.2.2.6 Visual Resources

The northernmost segments of the proposed DC transmission line and the alternative DC Tewksbury line share a common routing for about 180 km (112 mi), virtually the total distance within an established transmission line corridor. Thus, potential visual impacts associated with these two line segments would be similar. The remainders of the two routes traverse relatively similar terrain and landscapes of relatively similar quality. However, visual impacts related to the proposed DC route would be less severe than those of the Tewksbury DC route, primarily due to the following conditions. To provide adequate right-of-way for the Tewksbury line, existing transmission lines within a 7.2-km (4.5-mi) segment of an established transmission corridor would be altered. An existing 115-kV AC line would be relocated, and an existing 230-kV AC line and a planned 345-kV AC line would be mounted on double-circuit structures. Following these modifications, the paralleling transmission lines within the established transmission corridor would involve support structures of six differing designs. Furthermore, the double-circuit structures would be about 11 m (35 ft) taller than other structures in the corridor (ER, Vol. 4--Table IV-2). The differing designs and heights of structures would be highly intrusive in local landscapes and visible to numerous viewers, including travelers on U.S. I-495.

The potential for visual impacts associated with the eastern and western alternative DC routes would substantially exceed that for the proposed DC route. The comparatively extensive forest clearing requirements for the two alternative routes would be intrusive in numerous local landscapes. Additionally, the two alternative DC routes traverse relatively numerous concentrations of residential and commercial developments. Thus, transmission facilities would be viewed by comparatively large numbers of local residents as well as the traveling public. Levels of visual impacts would be particularly high along the northern segment of the western alternative DC route that generally parallels the Connecticut River Valley.

Much of the alternative Tewksbury converter terminal site is now cleared, and the immediate landscape views are dominated by transmission and substation facilities. Thus, development of the alternative terminal site would not appreciably degrade local landscapes. Vegetation surrounding the site provides a relatively effective screen that limits viewing distance, and the converter terminal would not normally be visible to the general public.

4.2.2.7 Cultural Resources

Adverse effects to cultural resource sites along the Tewksbury alternative route cannot be properly assessed without survey results from the right-of-way (which includes a 23.5-km [14.6-mi] segment of existing right-of-way both in New Hampshire and Massachusetts that is not part of the proposed project) and converter terminal site. No sites are presently listed on the National Register; one archeological site is located on the right-of-way (ER, Vol. 4--p. 51). It is unlikely that this alternative route and substation site would cause significant unmitigable impacts to archeological or historic sites.

The eastern and western alternative routes would require acquisition of substantial new right-of-way areas (641 and 441 ha [1,585 and 1,090 acres], respectively) that have not been surveyed for cultural resources (Office of Public Archeology, 1985--pp. 1-2). Surveys would be necessary in order to assess impacts to significant sites and determine appropriate mitigative measures. Although a high potential for sites exists in the Connecticut River Valley, along the northern segment of the western alternative (Comerford converter terminal to Walpole, New Hampshire), most impacts could probably be mitigated by avoidance, and, if necessary, data recovery.

4.2.2.8 Health and Safety

Construction, operation, and maintenance of any of the alternative routes would entail risks to human health and safety similar to those discussed for the proposed route (Section 4.1.8). The potential for impacts among alternatives would vary with distance of line, amount of structure relocations required, whether an AC substation would be required, and other such considerations.

4.2.2.9 Radio and Television Interference

The potential for the occurrence of radio and television interference is dependent on the proximity of receiver antennae to operational transmission lines. The Tewksbury alternative DC route would closely parallel relatively limited areas of residential and commercial developments. Thus, instances of complaints concerning radio and television interference (if any) would be relatively low. Complaints of interference would be more likely with respect to the eastern and western alternative DC routes, since these routes would parallel areas of substantially greater residential and commercial land use. Operation of the Tewksbury alternative converter terminal would not appreciably influence reception quality of local receiver units in proximity to the site.

4.3 ADVERSE EFFECTS THAT CANNOT BE AVOIDED IF THE PROJECT IS IMPLEMENTED

4.3.1 Air Quality

No serious air-quality impacts are anticipated if the project is implemented.

4.3.2 Land Features, Hydrology, Water Quality, and Water Use

Despite the use of mitigative measures to control erosion, some unavoidable increases of soil erosion and sedimentation within creeks and rivers would result from construction activities, particularly during the thunderstorm season. In addition, minor modification of natural topography, drainage patterns, and slopes would be unavoidable. Construction activities would result in temporarily increased suspended solids and turbidity in surface water bodies of the project area.

4.3.3 Land Use

Land use within the designated transmission line right-of-way would be controlled during the lifetime of the project and limited to those practices and activities that are compatible with the operation and maintenance of the line.

Small areas around structures located in croplands would become unavailable for agricultural use. The cumulative area affected would be of minor consequence.

About 135 ha (334 acres) of forest would be converted to and maintained as shrub and grassland vegetation for the duration of project operation. The additional 12 ha (30 acres) of forest cleared for the converter terminal site would represent a long-term commitment of forest resources, pending eventual dismantling of terminal facilities and reclamation of the site.

Minor deposits of sand and gravel would become unavailable in order to preserve the structural and operational integrity of the proposed line.

Development of the proposed transmission line would not displace or preclude use of any developed public recreational sites or facilities; however, recreational participants in the vicinity of the line could be exposed to views of the transmission facilities that would detract from the quality of the recreational experience.

Despite planning efforts, project-related traffic and construction activities would variously interfere with public use of local transportation routes during the construction phase of the proposed project.

Visual resources would be adversely affected throughout the immediate project area, but some impacts would be limited to the construction phase of the project. Virtually all visual impacts related to the presence of the transmission facilities would be incremental in nature.

4.3.4 Ecology

About 146 ha (361 acres) of forest habitat at the proposed converter station and along the proposed route would be cleared, but it is not anticipated that this would result in serious effects upon local wildlife populations. Indeed, some species would benefit from the clearing of the wooded habitat.

Disturbance of aquatic and wetland habitats and their associated biota would be an environmental impact of the proposed project and would primarily occur during construction activities. The environmental impacts expected from construction and operation of the transmission line would consist primarily of transitory effects on aquatic biota due to construction, provided that proper mitigative measures are implemented. Overall, a maximum of 7.7 ha (19 acres) of wetland habitat would be committed for support foundations and access roads. Impacts to regional habitats and biota would be minor.

4.3.5 Socioeconomics and Cultural Resources

No unavoidable adverse effects to socioeconomics and cultural resources currently are identified.

4.3.6 Health and Safety

A conservative interpretation of the available data leads to the conclusion that electrostatic fields and air ion concentrations in the right-of-way have the potential in very infrequent circumstances of inducing insignificant and transient physiological and psychological alterations in persons frequenting this area. The physiological and psychological parameters that could be affected would return to normal after exposure ceased. The slight alterations have not been associated with adverse health consequences. Persons frequenting areas outside the right-of-way would not be affected by the indicated electric phenomena.

4.4 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

4.4.1 Land Features

Use of sand, gravel, fuel, oil, water, and other materials during construction, maintenance, and operation of the proposed transmission facilities would constitute an irreversible and irretrievable commitment of resources. The sites occupied by transmission structures, the converter terminal, and other structures commit underlying resources, such as agriculturally productive soil, throughout the life of the project.

4.4.2 Ecology

Although wildlife habitat would be altered for the lifetime of the project, cover similar to existing habitat could be recovered after decommissioning. Recovery could occur by natural succession or by revegetation programs. Recovery of forest habitat would take several decades.

Aquatic and wetland habitat commitments would be relatively minor. In most cases, lost or modified habitat could be returned to original conditions after decommissioning.

4.5 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

This section summarizes the relationship between the proposed use of the environment implicit in the construction and operation of the transmission line interconnection and its related facilities and the actions that could be taken to maintain and enhance the long-term productivity of this same land and its resources.

Operation of the interconnection would result primarily in supplying electrical power needed to meet projected demand. The availability of the additional electricity would have a beneficial effect on the economy and should enhance continued growth and improvement in the service area.

A total of about 145 ha (358 acres) would be converted from present uses (mostly forested land) to project-related uses such as widening of the rights-of-way and construction of the converter terminal. Of this total, less than 20 ha (50 acres) would be permanently converted to project-related uses that would preclude other uses such as farming or wildlife cover.

4.6 CUMULATIVE IMPACTS

Implementation of the proposed Phase II of the interconnection would result in only very small incremental (cumulative) impacts to the NEPOOL system since the new transmission facilities would be constructed almost entirely on existing rights-of-way. Since one of the purposes of the interconnection is to displace oil and other fuels or energy sources, the proposed project would actually postpone or preclude the construction of new fossil-fueled generating facilities in the reasonably foreseeable future in the NEPOOL service area. Other positive incremental impacts include fuel cost savings, the ability to maintain systemwide reliability, opportunities for energy interchange, and an increased ability to make emergency energy transfers to either the United States or Canada for mutual reliability purposes. These effects are discussed in more detail in Section 1.

Since the energy to be purchased from Hydro-Quebec is surplus power, it is likely that the incremental effect on the Canadian generating system of providing the energy would be very small. This topic is discussed in more detail in Section 4.1.4.5 and Appendix C.

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5. GLOSSARY

ALTERNATING CURRENT (AC) - An electric current that reverses its direction at periodically recurring intervals.

ANADROMOUS SPECIES - Species of fish that ascend into rivers from the sea to spawn.

APPLICANT - Vermont Electric Transmission Company, which is applying for the amendment to Presidential Permit PP-76.

AQUIFER - A water-bearing stratum of permeable rock, sand, or gravel.

CARRYING CAPACITY - The maximum number of animals that can be supported by a given area of habitat.

COGENERATION - Production of electrical (or mechanical) energy and thermal energy from the same primary energy source.

COLDWATER FISHERIES - Fish assemblage characterized by trout, char, and/or whitefish. Water temperatures must be low enough to meet the thermal requirements for survival and spawning for natural populations to be maintained. If temperatures are too high, seasonal or annual non-sustaining coldwater fisheries could be maintained through stocking.

CONVERTER TERMINAL - Facility needed to convert DC power to AC power, and vice versa, so that the proposed DC line can be connected to the existing AC power system.

CUMULATIVE PRESENT WORTH - The sum of a series of annual expenditures expressed in terms of a given year's buying power of money.

CUMULATIVE PRESENT WORTH OF REVENUE REQUIREMENTS - Cumulative present worth of the series of annual revenue requirements (see definition below) of a given project.

dB (DECIBEL) - Unit for expressing the relative intensity of sounds on a scale from zero for the average least-perceptible sound to about 130 for the average pain level.

DECLINING SPECIES - A species whose populations are currently undergoing a prolonged, noncyclic decline in the state and, possibly, many other parts of its range, and is either approaching rarity or is already very rare in the state. Such species are likely to become endangered or threatened in the state within the near future.

DIRECT CURRENT (DC) - An electrical current flowing in one direction only and substantially constant in value.

ECOLOGICAL PROVINCE - A broad vegetative region having a uniform regional climate and the same type or types of zonal soils.

ENDANGERED SPECIES - A species classified as being in immediate danger of extinction throughout all or most of its range (federally listed); in danger of extinction in a state as a reproducing species; rare or very local throughout all or much of its range, or having a relatively restricted geographic range (state-listed).

FOSSIL FUEL - Fuel sources ultimately derived from living things. Major fossil fuels are coal, oil, and natural gas.

HARDWOODS - General term for deciduous trees (angiosperms).

HEMAGGLUTINATION - Reaction in which red blood cells suspended in a liquid collect into clumps and which occurs especially as a serologic response to a specific antibody.

HYDROCARBONS - Organic compounds often occurring in petroleum, natural gas, and coal.

HYDROELECTRIC - Of or relating to production of electricity by water power.

KILOWATT-HOUR (kWh) - Unit of work or energy equal to that expended by one kilowatt (1,000 watts) in one hour.

MEGAWATT (MW) - 1,000,000 watts.

PARTICULATES - Particles of material suspended in the atmosphere.

PCBs (POLYCHLORINATED BIPHENYLS) - Highly stable organochlorine compounds used in numerous diverse products such as lubricants, electrical equipment, paints, and plasticizers. These compounds remain persistent in the environment, are bioaccumulated, and can cause detrimental effects at low concentrations.

PHOTOCHEMICAL OXIDANTS - Secondary gaseous pollutants created in the atmosphere from conversions and reactions of primary gaseous pollutants (such as sulfur oxides and nitrogen oxides). They include ozone (O_3) and peroxyacetyl nitrate (PAN).

RARE SPECIES - Populations and/or individuals of a species occurring in very low numbers relative to other similar taxa in the state, although common or regularly occurring throughout much of their range. They may occur in a restricted geographic region or occur sparsely over a wider area. Although rare, populations are apparently stable.

REVENUE REQUIREMENTS - The amount of money that must be recovered or generated in order to pay for the interest, depreciation, taxes, insurance, fuel costs, and all other variable expenses associated with the construction, operation, and maintenance of a project.

SECONDARY CONTACT RECREATION - Recreational activities such as fishing or boating that do not generally involve continual direct contact with the water as do such water recreational activities as swimming.

SOFTWOODS - General term for coniferous trees (gymnosperms).

SPECIAL CONCERN SPECIES - A species whose populations have been shown to be suffering a decline that could threaten the species in the area if allowed to continue unchecked, or a species that occurs in such small numbers or with such a restricted distribution or specialized habitat that it could easily become threatened.

THREATENED SPECIES - A species likely to become endangered in the future throughout all or most of its range (federally listed) or all of its range within the state (state-listed).

WARMWATER SPECIES - Fish assemblage characterized by sunfish and bass (as well as by those species considered trash fish, such as carp, most suckers, and bullheads). Warmwater species generally inhabit waters with temperature ranges within which trout and other coldwater species cannot maintain self-sustaining populations.

6. LIST OF PREPARERS

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APPENDIX A. ENVIRONMENTAL DATA

Table A.1. Summary of 1982 Agricultural Data for Counties Traversed by the Proposed Phase II of the New England/Hydro-Quebec Transmission Line Interconnection

	Massachusetts			New Hampshire			
Categories	Middlesex	Norfolk	Worcester	Grafton	Hillsborough	Merrimack	Rockingham
Total land area (hectares)[a]	21,278	103,532	391,980	445,342	226,970	242,394	18,1072
Farms and land in farms							
Farms (number)	567	205	1,014	397	396	385	427
Average size of farms (hectares)	29	26	53	92	55	67	41
Land in farms (hectares)	16,258	5,422	54,072	36,570	21,828	25,647	17,631
Proportion of counties in farms (percent)	7.6	5.2	13.8	8.2	9.6	10.6	9.7
Use of land in farms							
Total cropland (hectares)	8,005	2,155	23,298	11,766	7,423	8,034	6,652
Harvested cropland	6,269	1,411	17,154	8,811	5,948	6,005	4,929
Cropland, pasture only	1,333	605	4,636	2,695	1,037	1,408	1,266
Other cropland	403	139	1,508	259	439	622	457
Total woodland (hectares)	4,978	2,284	23,663	20,834	12,121	15,015	9,244
Woodland pastured	425	92	4,665	2,818	1,086	1,823	1,335
Woodland unpastured	4,552	2,192	18,998	18,016	11,035	13,192	7,910
Other land (hectares)	3,275	983	7,110	3,970	2,283	2,597	1,735
Pasture other than cropland and pastured woodland	739	231	2,697	2,300	461	1,414	544
House lots, roads, wasteland, etc	2,536	752	4,413	1,670	1,822	1,183	1,191
Market value of agricultural products sold							
Total Sales ($1000)	45,543	9,121	47,319	16,320	15,858	13,714	12,877
Average per farm (dollars)	80,324	44,494	46,666	41,108	40,045	35,621	30,157
Crops, including nursery and greenhouse products ($1000)	24,114	5,941	13,005	1,008	7,175	3,509	4,767
Major commodity groups ($1000)							
Hay, silage and field seeds	889	122	1,373	343	446	715	357
Vegetables, sweet corn, and mellons	3,158	361	2,171	80	1,329	137	NR[b]
Fruits, nuts, and berries	2,054	417	6,465	205	4,049	620	1,840
Nursery and greenhouse products	18,007	5,030	2,845	352	1,319	1,938	1,854
Livestock, poultry and products ($1000)	21,429	3,180	34,314	15,311	8,682	10,205	8,110
Major commodity groups ($1000)							
Poultry and poultry products	2,500	358	9,873	NR[b]	1,710	889	2,457
Dairy products	2,761	705	19,896	12,123	5,629	7,791	3,301
Cattle and calves	NR[b]	NR[b]	2,738	2,137	744	1,180	564
Hogs and pigs	1,133	151	1,215	40	299	121	128

[a] One hectare equals 2.47 acres.

[b] NR indicates not reported.

Sources: Bureau of the Census (1984a, 1984b).

Table A.2. Area by Land Classes and Forestland Ownership for Counties Traversed by the Proposed Phase II of the New England/Hydro-Quebec Transmission Line Interconnection (thousands of hectares)[a]

States and Counties	Total Land in Counties	Nonforest Land Use	Forested Land: Total Forest Area	Forested Land: Commercial Timberland[b]	Forested Land: Noncommercial Timberland	Public Ownership: Federal	Public Ownership: State	Public Ownership: County and Municipal	Private Ownership: Farmers Owned	Private Ownership: Other Private
Massachusetts[c]										
Middlesex	213.7	119.2(55.8)[d]	94.5(44.2)[d]	90.8(96.0)[e]	3.7(3.9)[e]	1.2	3.4	2.3(7.6)[f]	5.5	78.4(92.4)[f]
Norfolk	102.1	51.0(50.0)	51.1(50.0)	44.8(87.7)	6.3(12.3)	0.4	1.1	1.2(6.0)	2.6	39.4(93.7)
Worcester	391.9	123.0(31.4)	268.9(68.6)	259.3(96.4)	9.6(3.6)	0.0	20.0	3.5(9.1)	24.2	211.6(90.9)
Totals	707.7	293.2(41.4)	414.5(58.6)	394.9(95.3)	19.6(4.7)	1.6	24.5	7.0(8.4)	32.3	329.6(91.6)
New Hampshire[g]										
Grafton	448.5	46.5(10.4)	402.0(89.6)	360.3(89.6)	41.7(10.4)	95.9	5.4	1.3(28.5)	24.7	233.0(71.5)
Hillsborough	231.3	46.7(20.2)	184.6(79.8)	178.7(96.9)	5.9(3.2)	0.8	1.8	2.1(2.6)	7.6	166.5(97.4)
Merrimack	240.9	44.6(18.5)	196.4(81.5)	193.6(98.6)	2.8(1.4)	3.5	6.0	1.9(5.9)	8.7	173.5(94.1)
Rockingham	178.9	45.1(25.2)	133.8(74.8)	127.8(95.5)	6.0(4.5)	0.0	2.5	0.9(2.7)	5.8	118.5(97.3)
Totals	1099.6	182.9(16.6)	916.8(83.4)	860.4(93.8)	56.4(6.2)	100.2	15.7	6.2(14.2)	46.8	691.5(85.8)

[a] One hectare equals 2.47 acres.

[b] Forest land producing or capable of producing more than 20 cubic feet of industrial wood per acre per year.

[c] Source: Peters and Bowers (1977).

[d] Numbers in parenthesis indicate percentages of total land areas in respective counties and counties by states.

[e] Numbers in parenthesis indicate percentages of total forested land in respective counties and counties by states.

[f] Numbers in parenthesis indicate total public and total private holding as percentages of the commercial timberland in respective counties and counties by states.

[g] Source: Kingsley (1976).

Table A.3. Area of Commercial Forestland, by Forest Types, for Counties Traversed by the Proposed Phase II of the New England/Hydro-Quebec Transmission Line Interconnection (hectares)[a]

	Counties in New Hampshire[b]				Counties in Massachusetts[c]		
Forest Types	Grafton	Merrimack	Hillsborough	Rockingham	Middlesex	Worcester	Norfolk
White pine/red pine/hemlock[d]	50,420(13.9)[e]	78,310(40.5)	75,190(42.1)	59,530(46.6)	17,730(19.5)	53,340(20.6)	7,280(16.3)
Spruce/fir[f]	79,770(22.1)	2,790(1.4)	2,830(1.8)	2,310(1.8)	240(0.2)	1,210(0.5)	160(0.4)
Pitch pine[g]	810(0.2)	2,390(1.2)	2,100(1.2)	1,620(1.3)	2,020(2.2)	7,120(2.7)	1,170(2.6)
Oak/pine[h]	3,800(1.1)	4,530(2.3)	3,970(2.2)	2,140(1.7)	7,530(8.3)	28,090(10.8)	3,800(8.5)
Oak/hickory[i]	12,670(3.5)	20,030(10.3)	19,220(10.8)	11,980(9.4)	23,590(26.0)	70,900(27.3)	11,940(26.7)
Elm/ash/red maple[j]	32,420(9.0)	48,080(24.8)	40,150(22.5)	27,400(21.4)	32,050(35.3)	81,020(31.2)	16,230(36.2)
Maple/beech/birch[k]	157,910(43.8)	28,850(14.9)	28,000(15.7)	17,400(13.6)	4,010(4.4)	10,200(3.9)	2,190(4.9)
Aspen/birch[l]	22,540(6.3)	8,580(4.4)	7,200(4.0)	5,420(4.2)	3,640(4.0)	7,450(2.9)	2,020(4.5)
Totals	360,340	193,560	178,660	127,800	90,810	259,330	44,790

[a] One hectare equals 2.47 acres.

[b] Source: Kingsley (1976).

[c] Source: Peters and Bowers (1977).

[d] Eastern white pine, red pine, or hemlock, singly or in combination, constitute a plurality of the stocking. Common associates: aspen, birch, and maple.

[e] Numbers in parenthesis indicate percentages of the totals for the respective columns.

[f] Spruce or balsam fir, singly or in combination, constitute a plurality of the stocking. Cedar swamps are also included in this type. Common associates: white cedar, tamarack, maple, birch, and hemlock.

[g] Pitch pine constitutes a plurality of the stocking. Common associates: oaks (in Massachusetts, a pitch pine/eastern red cedar type).

[h] Hardwoods (usually red or black oaks) constitute a plurality of the stocking, but in which pines constitute 25% to 30% of the stocking.

[i] Oaks or hickory, singly or in combination, constitute a plurality of the stocking unless pines constitute 25% to 50% of the stocking, in which case the type is oak/pine. Hickory is seldom present in New Hampshire. Common associates: elm and maples.

[j] Elm, ash, or red maple, singly or in combination, constitute a plurality of the stocking. Common associates: beech, eastern white pine, basswood and sugar maple.

[k] Sugar maple, beech, or yellow birch, singly or in combination, constitute a plurality of the stocking. Common associates: hemlock, elm, basswood, eastern white pine, white or sweet birch, and red maple.

[l] Aspen, balsam poplar, paper or gray birch, singly or in combination constitute a plurality of the stocking. Common associates: red maple and balsam fir.

Table A.4. Summary of Selected Streamflow Records for Watersheds along the Proposed Transmission Line Route

River	Location	Record (years)	Drainage Area (km^2)[a]	Discharge (m^3/s)[a] Average	Maximum	Minimum
Connecticut	Dalton, NH	56	3,920	82.3	1,370	3.26
Ammonoosuc	Bethlehem Junction, NH	44	227	5.9	306	0.5
Smith	Bristol, NH	65	222	4	229	0.08
Contoocook	West Hopkinton, NH	20	1,110	19.8	187	0.43
Piscataquog	East Weare, NH	20	164	2.7	43.3	0.01
Blackwater	Goffs Fall below Webster, NH	58	334	6.0	311	0.22
Merrimack	Manchester, NH	47	8,010	149	2,900	2.78
Nashua	East Pepperell, MA	48	1,120	16.1	592	0.03
North Nashua	Leominster, MA	48	285	5.5	462	0.3
Concord	Lowell, MA	47	1,050	17.8	153	0.11
Charles	Waltham, MA	52	588	8.5	117	<0.01
Charles	Dover, MA	46	477	8.6	91	0.01
Blackstone	Northbridge, MA	38	360	7.5	479	<0.01

[a] 1 km^2 = 0.386 mi^2; 1 m^3/s = 35.32 ft^3/s (cfs).

Sources: Geological Survey (1984, 1985).

Table A.5. Major Forest Types in the Phase II Study Area

Forest Type	Predominant Species	Associated Species
White and red pine	White pine, hemlock, red pine	Red maple, red oak, quaking aspen, bigtooth aspen, sugar maple, red spruce, yellow birch, white oak, black cherry, balsam fir
Oak/hickory	Oaks (red, chestnut, white, black, scarlet)	Black cherry, sugar maple, red maple, beech, white ash, white pine, black birch, white birch, hickory (shagbark, pignut, mockernut)
Elm/ash/maple	American elm, black ash, red maple	Beech, white pine, sugar maple, basswood
Maple/beech/birch	Sugar maple, beech, yellow birch	Hemlock, American elm, basswood, white pine, white birch, red maple
Spruce/fir	Red spruce, balsam fir, northern white cedar, white spruce, black spruce	Yellow birch, white pine, hemlock, red maple, quaking aspen, paper birch, tamarack
Aspen/birch	Quaking aspen, bigtooth aspen, balsam poplar, paper birch, gray birch	Pin cherry
Oak/pine	Red oak, black oak	White pine, red pine
Pitch pine	Pitch pine	Oaks

Sources: Kingsley (1976, 1977); Jorgensen (1978); U.S. Department of Energy (1984); ER, Vols. 2 and 3.

Table A.6. Habitat Characteristics of Trout Streams

Factor	Habitat Characteristics Relative to Stream Rating: Good	Excellent
Cover	Moderate undercuts, or brush, stumps	Extensive undercuts, stumps, brush in stream close to bank
Substrate	50% gravel	100% gravel, rubble
Current	Moderately variable	Extremely variable across channel, with numerous "edges"
Pool/riffle ratio	75:25 or 25:75	Near 50:50, with good interspersion
Width/depth ratio	Low	Very low

Source: Galvin (1979).

Table A.7. Life History Aspects of the Major Salmonids in the Vicinity of the Proposed Route

Parameter	Life History Aspects of Salmonid Species Brook Trout (*Salvelinus fontinalis*)	 Brown Trout (*Salmo trutta*)	 Rainbow Trout (*Salmo gairdneri*)	 Atlantic Salmon (*Salmo salar*)
Spawning season	Late summer to autumn.	Late autumn to early winter.	Usually spring.	Fall.
Spawning temperature	4.4-9.4°C (40-49°F).	6.7-8.9°C (44-48°F).	10.0-15.5°C (50-60°F).	Commences when T°[a] reaches 6.1°C (43°F).
Spawning habitat	Gravel beds in shallow [usually <0.3 m (1 ft)] headwater streams or gravelly lake shallows where spring upwelling and moderate current exist.	Primarily shallow, gravelly headwaters.	Smaller tributaries of their river habitat or inlet or outlet streams of their lake habitat. Spawn on fine gravel in riffles above a pool.	Tributary streams of lakes. Usually spawn in gravelly riffles above or below a pool.
Egg development	Hatch in 50 to 100 days (T° dependent) with upper lethal T° limit for developing eggs f11.7°C (53°F).	Hatch in 40 to 70 days. Eggs will develop normally at T° up to 10°C (50°F).	Hatch in 18 to >100 days (T° dependent). Upper T° limit f15.5°C (59.9°F).	Hatch by April. Eggs develop normally at T° up to 10°C (50°F).
Larval development	Remain in nest until yolk sac absorbed. Become free-swimming when f38 mm (1.5 in) long.	Remain in nest until yolk sac absorbed. 7-day TL_{50} for sac fry: 22-23°C (71.6-73.4°F).	Become free-swimming 3-7 days after hatching.	Remain in nest f1 month until yolk sac absorbed. Sac fry median lethal T° 22-23°C (71.6-73.4°F).
Thermal preference	14-19°C (57.2-66.2°F).		Optimum below 21°C (69.8°F).	
Thermal requirements for satisfactory growth	≦20°C (68°F).	≦18.3-23.9°C (65-75°F).	≦21°C (75°F).	
Thermal requirements for spawning	≦12.8°C (55°F).		5.5-13°C (41.9-55.4°F) (peak T°).	
Food	Aquatic and terrestrial insects, molluscs, crustaceans, fish, and small mammals.	Aquatic and terrestrial insects, crustaceans, molluscs, amphibians, fish, and rodents.	Zooplankton, larger crustaceans, insects, snails, leeches, fish, and frogs.	Aquatic and terrestrial insects and fish.
Other requirements and comments	Dissolved oxygen minimum of 5 ppm throughout year. Water must be free of heavy silt, noxious gases, and other pollutants. Upper lethal T° range: 21-26.6°C (69.8-79.8°F).	Can withstand less favorable environments of of lower stream reaches. Upper critical T° f25°C (77°F). Minimum dissolved oxygen tolerance 4.5 ppm (summer) and 2-3 ppm (winter).	Life history characteristics are highly variable depending on location, type, and habitat. Can tolerate T° range of 0.0-28.3°C (32-83°F).	Parr succumb to T° between 32.9-33.8°C (91.2-92.8°F).

[a] T° = temperature.

Sources: Scott and Crossman (1973), Carlander (1969), Eddy and Underhill (1974), and Becker (1976).

Table A.8. Rare Plants in the Study Area for the Proposed Phase II Transmission Line

Species	Location	Status[a]	Habitat
Dwarf ragwort (*Senecio pauperculus*)	Monroe, NH	R	Calcareous ledges, gravels
Small drop-seed (*Sporobolus neglectus*)	Monroe, NH	R	Calcareous soils, especially limy ledges and pastures
Sticky false asphodel (*Tofieldia glutinosa*)	Monroe, NH	R	Calcareous marshes, damp ledges and shores
Grass-of-parnassus (*Parnassia glauca*)	Monroe, NH	R	Riverbanks, wet calcareous soils
Spurred gentian (*Halenia deflexa*)	Monroe, NH	R	Moist, cool woods
Golden-fruited sedge (*Carex aurea*)	Monroe, NH	R	Meadows, wet banks
Garber's sedge (*Carex garberi*)	Monroe, NH	R	Bogs, swamps, wet meadows, and rich moist woods
Showy lady's slipper (*Cypripedium reginae*)	Monroe, NH	R	Swamps, wet meadows, rich moist woods, calcareous soils
Variegated horsetail (*Equisetum variegatum*)	Monroe, NH	R	Riverbanks, calcareous shores
Wide-leaved lady's tresses (*Spiranthes lucida*)	Monroe, NH	R	Alluvial shores and slopes, rich damp meadows and thickets
Hairy bedstraw (*Galium pilosum*)	Hudson, NH	R	Dry woods
Climbing fern (*Lygodium palmatum*)	Ayer, MA	T	Semi-open edge of woods and streams, damp woods

[a] R = rare; T = threatened.

Sources: Dowhan and Craig (1976); Coddington and Field (1978); Storks and Crow (1978); Brackley and Hentcy (1985); Sorrie (1985); ER, Vols. 2 and 3.

Table A.9. Endangered and Threatened Fish and Wildlife in the Study Area for the Proposed Phase II Transmission Line[a]

Species	Status[b]	Habitat
Fish		
Shortnose sturgeon (Acipenser brevirostrum)	E (F, MA, NH)[c]	Lower reach of Merrimack River
American brook lamprey (Lamptera appendix)	T (MA)	Tributary to Blackstone River
Birds		
Bald eagle (Haliaeetus leucocephalus)	E (F, MA, NH)	Near oceans, rivers, lakes
Peregrine falcon (Falco peregrinus)	E (F, MA, NH)	Coasts, mountains, woods
Osprey (Pandion haliaeetus)	T (NH)	Seacoasts, lakes, rivers
Northern harrier (Circus cyaneus)	T (MA, NH)	Grasslands, marshes
Red-shouldered hawk (Buteo lineatus)	T (NH)	Fields, wetlands
Cooper's hawk (Accipiter cooperii)	T (NH)	Open woodlands, wood margins
Common loon (Gavia immer)	T (NH)	Lakes, rivers
Pied-billed grebe (Podilymbus podiceps)	T (MA)	Shallow water bodies
Least bittern (Ixobrychus exilis)	T (MA)	Marshes
King rail (Rallus elegans)	T (MA)	Marshes
Upland sandpiper (Bartramia longicauda)	E (MA), T (NH)	Low, grassy areas
Short-eared owl (Asio flammeus)	E (MA)	Open habitats
Whip-poor-will (Caprimulgus vociferus)	T (NH)	Woods near fields
Purple martin (Progne subis)	T (NH)	Multicelled nesting boxes or gourds in cities and farmyards
Sedge wren (Cistothorus platensis)	E (MA)	Sedge meadows
Golden-winged warbler (Vermivora chrysoptera)	T (MA)	Gray birch woods, shrublands
Eastern bluebird (Sialia sialis)	T (NH)	Roadsides, farmyards, abandoned orchards

Table A.9. Continued

Species	Status[a]	Habitat
Amphibians and Reptiles		
Marbled salamander (Ambystoma opacum)	T (MA)	Varies from moist, sandy areas to dry hillsides
Eastern spade foot (Scaphiopus holbrooki)	T (MA)	Forests with loose or sandy soil
Blanding's turtle (Emydoidea blandingi)	T (MA)	Marshes, bogs, lakes, small streams
Timber rattlesnake (Crotalus horridus)	E (MA)	Timbered terrain, especially second-growth
Northern copperhead (Agkistrodon contortrix)	E (MA)	Rocky, wooded hillsides and mountainous areas

[a] Sources: Blodget (1983); Buckley (1984); Cardoza and Mirick (1979); Conant (1975); Massachusetts Natural Heritage Program (1985); Robbins et al. (1983); Smith and Coate (1985).

[b] E = endangered; T = threatened; F = federally listed; MA = Massachusetts-listed; NH = New Hampshire-listed; underlined state is state within study area where species is reported.

[c] This species is reported from the Massachusetts portion of the study area.

Table A.10. Population Trends and Projections for Towns in the Study Area

Towns	1960	1970	1980	Percent Change, 1970-1980	Projected, 1990
NEW HAMPSHIRE					
Grafton County					
Monroe	421	385	619	60.8	768
Lyman	201	213	281	31.9	313
Bath	604	607	761	25.4	839
Haverhill	3,127	3,090	3,445	11.5	3,600
Benton	172	194	333	71.6	402
Warren	548	539	650	20.6	725
Wentworth	300	376	527	40.2	598
Rumney	820	870	1,212	39.3	1,402
Groton	99	120	255	112.5	317
Hebron	153	234	349	49.1	427
Alexandria	370	466	706	51.5	877
Merrimack County					
Hill	396	450	736	63.6	970
Andover	955	1,138	1,587	39.5	2,019
Salisbury	415	589	781	32.6	1,000
Webster	457	680	1,095	61.0	1,424
Boscawen	2,181	3,162	3,435	8.6	3,496
Concord City	28,991	30,022	30,400	1.3	32,170
Hopkinton	2,225	3,007	3,861	28.4	4,713
Bow	1,340	2,479	4,015	62.0	5,246
Dunbarton	632	825	1,174	42.3	1,529
Hillsborough County					
Goffstown	7,230	9,284	11,315	21.9	13,366
Bedford	3,636	5,859	9,481	61.8	11,803
Merrimack	2,989	8,595	15,406	79.2	17,023
Litchfield	721	1,420	4,150	192.3	5,166
Hudson	5,876	10,638	14,022	31.8	17,341
Pelham	2,605	5,408	8,090	49.6	9,230

Table A.10. Continued

Towns	1960	1970	1980	Percent Change, 1970-1980	Projected, 1990
Rockingham County					
Londonderry	2,457	5,346	13,598	154.4	16,648
Windham	1,317	3,008	5,664	88.3	-[a]
MASSACHUSETTS					
Middlesex County					
Tyngsborough	3,302	4,204	5,683	35.2	7,400
Dunstable	824	1,292	1,671	29.3	2,080
Groton	3,904	5,109	6,154	20.5	6,780
Ayer	14,927	8,325	6,993	-16.0	6,840
Shirley	5,202	4,909	5,124	4.4	5,020
Worcester County					
Lancaster	3,958	6,095	6,334	3.9	6,940
Sterling	3,193	4,247	5,440	28.1	6,190
West Boylston	5,526	6,369	6,204	-2.6	6,300
Boylston	2,367	2,734	3,476	26.9	4,030
Shrewsbury	16,622	19,196	22,674	18.1	25,000
Grafton	10,627	11,659	11,238	-3.6	12,210
Millbury	9,623	11,987	11,808	-1.5	12,220
Sutton	3,638	4,590	5,855	27.6	6,700
Upton	3,127	3,484	3,886	11.5	4,160
Milford	15,749	19,352	23,390	20.9	25,230
Norfolk County					
Medway	5,168	7,983	8,447	5.8	9,160

[a] Data missing.

Sources: Bureau of the Census (1962a, 1962b, 1973a, 1973b, 1981a, 1981b).

Table A.11. Landscape Quality Matrix

	Distinctive	Noteworthy	Common
Landform	Drumlins, hills and ridges or other noted geological features providing distant views; high relative relief greater than 200 feet; steep slopes; sharp exposed bedrock outcrops.	Low rounded hills and gently rolling terrain; relative relief 100-200 feet.	Nearly flat to gentle sloping terrain; relative relief less than 100 feet.
Water elements	Major river courses, cascades or falls, large placid lakes or reservoirs; shoreline development absent or sympathetic to water element.	Secondary rivers and meandering streams, moderate-size lakes, ponds, and impoundments; low-density development.	Narrow, slow-moving or intermittent streams and creeks, small farm ponds and similar minor water features; high density shoreline development.
Vegetation	Stands of dense forest, seen as masses of varying color and texture; mosaic of natural and pastoral vegetation; stands of old timber growth greater than 60 feet in height.	Mixed stands of forest and secondary growth seen as interspersed vegetation pattern; some timber greater than 60 feet in height.	Stands of scrubland or unbroken woodland; separated by agricultural or urban land uses; secondary growth common; most timber under 60 feet in height.
Man-made modifications	Designated historic districts, scenic areas or scenic rivers and public park and recreation areas; areas where man's impression is sympathetic to the landscape; farmsteads; little contemporary development.	Moderate-size communities supporting some business, light industry and commercial development occurring in a semi-rural setting; some historic buildings or districts; occasional elements such as quarries, utility lines, junkyards, landfills, and tank farms, but inconspicuous such that visual integrity is not lost.	Large areas of urbanization, industrialization, suburban sprawl or highway strip development dominating the landscape; major "eyesores" that destroy visual integrity.

Source: ER, Vol. 7--Table III-5.

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APPENDIX B. FLOODPLAIN/WETLAND ASSESSMENT FOR THE PROPOSED ROUTE

APPENDIX B. FLOODPLAIN/WETLAND ASSESSMENT FOR THE PROPOSED ROUTE

B.1 PROJECT PURPOSE AND DESCRIPTION

The New England Power Pool (NEPOOL), in cooperation with Hydro-Quebec, proposes to purchase an additional 70 TWh (million MWh) of energy over a 10-year period currently scheduled to begin in 1990. This is in addition to the 33 TWh of surplus hydroelectric energy that NEPOOL member utilities formally agreed to purchase in 1983 from Hydro-Quebec (Phase I). The additional power purchase would necessitate the construction of new facilities to transmit the energy to load centers in central New England.

The proposed project involves extension of the ±450-kV, high-voltage, direct-current (DC) transmission line from the Town of Monroe, New Hampshire (site of the Comerford converter terminal for Phase I) to the town of Groton, Massachusetts. The DC line would terminate at a 1800-MW DC/AC converter terminal to be constructed at the town line of Groton and Ayer, Massachusetts, adjacent to an existing 345-kV AC substation. Additionally, two linearly connected 345-kV AC transmission lines would be constructed adjacent to existing transmission lines in Massachusetts. These lines would originate at the proposed converter terminal and terminate at a 345-kV AC substation at West Medway, Massachusetts. Associated with the proposed project would be the construction of an overhead dedicated metallic return conductor as part of both the Phase I and Phase II transmission lines and AC transmission system relocations between Sandy Pond and Millbury substations in Massachusetts. The proposed route would involve construction of 298 km (185 mi) of transmission lines in New Hampshire and Massachusetts.

B.2 FLOODPLAIN/WETLAND EFFECTS

It is DOE's policy to avoid adverse impacts on floodplains and wetlands to the extent possible (10 CFR 1022). To this end, 10 CFR 1022 provides for compliance with Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands).

The proposed converter terminal would be located in an upland site that is not in a floodplain and does not contain wetland areas (ER, Vol. 1). Therefore, only the transmission lines are of potential concern relative to floodplain/wetland effects. From the Comerford converter terminal to the West Medway substation, the proposed route would traverse the following watershed basins: Connecticut River (New Hampshire), Merrimack River (New Hampshire and Massachusetts), Blackstone River (Massachusetts), and the Charles River (Massachusetts) (see Figures 2.2 through 2.4). Portions of the proposed route consist of forested and unforested wetlands and floodplains (ER, Vol. 7--Figures III-1.1 through III-1.12, Vol. 8--Figures III-1.1 through III-1.22). Locations of wetland along the route were determined from U.S. Fish and Wildlife draft wetland inventory maps (where available), aerial photos, right-of-way maps, and field surveys (ER, Vols. 7 and 8). Floodplains were determined from Flood Insurance Rate Maps or Flood Hazard Boundary Maps (Flood Insurance Agency 1976, 1979; Federal Emergency Management Agency 1982).

B.2.1 Wetlands

The New Hampshire portion of the proposed route would cross (span) 98 wetlands over a total linear distance of about 12.4 km (7.7 mi) (ER, Vol. 8--Table III-1). The Massachusetts portion of the route would cross 119 wetlands over a total linear distance of about 13.7 km (8.5 mi) (ER, Vol. 7--Table III-1).

The wetlands in the vicinity of the proposed route are dominated by emergent vegetation, scrub/shrub vegetation, and forested vegetation. Wetlands dominated by emergent vegetation (e.g., marshes, wet meadows, and ponds) are basically wet grasslands containing plant species adapted to submerged soils (Darnell 1976). These habitats usually contain zoned gradations of plant species as follows (from shallow to deeper water): (1) emergent plants (e.g., reeds, cattails, bulrushes, sawgrasses, sedges, and arrowheads), (2) floating leafy plants (e.g., water lilies, pond lilies, smartweeds, spatterdocks, and some pondweeds), and (3) submerged plants (e.g., waterweeds, some pondweeds, muskgrasses, milfoils, coontails, bladderworts, hornworts, and buttercups) (Darnell 1976). Based on total acreage of various wetland types along the proposed route (531 acres), about 32% (168 acres) of the wetlands contain predominantly emergent vegetation (ER, Vol. 7--Table III-2, Vol. 8--Table III-2).

The emergent and pond wetlands contain a diverse and productive fauna, including various species of aquatic and terrestrial invertebrates, fishes, amphibians, and reptiles. The wetlands provide important nesting, brooding, feeding, migratory stopover, and overwintering habitat for waterfowl and shorebirds (Darnell 1976). They also provide habitat for such mammals as muskrat, short-tailed shrew, star-nosed mole, eastern cottontail rabbit, beaver, meadow vole, and red fox (Godin 1977).

Scrub/shrub wetlands or swamps are areas dominated by woody vegetation less than 6 m (20 ft) tall, including true shrubs, young trees, and trees and shrubs that are small or stunted due to environmental conditions (Cowardin et al. 1979). Dominant woody species include alder, willow, blueberry, sumac, winterberry, steeplebrush, sweet pepperbush, buttonbush, red osier dogwood, spirea, bog rosemary, bog laurel, leatherleaf, and young trees of such species as red maple and black spruce. Sensitive fern and sedges are predominant herbaceous species (Cowardin et al. 1979; ER, Vols. 7 and 8). About 12% (by area) of the wetlands along the proposed route contain a predominant scrub/shrub vegetation community. About 51% of the wetlands contain a combination of emergent and scrub/shrub wetlands (ER, Vol. 7--Table III-2, Vol. 8--Table III-2).

The forested wetlands or swamps are dominated by living or dead trees that are at least 6 m (20 ft) tall. Along the proposed route, forested wetlands are typically dominated by red maple, with black ash and gray birch also present. Coniferous species, which are less common, include larch, black spruce, Atlantic white cedar, and white pine (ER, Vols. 7 and 8). Shrub and herbaceous layers are dominated by the species common in the scrub/shrub wetlands. The presence of forested wetlands dominated by dead trees results from construction of man-made impoundments and beaver ponds, fire, pollution, or insect infestation (e.g., spruce budworm outbreaks) (Cowardin et al. 1979). Only about 5% (26 acres) of the wetlands along the proposed route contain a forested component (ER, Vol. 7--Table III-2, Vol. 8--Table III-2).

Animal life in scrub/shrubland and forested wetlands is similar to that for marshy wetlands, but includes a more diverse bird and mammal species assemblage because of the increased habitat and food resources provided by understory and canopy vegetation. Waterfowl and shorebirds found in the marshy wetlands also frequent swampy wetlands; also present are such species as arboreal songbirds, birds of prey, and woodpeckers. Large mammals, such as white-tailed deer, occur in swampy wetlands, as do many smaller mammals such as mice, voles, squirrels, shrews, weasels, otters, lemmings, and bats (Godin 1977).

Wetland habitat can be impacted by clearing of vegetation, construction and improvement of access roads, use of heavy machinery, and installation of structures. The potential effects resulting from these activities include minor disruption of drainage patterns, erosion and siltation, habitat destruction, changes in water temperature, increased public access, wildlife displacement, water-level modification, and addition of chemicals. Swampy wetlands would be impacted more by long-term changes in water quality and water level, whereas marshy wetlands could be impacted by short-term modifications (Darnell 1976). Fluctuations in water level might also be detrimental to vegetation located adjacent to wetlands (Boelter and Clare 1974). While emplacement of tower bases would result in the loss of some wetland habitat, they might prove to be preferred habitat for nesting waterfowl and calving deer (Thorsell 1976). Because the area of wetlands impacted by the project would be small relative to the total wetland area occurring within the proposed rights-of-way (26.1 acres to be cleared and a maximum permanent displacement of 19 acres for access roads and new structures out of 531 acres within the rights-of-way) (ER, Vol. 7--Table III-7, Vol. 8 --Table III-7), the overall impacts to wetland habitat would not be of sufficient magnitude to cause localized extinction of any species. Additionally, the habitat that would be affected is not unique to the area. Impacts to wetland habitat would also be minimal because the majority of wetlands would be spanned, and construction activities (e.g., structure placement) would be minimized within these wetland areas.

In a previous project, no vegetative changes related to construction were observed in a cattail marsh in Massachusetts through which a 345-kV transmission line was routed (Thibodeau and Nickerson 1984). Construction was carried out in winter, and equipment was driven across the frozen marsh without any observed alterations to the substrate (e.g., swamp mats). Bog vegetation was found to recover naturally within four growing seasons from the effects of transmission line construction and maintenance (Nickerson and Thibodeau 1984). Thus, relative effects of construction would depend upon the season and/or type of wetland, as well as upon construction methods and mitigative measures employed.

Some minor adverse impacts to wetland wildlife, especially waterfowl, could result from vegetation clearing and management, including herbicide use, within and adjacent to wetlands. Clearing operations could reduce mast used by black duck, wood duck, and green-winged teal; remove some cover for ground-nesting waterfowl; and eliminate mature trees with cavities used for nesting by wood ducks and mergansers. However, some beneficial impacts could result from increased shrub cover and increased nesting cavities in wind-damaged trees (U.S. Department of Energy 1978).

Wetlands would be spanned where possible, with support structures placed outside the wetlands. However, locating some structures within wetlands would be unavoidable. A maximum of 88 wetlands would be affected by new structure placement, existing structure removal, and/or forest clearing. This includes a maximum of 33 wetlands in New Hampshire (ER, Vol. 8--Table III-6) and 55 wetlands in Massachusetts (ER, Vol. 7--Table III-6). Construction or improvements to access roads would be needed for placement of new structures. Of the 214.9 ha (531.1 acres) of wetlands within the Phase II rights-of-way, only a maximum of 10.6 ha (26.1 acres) would require clearing of forest vegetation. Wetlands in these areas would be modified to scrub/shrub or emergent wetlands. These modified wetlands would be maintained, if necessary, by the application of herbicides according to company policy (see Tables B.1 and 4.7). During construction, up to 39.3 ha (97 acres) of wetlands would be disturbed by vehicle traffic and other short-term activities related to structure modification and access road construction. This disturbance would recover within a few growing seasons. New structures and access roads would cause the long-term loss, at most, of 7.7 ha (19 acres) of wetlands--3.2 ha (8 acres) in Massachusetts (ER, Vol. 7--Table III-7) and 4.5 ha (11 acres) in New Hampshire (ER, Vol. 8--Table III-7). It is not expected that placement of new structures or access roads would significantly impound or otherwise alter any of the wetlands. For example, pads for each structure would only occupy 0.06 acre and would be only 0.3 m (1 ft) above the wetland surface (ER, Vol. 8). Also, less than 3.1 km (2 mi) of new access roads would be constructed within wetlands, with culverts and breaks installed to maintain drainage patterns and water table levels (ER, Vols. 7 and 8).

Following construction, impacts to wetlands could result from maintenance of access roads, increased public access, and periodic maintenance of the line or underlying right-of-way vegetation; however, such impacts would be minimal. Reduction of habitat use by waterfowl directly under transmission

Table B.1. Limitations on Herbicide Application

Sensitive Site Description	Application Limitation Establishing Protective Buffer (in feet)
New Hampshire	
Wells[a]	
Public--Gravel Packed	400
Other	250
Private	50
Tributaries or Shorelines of Public Reservoirs[b]	
Krenite	50
Other herbicides	100
Streams, Brooks, Ponds, Lakes	
Foliar and basal treatments	10
Cut stump treatments	None
Crops[c]	
Foliar treatment	50
Cut stump and basal treatments	None
Pastures (all treatments)[c]	
In use	25
Not in use	None
Gardens	
Foliar treatment	25
Cut stump and basal treatments	None
Residences	
Foliar treatment	25
Cut stump and basal treatments	None
Water within wetlands	
Within public water supply watershed	
Krenite	50
Other herbicides	400
Not within public water supply watershed	
Foliar and basal treatments	10
Cut stump treatments	None
Massachusetts	
Wells[d]	
Public--Gravel Packed	
Krenite	50
Other herbicides	400
--Tubular	
Krenite	50
Other herbicides	250
Private	
Krenite	50
Other herbicides	100

Table B.1. Continued

Sensitive Site Description	Application Limitation Establishing Protective Buffer (in feet)
Tributary or Shoreline of a Public Reservoir[d]	
Krenite	50
Other herbicides	400
Streams, Brooks, Ponds, Lakes	
Foliar and basal treatments	10
Cut stump treatments	None
Crops	
Foliar treatment[d]	50
Basal and cut stump treatments	None
Pastures (all treatments)	
In use	25
Not in use	None
Gardens	
Foliar treatment[d]	50
Basal and cut stump treatments	None
Residences	
Foliar treatment[d]	50
Basal and cut stump treatments	None
Water within wetlands	
Within public water supply watershed	
Krenite	50
Other herbicides	400
Not within public water supply watershed	
Foliar and basal treatments	10
Cut stump treatment	None

[a] The 250-ft and 400-ft application limitations around public wells are established by the New Hampshire Pesticide Control Board (N.H. Ad. Rules, Pes 502.10). All other application limitations are set by internal company policies.

[b] New Hampshire regulations prohibit herbicide drift or flow into public water supplies (N.H. Ad. Rules, Pes 502.03).

[c] The New Hampshire Pesticide Control Board's regulations require that herbicide applications do not contaminate crops or pasture (N.H. Ad. Rules, Pes 502.04).

[d] As established by the Department of Food and Agriculture's "Interim Guidelines Relative to the Use of Herbicides to Control Woody Vegetation on Railroad Layouts and Rights-of-Way in Massachusetts." All other application limitations are set by internal company policies.

Source: Supplemental response from Vern R. Walker to Anthony Como (DOE, ERA), dated 9 October 1985.

lines has been noted in similar situations, but this effect quickly diminishes away from the transmission line (Willdan Associates 1982).

Overall, only a fraction of a percent of the total wetlands in the states of New Hampshire and Massachusetts would be affected by construction and operation of the Phase II project.

B.2.2 Floodplains

A total of 105 floodplains would be crossed along the proposed route. It is estimated that project-related structures would be placed on 55 of these floodplains, including 38 structures to be placed in 21 floodplains in New Hampshire (ER, Vol. 8--Table III-8) and 79 structures to be placed in 34 floodplains in Massachusetts (ER, Vol. 7--Table III-8). Thirty-three of the structures would be placed within 20 of the wetlands that occur in the 100-year floodplains (ER, Vol. 7--Table III-6, Vol. 8--Table III-6). Concern about floodplain effects primarily relates to displacement of floodplain storage volume by structures, foundation pads, and access roads. Loss of flood storage volume associated with the structures and associated access roads is estimated at 9,900 m^3 (8 acre-ft)--2,500 m^3 (2 acre-ft) in upland areas and 7,400 m^3 (6 acre-ft) in the wetland areas (ER, Vols. 7 and 8).

This is a very insignificant portion of the total floodplain volume considering that the floodplain for a given water body could extend up to several hundred meters from the bank and several kilometers beyond the area of the proposed transmission line. No significant impoundment, obstruction, or other modification of flood waters would result. Other impacts to floodplain habitat and biota would be somewhat similar to those discussed for wetlands.

B.3 MITIGATIVE MEASURES

In addition to avoidance of floodplains and wetlands when possible, proper construction and maintenance procedures would be used to minimize potential impacts. Additionally, numerous mitigative measures would be implemented to further reduce the risk of significant adverse environmental consequences. These measures include the following:

- Prior to construction, each wetland would be reviewed in order to determine location of structures and foundation types to be used and for best method of access.
- Right-of-way preparation and construction would be supervised by experienced foresters and construction supervisors.
- All work in wetlands would be conducted in accordance with conditions of the Corps of Engineers General Permit, as well as those of applicable state and local regulations.

- *Road widths would be kept to the minimum required to accommodate equipment.*
- *Cuts would be made only where necessary to reduce road grades to acceptable levels.*
- *Access roads would be designed to cross streams as nearly perpendicular as possible.*
- *Transmission line structures would not be placed on steep, highly erodible slopes and would be placed to avoid wetlands and floodplains wherever possible.*
- *Erosion- and sedimentation-control procedures would be implemented.*
- *Special equipment or practices would be used in wetland terrain to minimize damage to vegetation and soil.*
- *Excavated material not used for backfill would be moved to upland areas for disposal.*
- *Existing roads and cleared areas would be used for access and for construction staging areas wherever possible.*
- *Construction adjacent to wetlands would be carried out so as to minimize potential changes to existing water regimes.*
- *Road surfaces would be constructed to promote natural drainage.*
- *Properly sized culverts and breaks would be installed to allow free passage of water and would be routinely inspected and maintained to ensure that surface drainage and water tables remain unaffected.*
- *Only clean fill would be used for structure pads and access roads.*
- *Structure pads and access road height would be limited to approximately 0.3 m (1 ft) above wetland surfaces.*
- *In some areas, fill roads would be breached after construction to minimize changes in preconstruction water levels.*
- *In cases where a wetland can be spanned, construction would be limited to adjacent upland areas where feasible.*
- *Work areas would be cleaned up and restored to ensure revegetation and the maintenance of surface drainage.*

- *An integrated vegetation management system would be utilized. Undesirable vegetation near streams would not be treated by the foliar herbicide application method; however, once manually cut, stumps may be treated with herbicide. Vegetation growing in standing water in wetlands would not be treated with herbicides but, rather, would be manually cut or treated at a later date when the area is dry.*

- *Synthetic filter fabric-based roads could be used in deep wetlands to minimize fill required for access roads.*

- *If construction of permanent gravel access roads is not feasible, optional means of access in place of access roads may be utilized, such as swamp mats or all-terrain vehicles. Off-right-of-way access, if available, may also be utilized to best satisfy environmental objectives. These means could also be utilized for routine inspection and maintenance of structures in the absence of permanent access roads.*

Other specific mitigative measures are listed in Section 4.1.10.

B.4 ALTERNATIVES

Alternatives to the proposed action are essentially limited to those described in Section 2.2 (i.e., alternative routes, an underground transmission system, no action, and alternative generating facilities). For reasons stated in Section 2.2, the only viable alternatives to the proposed project are the alternative routes or underground design. Economic considerations have an important influence on the choice of the proposed project route design (i.e., overhead system) over the alternative routes and design (i.e., underground system).

The economic considerations are largely linked with environmental impacts that would ensue from the alternatives. For example, the increased costs of an underground system are partly related to increased clearing and trenching. Obviously, trenching through all the wetlands within the Phase II rights-of-way (accompanied by increased access road needs) would have a greater impact than that associated with structure placements and access requirements for the proposed design. As stated in Section 4.2.2.4, a greater expanse of wetlands would be crossed by the proposed route than by either the eastern or western alternative route. (See Figures 2.5 through 2.10 for major basins crossed by alternative routes.) However, it is uncertain as to whether this would equate to equivalently less structure and access road requirements in the wetlands. Also, the Staff believes that the much increased environmental costs that would occur from forest clearing (and potential erosion) for the alternative routes (see Section 4.2.2.4) offsets the minor differences in wetland effects among alternatives.

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APPENDIX C. REPRODUCTION OF APPLICANT'S SUPPLEMENT TO THE ENVIRONMENTAL REPORT, ENTITLED: "INFORMATION RELEVANT TO COMMENTS FILED BY THE NATIONAL AUDUBON SOCIETY ON THE DEIS"

UNITED STATES OF AMERICA
BEFORE THE
DEPARTMENT OF ENERGY
ECONOMIC REGULATORY ADMINISTRATION

Application for Amendment of Presidential Permit PP-76 Authorizing the Vermont Electric Transmission Company to construct, connect, operate and maintain electric transmission facilities across the international border between the United States and Canada	Docket No. PP-76A

INFORMATION RELEVANT TO COMMENTS FILED BY
THE NATIONAL AUDUBON SOCIETY
ON THE DEIS

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January 15, 1987

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INFORMATION RELEVANT TO COMMENTS FILED
BY THE NATIONAL AUDUBON SOCIETY ON THE DEIS

I. INTRODUCTION

On 14 October 1985, the New England Power Pool (NEPOOL) entered into a second energy purchase agreement with Hydro-Quebec, the Provincial utility of Quebec, Canada. This second energy purchase agreement is in addition to the Phase I energy purchase agreement between NEPOOL and Hydro-Quebec, which provides for the delivery of 33 terawatt hours (TWh) of energy to NEPOOL within an 11-year period that began in 1986. The second agreement, referred to here as the Phase II Contract, is a firm energy contract providing for the guaranteed delivery of 70 TWh of energy to NEPOOL over a period of 10 years. It is expected that energy will be delivered under the Phase II Contract at a rate of 7 TWh per year. These deliveries are expected to begin in 1990. To allow for the transmission of this energy, the U.S. Department of Energy (DOE) has been requested to amend Presidential Permit PP-76, which currently authorizes the importation of 690 MW of power, to allow the importation of up to 2000 MW of power.

By letter dated 26 September 1986, counsel for the National Audubon Society (Audubon) commented on the Draft Environmental Impact Statement (DEIS) prepared by DOE in connection with the pending request to amend Presidential Permit PP-76. In its letter, Audubon asserted that the DEIS is flawed because: 1) it fails to acknowledge that the proposed amendment would trigger

changes in the operation of the existing hydro-facilities and/or the development of several hydroelectric projects in and around James Bay; 2) it fails to consider the effect the proposed amendment may have on the migratory bird populations of the United States and Canada that currently use James Bay as a major staging area; and 3) it fails to consider any other consequences the proposed amendment could have in and around James Bay itself.

In response to the comments submitted by Audubon, this document provides specific information concerning changes in the operation of existing generating facilities that could occur in the James Bay region of Quebec in connection with sales under the Phase II Contract, as well as the question of incremental construction of new generating facilities. In addition, it assesses the potential effects of generating energy for Phase II Contract sales on those species of migratory birds that use James Bay as a staging area.

This document does not assess potential impacts of sales under the Phase II Contract on other aspects of the domestic Canadian environment in and around James Bay. However, this document does summarize the Canadian environmental review of the La Grande project to date, and the environmental review procedures that would apply to any future development of James Bay by Hydro-Quebec.

II. ENVIRONMENTAL REVIEW OF THE LA GRANDE COMPLEX AND TRANSMISSION FACILITIES

This section summarizes briefly the environmental reviews associated with past development of the La Grande complex. It also summarizes requirements for environmental impact assessments for any future developments. These topics are discussed in detail in Appendix A.

In 1971, Hydro-Quebec (the government-owned electric utility in the Province of Quebec), in cooperation with the Government of Quebec, set up the Societe d'energie de la Baie James (SEBJ) to develop the hydroelectric energy potential of the La Grande Riviere and other rivers in northern Quebec. To date, three powerhouses have been placed in service on the La Grande Riviere: LG2, capacity of 5328 MW, in service since October 1979; LG3, 2304 MW, August 1982; and LG4, 2650 MW, May 1984.

Development of the hydroelectric potential of the La Grande Riviere has included careful environmental review and accommodation. Since the formation of SEBJ in 1971, its Environment Department has utilized its extensive resources to meet its responsibilities for environmental protection and monitoring, aided by a board of advisors representing both the native peoples of the affected regions and the scientific specialties relevant to consideration of environmental matters.

North of the 49th Parallel, environmental protection was addressed not only by internal SEBJ policies, but also by the James Bay and Northern Quebec Agreement, signed in November 1975. This major social contract, which was entered into by SEBJ and

Hydro-Quebec, the native peoples, and the governments of Quebec and Canada, establishes the rights and obligations of native peoples and other parties concerned with development in Northern Quebec. The Agreement stipulates how the region's resources can be managed and developed, and it approves the development scheme for the La Grande complex. Pursuant to that Agreement, a major baseline environmental study of the area was completed in late 1978, covering not only hydrology but also terrestrial and aquatic ecology. This extensive scientific effort has been followed by major environmental monitoring studies by SEBJ and Hydro-Quebec, both during and after construction. These studies analyzed the impacts of development on such environmental parameters as water quality, ice cover, the plume from the La Grande Riviere, productivity of James Bay, and such ecologically important natural systems as eelgrass beds.

Future development north of the 49th Parallel will also be subject to the detailed requirements of the Agreement for environmental impact assessments. South of the 49th Parallel, environmental review is required under the authority of the Canadian National Energy Board over power lines crossing the international border and exports of electric energy from Canada, as well as under the statutes and regulations of the Province of Quebec. In addition, future development undertaken by Hydro-Quebec will be governed by the internal policies and procedures of the company.

In summary, the development of the La Grande complex, past and future, has been and will continue to be undertaken only in conjunction with comprehensive reviews of environmental impacts. The procedures associated with these reviews provide ample opportunity for the raising and resolving of environmental issues under Canadian federal and provincial law. DOE is entitled to rely upon these procedures and reviews to protect the Canadian habitat upon which migratory birds depend.

III. MODIFICATIONS IN CONSTRUCTION AND OPERATIONS ASSOCIATED WITH PHASE II CONTRACT SALES TO NEPOOL

A brief description is presented here of the changes in construction and operations that could occur due to Phase II Contract sales to NEPOOL. These topics are discussed in greater detail in Appendix B.

The generation of energy for sale to NEPOOL under the Phase II Contract would involve no additional dam construction, dam modification, or creation of reservoirs, beyond what is already planned to meet internal Quebec needs. The Phase II Contract requires the construction in Canada of only a $\pm$ 450 kV dc transmission line, from Radisson (near LG2) to Des Cantons, and an ac/dc converter terminal at Radisson. In addition, Hydro-Quebec plans to advance, by three years (from 2000 to 1997), the already planned construction of LG1 and its associated 735 kV ac transmission line, which facilities will be needed in any case to meet Quebec's internal energy requirements. LG1 will be a run-of-the-river generating unit without a significant reservoir.

Aside from the advanced availability of LG1, Hydro-Quebec expects to supply energy to NEPOOL from surplus energy available from generating facilities supplying Quebec's domestic energy needs.

The generation of energy for Phase II Contract sales may well not modify the operations of generating stations on the La Grande Riviere. The La Grande complex is an interlocking reservoir system that must be operated within the limits on minimum and maximum reservoir drawdowns and river flows prescribed by the James Bay and Northern Quebec Agreement and by Hydro-Quebec operating permits. Due to these legal requirements and the necessities imposed by weather (snowfall and rain volume in the watershed and resulting water levels in the reservoirs), it is expected that the La Grande generating stations would operate in substantially the same manner whether or not Phase II Contract sales are made.

For the same reasons, reservoir drawdowns and river flows are expected to be substantially the same whether or not Phase II Contract sales are made. Nevertheless, for purposes of deriving a worst-case analysis of the issues raised by Audubon, several worst-case assumptions can be made. These assumptions are that changes in generating operations somewhere in the La Grande complex would occur in order to generate the energy for Phase II Contract sales, and that as a result, changes in reservoir drawdowns and river flows would occur that would not occur in the absence of those sales. These worst-case assumptions are unrealistic. As explained above, the La Grande complex is expected to operate in substantially the same manner whether sales of energy under the Phase II Contract are made or not, for the water volume in the system either would have to be run through turbines to generate energy or would have to flow through spillways.

Even assuming that some portion of projected reservoir drawdowns could be properly attributed to Phase II Contract sales, those incremental drawdowns would be minor, and would be within the range of variation in drawdowns already anticipated for energy generation for Quebec consumption or other sales. A similar conclusion is reached concerning river flows at the mouth of the La Grande. There are only minor differences between current monthly flows and projected monthly flows that include any increased flows associated with Phase II Contract sales. (For pertinent data, see Appendix B, Section B.3.) Any increases attributable solely to Phase II Contract sales would be even smaller.

IV. POTENTIAL EFFECT ON MIGRATORY BIRDS OF INCREMENTAL CHANGES ASSOCIATED WITH PHASE II CONTRACT SALES TO NEPOOL

As stated above, no changes are anticipated to occur to reservoir drawdowns or river flows as a result of sales of energy to NEPOOL under the Phase II Contract. However, by using the worst-case assumptions described above, which amount to assuming that some incremental drawdowns and river flows may be attributed to Phase II Contract sales, it is possible to assess whether such

changes would be likely to produce adverse effects on migratory bird species utilizing the James Bay environment. This Section provides a summary of that assessment, the detailed discussion of which can be found in Appendix C.

The freshwater habitat provided by the existing La Grande reservoirs is very sparsely used by migratory bird species. Even under the worst-case assumptions, any additional drawdown of a reservoir in any given year would be minimal and within the range of variation in drawdown anticipated without Phase II Contract sales. Therefore, any assumed additional drawdown would not be expected to produce adverse effects on migratory bird populations. The significant issue from the standpoint of migratory bird populations is whether the estuarine habitat of James Bay would be adversely affected by any increased river flows.

A recent literature review has been conducted on the significance of James Bay to migratory birds. This review is included here as Appendix D and is discussed in Section B.1 of Appendix C. The available literature clearly establishes the importance of certain habitats provided by James Bay for a number of species of migratory birds. The diverse marsh environment of the southern and western coasts of James Bay -- approximately 150-300 km away from the mouth of the La Grande Riviere -- seems to offer a higher quality habitat than the predominantly rocky shoreline of the eastern coast. (See map of James Bay enclosed inside back cover.) Nevertheless, some species of waterfowl and shorebirds utilize portions of the east coast as spring and fall staging areas in their migration. Atlantic Brant, in particular, depend on eelgrass beds as a preferred food source during migration staging. Red Knots and Hudsonian Godwits also appear to be species for which the James Bay environment has special significance, although the west coast of the Bay appears to offer a more attractive environment for those species, and for shorebirds generally, than does the east coast.

The issue that arises, therefore, is whether any changes in La Grande river flows assumed to occur under worst-case assumptions would be likely to have an adverse effect on the habitat upon which such species depend. The ecological significance of such changes can be assessed by examining both physical and biological parameters.

As pointed out above, SEBJ and Hydro-Quebec have conducted extensive baseline and monitoring studies of key physical and biological parameters since before development began on the La Grande Riviere. This wealth of monitoring data provides documentation of past physical and biological changes resulting from changes in river flows. This data base also enables a projection and assessment to be made of what physical and biological changes could be expected due to future, worst-case modifications to river flows associated with Phase II Contract sales.

With regard to key physical parameters, extensive historical information is available concerning circulation in the Bay, the

plume of the La Grande Riviere into the Bay, salinity, temperature and ice cover. The substantial development of the La Grande complex between 1978 and 1984 has brought about significant increases in river flows, especially in winter. Even these major changes, however, have had minimal effect on these key physical parameters.

Between 1978 and 1984, there has been no measurable increase in the Bay's surface circulation outside the delta of the river, even in winter. While the winter plume of fresh water from the river has increased in size due to the increased winter river flows, the size and shape of the plume in summer are essentially unchanged from what they were before development. The change in the temperature of the water at the river mouth itself has been minor, and changes in the Bay, if any, would have been less. Finally, the local ice conditions in James Bay have been only slightly altered, near the mouth of the river. Therefore, even the significant changes in river flows from 1978 to the present have brought about only slight changes in these physical parameters in James Bay.

Even if it is assumed, using worst-case assumptions, that changes in river flow would occur in association with Phase II Contract sales to NEPOOL, such changes would still be within the range of variation in flow expected for the river with or without such sales. Also, such assumed changes would be minute when compared to the changes in flow experienced on the river from 1978 to the present. Therefore it is also valid to conclude that any changes in key physical parameters in James Bay due to such worst-case modifications would be insignificant, and would be within the range of variation expected with or without Phase II Contract sales.

With regard to biological parameters having significance from the standpoint of migratory birds, historical information is also available. The productivity of James Bay as a whole is rather low due to lack of nutrient availability and other factors. Nevertheless, the number and abundance of benthic species on the east coast of James Bay increased from 1982 to 1984. Because the La Grande Riviere did not provide significant nutrient contributions to James Bay even under natural conditions, project-related changes in river flows have had little effect on nutrient concentrations in James Bay. Biological conditions have been monitored at the mouths of the La Grande and Eastmain rivers over the course of development. The strong currents, generally low salinity conditions, and sandy substratum of the La Grande delta did not allow high benthic productivity there. Therefore, from the standpoint of the food web upon which migratory birds rely, there is no evidence that flow modifications in the La Grande Riviere to date have induced significant or measurable changes in the general productivity of the Bay.

This general conclusion is confirmed by studies of eelgrass beds, on which species such as Atlantic Brant depend. Eelgrass is generally absent in river mouths where substrate instability

limits its growth. In 1974-1975, prior to development, the Canadian Wildlife Service determined that there were no eelgrass beds within 16 km of the mouth of the La Grande Riviere. Monitoring studies undertaken by SEBJ show that, between 1982 and 1986, there was no evidence of a change in the density of eelgrass beds in areas that might be affected by the La Grande Riviere's freshwater plume. This is consistent with what is known about the tolerance range of eelgrass for both temperature and salinity, together with data on these physical parameters for the small bays along James Bay's east coast.

Finally, population data available do not support a conclusion that migratory bird species have been adversely affected by development of the La Grande to date. The Canada Goose population in the Atlantic Flyway is increasing, and the species generally has reached unprecedented high population levels between 1980 and 1985. The Atlantic Brant population in the Atlantic Flyway has increased steadily for the period 1980-1985. In addition, the literature search recently conducted (Appendix D) found no documentation in the literature that any development to date has had a significant adverse effect on migratory bird populations utilizing James Bay. Finally, SEBJ has obtained no indication that the native peoples have experienced changes in their hunting success due to the La Grande development.

The available evidence indicates that even the significant changes in river flows from 1978-1985 have had no adverse effects on migratory bird populations or their habitats. Even if it is assumed, using worst-case assumptions, that changes in river flow could occur in association with Phase II Contract sales to NEPOOL, such changes would be minute when compared to changes in flow experienced from 1978 to 1985. Therefore, it is reasonable to conclude, on the basis of all available data, that no adverse effects on migratory bird populations or habitats would occur as a result of Phase II Contract sales.

V. CONCLUSION

The development of the La Grande Riviere hydroelectric complex has been attended by extensive environmental reviews and safeguards. Future operations will be accompanied by environmental monitoring, and any future development must comply with requirements for environmental review set by Canadian law. In particular, the potential for any impact on migratory bird populations or habitats has been, and will continue to be, closely studied.

The Phase II Firm Energy Contract between Hydro-Quebec and NEPOOL requires the construction of no dams, reservoirs or generating capacity, whether in the La Grande area or elsewhere, beyond what is already constructed or planned to meet internal Quebec needs. Even using an unrealistic, worst-case assumption that Phase II Contract sales could produce some increases in river flows and reservoir drawdowns, such increases would not be

expected to produce any adverse effects on migratory birds, for several reasons. First, migratory birds use the freshwater habitats of the reservoirs very sparsely, and should not be adversely affected by any incremental drawdowns that might occur. Second, any incremental increases in river flows would not be expected to affect adversely the eelgrass beds or other food supplies for migratory species in James Bay, nor the nutrient availability or general productivity of the Bay. Key physical parameters that might have the potential to affect migratory bird habitats -- such as circulation, salinity and temperature -- would be expected to change little, if at all. In no case would they be expected to change so as to affect bird habitats adversely. These conclusions are based on a comparison with the substantial river flow modifications that occurred between 1978 and the present, and on the documented lack of adverse biological or ecological effects during that period.

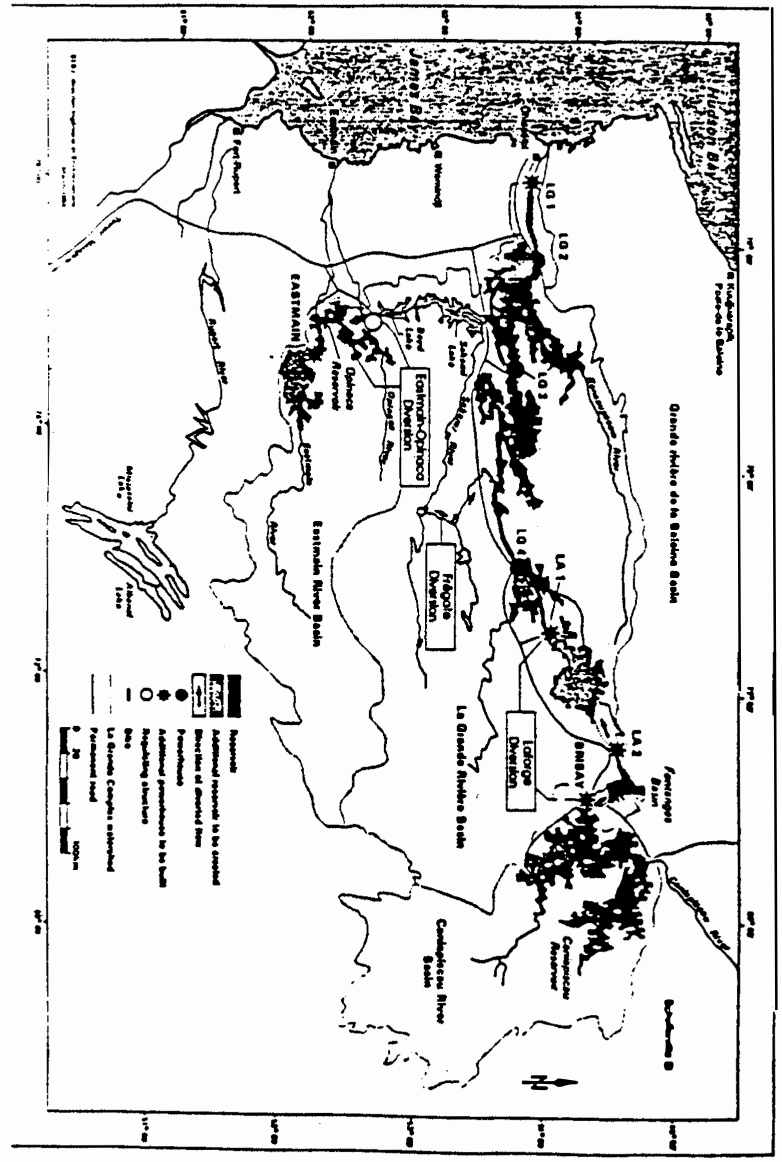
Therefore, it must be concluded, on the basis of all available information, that the generation of energy for Phase II Contract sales to NEPOOL, even under worst-case assumptions, would have no adverse effect on the habitats or populations of migratory bird species that utilize James Bay as a staging area in migrations to or from the United States.

ENVIRONMENTAL REVIEW OF THE LA GRANDE COMPLEX AND TRANSMISSION FACILITIES

A. The La Grande Complex

Hydro-Quebec is the government-owned electric utility which generates, transmits and distributes almost all the electricity sold in the Province of Quebec. Over 15 years ago, the Government of Quebec decided to develop the hydroelectric energy potential of the northern Quebec rivers flowing into James Bay. To execute the development of the La Grande, the Government of Quebec, in cooperation with Hydro-Quebec, set up in December 1971 a project management corporation, the Societe d'Energie de la Baie James (SEBJ), with full responsibility for the planning and construction of the La Grande complex. Development of the complex was planned to proceed in two stages.

The initial development of the La Grande Riviere was designed to be a complete and self-sufficient project, economically justified on its own merits and not dependent upon additional, future construction to realize its value as a source of power. This initial stage of the La Grande hydroelectric development consisted of construction, beginning in 1974, of three powerhouses on the La Grande Riviere (LG2, LG3 and LG4). In addition, the waters from the upper basins of the Eastmain River to the south, and the Caniapiscau River to the east were diverted into the La Grande Riviere (Figure A-1). These two diversions nearly doubled the annual average flow of the La Grande Riviere,



La Grande Hydroelectric Complex

which has gone from 1800 m^3/s to 3400 m^3/s (see Appendix B, Table B-2). Power from the existing generating stations along the La Grande Riviere is transmitted to the load centers in southern Quebec by five 735 kV ac transmission lines.

The La Grande 2 powerhouse (LG2, fully developed capacity of 5328 MW) has been in service since October 1979 and the La Grande 3 powerhouse (LG3, 2304 MW) since August 1982. The La Grande 4 powerhouse (LG4, 2650 MW) was first placed in service in May 1984. The diversion of the Eastmain River has been operational since October 1980; the diversion of the Caniapiscau River was complete in September 1984.

A project is also underway to provide an additional 1998 MW of peaking capacity at the La Grande 2 development. This project entails construction of a new generating station, La Grande 2A (LG2A), to meet peak consumption requirements for the Province of Quebec. The first part of this LG2A addition will be commissioned in 1993 and the second part in 1994.

The second stage of the Hydro-Quebec's La Grande project will consist of construction of three additional generating stations: La Grande 1 (1,368 MW), Brisay (386 MW) and Laforge 1 (780 MW). The purpose of this additional capacity will be to supply baseload power to meet demand within Quebec. According to present plans, commissioning of these stations is due to begin in the late 1990s.

B. History of Environmental Review of the La Grande Project

Development of the hydroelectric potential of the La Grande region has included, from the outset, extensive environmental review and accommodation. This review has been carried out by the project developers in conjunction with affected and interested parties. The history of this concern for the environment is described in this section.

From the very inception of development, environmental considerations have played a significant part in project decisionmaking. In 1971, when the Government of Quebec announced its intention to develop the hydroelectric energy potential of the Quebec rivers flowing into James Bay, two development options were open: (1) to develop the resources of the southern rivers (Nottaway, Broadback and Rupert) flowing into James Bay; or (2) to develop those of the northern rivers (La Grande Riviere, Eastmain and Caniapiscau). (See the map of James Bay enclosed with this report.) A federal-provincial task force was created to perform a preliminary assessment of the environmental impacts of the two options. The task force produced a report indicating that the development of the northern rivers, specifically La Grande Riviere, would be environmentally preferable to the development of the Nottaway, Broadback and Rupert Rivers (Federal Provincial Task Group, 1971).

In 1971, when the decision was made to develop the hydroelectric resources of the La Grande region, there were as yet no comprehensive national or provincial laws in Canada directly addressing environmental protection.1/ However, the public was beginning to focus more attention on environmental protection and drafting of environmental protection legislation was underway. Aware that the enormous scale of the La Grande hydroelectric project2/ would have a major impact on the environment of the La Grande Riviere region, SEBJ established internal company mechanisms (described in more detail in Sections B.1 and B.3 below) to take environmental factors into account during the planning and construction of the La Grande project.

1. Environmental Policy of SEBJ

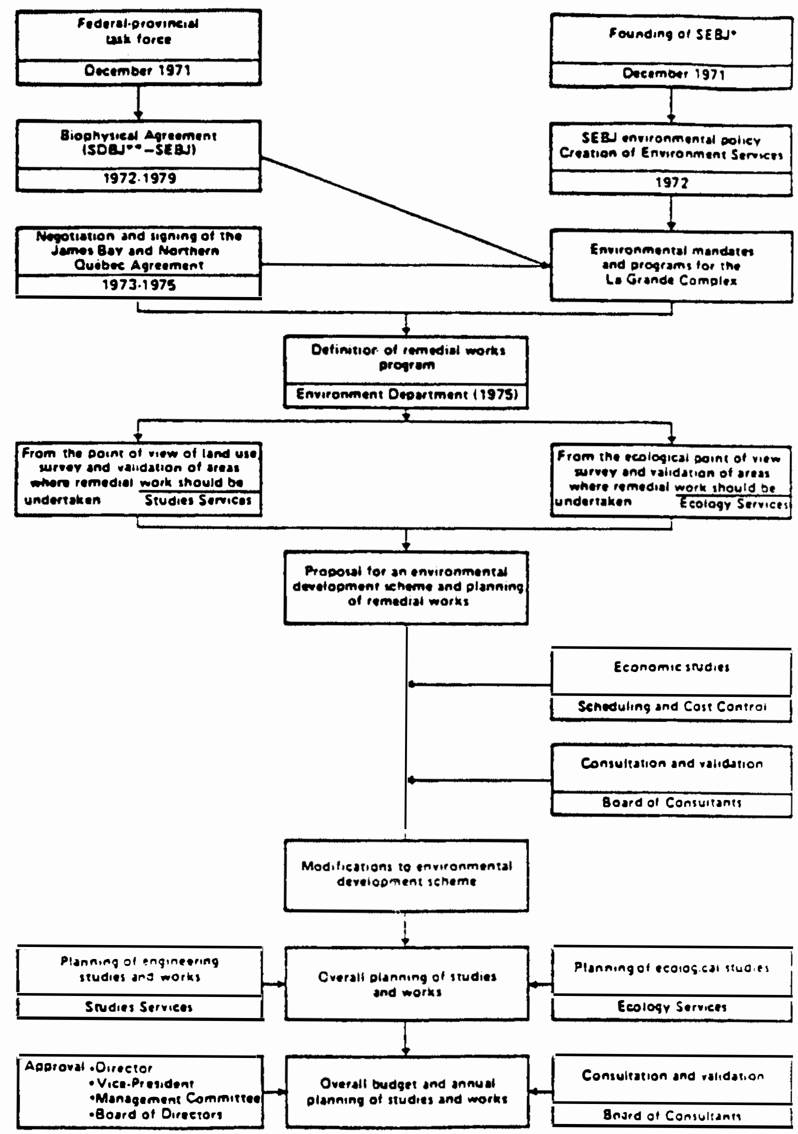
Soon after it was formed in 1971, SEBJ began developing its environmental action policy for the La Grande complex. (Table A-1.) Environmental protection objectives were: (1) to ensure that all environmental laws and regulations in force would be complied with; and (2) to ensure that, during planning, preparation of detailed design and specifications, and during construction, ecological considerations would be taken into account in the decisionmaking on an equal basis with technical and economic considerations (Soucy, 1983).

1/ The Quebec Environment Quality Act was not enacted until 1972.

2/ The initial development of the hydroelectric potential of the La Grande Riviere required the building of 1500 km of road infrastructure, as well as the placing of 150 million m^3 of material to erect the 182 dikes and dams that retain the water of five large reservoirs covering more than 11,500 km^2 (Soucy, 1983).

OVERALL ENVIRONMENTAL DEVELOPMENT SCHEME

Table A-



*Société d'énergie de la Baie James **Société de developpement de la Baie James

Source: Soucy, 1983.

In order to achieve these objectives, SEBJ set up its own Environment Department (Table A-2), to which it allocated a budget of over $200 million. SEBJ's permanent environmental staff has expertise in many environmental fields. This substantial expertise is supplemented by the specialized expertise of academics and other consultants as needed. The Environment Department was assigned responsibility for:

- drawing up environmental protection directives to which all those working on the project had to adhere;

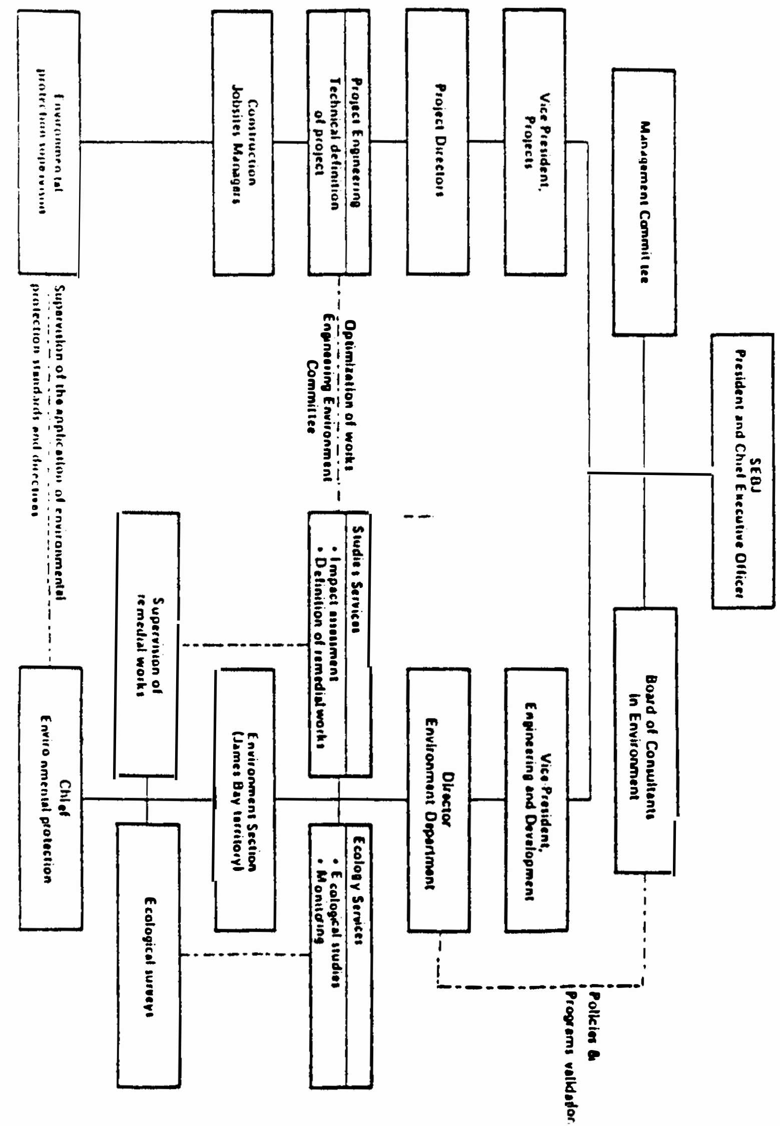
- formulating specific recommendations for the design and construction of the project features, such as dikes and dams;

- evaluating the project's environmental impact and preparing impact assessment reports for each major section of the work during the preparation of the detailed engineering design; and

- ensuring that the project features were built in compliance with the laws and regulations in force and additional standards and directives drawn up by SEBJ.

(Soucy, 1983.)

In addition to the above responsibilities, the Environment Department continually evaluates any changes in habitats during and after construction by means of scientifically recognized environmental followup, and develops remedial measures aimed at improving the biological quality of new habitats. Between 1977 and 1984, SEBJ commissioned numerous biological field studies to monitor environmental impacts of the La Grande development. At the peak of this activity, SEBJ had a team of approximately 20 biologists in the field. SEBJ retains



ORGANIZATION CHART OF THE ENVIRONMENT DEPARTMENT responsibility for this environmental monitoring until development of a project is complete, after which time monitoring functions are transferred to Hydro-Quebec. Since 1985, Hydro-Quebec has continued the monitoring effort on developed portions of the La Grande project. Through the combined monitoring efforts of SEBJ and Hydro-Quebec almost 500 reports have been prepared on a wide variety of subjects, including flora and fauna, water quality, freshwater/saltwater changes, erosion, geology and geomorphology. This monitoring is conducted by ecosystem within each river basin. It is customary to conduct two years of monitoring before a modification is made to the environment.

Furthermore, to ensure that all action taken by the Environment Department met environmental protection objectives, a board of consultants was formed to gather the opinions and recommendations of environmental experts outside SEBJ. This board consisted of twelve members, including representatives of the native populations, as well as specialists in various environmental fields from academic circles, private firms and parapublic corporations (Soucy, 1983).

2. James Bay and Northern Quebec Agreement

Environmental protection of the James Bay region of northern Quebec was addressed not only by internal SEBJ policies, but also by a major social contract adopted as law by the Canadian and Quebec governments, known as the James Bay and Northern Quebec

Agreement. This Agreement is the major legal instrument governing protection of the environment in Quebec north of the 49th Parallel.

The James Bay and Northern Quebec Agreement was signed in November 1975 after one year of intensive negotiations. The Agreement establishes the rights and obligations of native peoples and other parties concerned with development in northern Quebec. It stipulates how the region's resources will be developed and approves the development scheme for the La Grande complex.

The following were parties to the Agreement:

- the Grand Council of the Crees, acting on behalf of a number of Cree Bands;
- the members of the Cree Bands and the Bands themselves;
- the Northern Quebec Inuit Association acting on behalf of the Inuit of Quebec and the Inuit of Port Burwell;
- the Inuit tribes themselves;
- La Societe d'Energie de la Baie James (James Bay Energy Corporation);
- La Societe de developpement de la Baie James (James Bay Development Corporation);[3]
- La Commission hydroelectrique du Quebec (Hydro-Quebec);

[3] The James Bay Development Corporation is responsible for the overall development of the James Bay territory, including roads, mining and other resources, but excluding hydroelectric development.

- the Government of Canada; and
- the Government of Quebec.

Under this Agreement, the native peoples surrendered all native claims in exchange for lands for their communal use, permanent guarantees of exclusive hunting, fishing and trapping rights, considerable power of self-management and assured participation in decisions that are likely to have an impact on their environment. In addition, the Government of Quebec has undertaken to provide a number of public services for the native population. The Agreement has created new channels of communication with the local people. This has led to their taking a more active part in defining and implementing remedial measures and modifying certain technical features of the La Grande complex. During the 20 years following the signing of the Agreement, an amount of $225 million will have been paid to the native peoples in compensation over and above the services to which the native peoples are entitled under the Agreement (Soucy, 1983).

The James Bay and Northern Quebec Agreement was affirmed by the Parliament of Canada pursuant to the James Bay and Northern Quebec Settlement Act, S.C. 1976-77, c. 32, and by the Legislature of Quebec pursuant to the Act respecting the James Bay and Northern Quebec Agreement, L.R.Q. c. C-67. In addition, the substance of Sections 22 and 23 of the Agreement relating to the environment and future development was incorporated into Quebec provincial legislation addressing the environment, the Environment Quality Act, L.R.Q. c. Q-2.

Pursuant to the James Bay and Northern Quebec Agreement, a major baseline environmental study of the James Bay area was undertaken. The Environment Department worked with a large number of scientists from government agencies, academic circles and private firms in a major effort to compile comprehensive biophysical inventories for the James Bay territory.

The major effort of collecting basic environmental data was completed in late 1978, with the publication of a report taking stock of the information gathered and entitled "Connaissance du milieu du territoire de la Baie James et du Nouveau-Quebec" (Understanding the Environment of the James Bay Territory and New Quebec). This document represents the synthesis of 180 separate studies of the James Bay and northern Quebec environment, most of them conducted after the La Grande development plans were announced. This report examined, among other things, the hydrology, terrestrial ecology (including avifauna) and aquatic ecology of the James Bay and northern Quebec region.

This extensive scientific effort has been followed by major environmental monitoring studies, during and after construction, which have analyzed the impacts of development on such environmental parameters as water quality, ice cover, the plume from the La Grande Riviere, productivity of James Bay, and such ecologically important features as eelgrass beds.

3. Mechanisms for Environmental Involvement

To carry out its policy of considering environmental impacts, SEBJ set up a number of management mechanisms to ensure integration of environmental concerns into all aspects of the planning, construction and operation of the La Grande project (Table A-3).

The main tools and mechanisms for environmental protection developed for the La Grande complex consisted of:

- a joint environment-engineering committee for optimizing the major components of the project;
- general environmental protection directives that are included in the rules of internal administration;
- bid specifications that incorporate general environmental protection standards as well as special standards for the various types of work;
- a permanent environmental protection team monitoring the construction work day-by-day and able to suitably advise the contractors when there are unexpected environmental problems;
- monitoring that is designed not only to determine the long-term evolution of new habitats created but also, in the short term, to provide the necessary information making it possible to adjust the environmental standards for projects to be completed or remedial measures to be implemented; and
- operating manuals related to environmental protection.

(Soucy, 1983.)

One of the most basic tasks of the Environment Department proved to be making participants in the project at all levels aware of the need to be concerned with the environment. In achieving this goal, the board of experts, the Engineering-Environment Joint Committee, the permanent environmental jobsite team, the environmental directives, and the operating manual for the structures comprised an effective means of reaching, in turn, the administrators, designers, builders and operators and of making environmental protection an everyday reality.

C. Safeguards for Future Environmental Review

Future development of the La Grande project will be undertaken pursuant to the James Bay and Northern Quebec Agreement, which governs, among other things, all hydroelectric development north of the 49th Parallel in the Province of Quebec. In addition, national and provincial laws will govern protection of environmental values in future development of the La Grande complex, and of other hydroelectric resources in Quebec. Finally, internal SEBJ procedures and mechanisms for protection of environmental interests will continue to be used.

1. North of the 49th Parallel: the James Bay and Northern Quebec Agreement

The cornerstone of the program established under the James Bay and Northern Quebec Agreement to protect the environment and the social fabric of Quebec's North is compulsory assessment of projects on the basis of their sociological and environmental

Integration Process for Environmental Aspects in Hydroelectric Projects

SEQUENCES IN THE EXECUTION OF A HYDROELECTRIC COMPLEX	PRINCIPAL ENVIRONMENTAL ACTIVITIES	MECHANISMS AND METHODS OF TAKING ACTION	ACTION CARRIED OUT AT JAMES BAY
SELECTION OF PROJECT TO BE EXECUTED	• Establishing of technical, economic and environmental constraints for each of the projects under study	• Definition of energy needs and scheduling of projects in a master plan for development • Cost/benefit analysis of the various schemes and socioeconomic and environmental justification of the project selected	• Sequencing of execution of James Bay projects — La Grande Complex — Phase I — La Grande Complex — Phase II — Grande Baleine Complex — Nottaway-Broadback-Rupert Complex
PROJECT DEVELOPMENT SCHEME • Definition of the overall configuration of the project	• Analysis of the various powerhouse, reservoir and river diversion alternatives	• Environmental and social impact statement, including the nature and scope of remedial measures • Analysis of the report by the government environmental impact assessment commission	• Report on the impact of the Nottaway-Broadback-Rupert hydroelectric project • Report on the impact of the Grande-Baleine hydroelectric project
PRELIMINARY PROJECT • Optimization of each of the components of the project	• Optimization of water levels (max. and min.) in the reservoirs • Design of spillways • Impounding methods • Outline of roads	• Comparative appraisal of the alternative solutions using recognized impact assessment methods incorporating technoeconomic, environmental and social aspects (Odum, Holmes, Sorensen and cartographic methods) ◦ Evaluation by a group made up of environmental and engineering experts	• Locating of the La Grande 1 powerhouse (Odum) • Locating of the La Grande 4 spillway (Odum) • Water levels of Lake Sakami (Holmes and Sorensen) • 315 kV energy transmission line — Tilly station — Brisay powerhouse (Holmes and cartographic) • Access route to the Nemiscau-Complex village (Holmes and cartographic)
PROJECT • Preparation of drawings and technical specifications	• Revision of technical specifications and tender documents • Definition and design of remedial measures	• Inclusion of environmental protection policies in tender documents, as well as clauses defining environmental protection measures and specifying contractors' responsibilities and obligations with respect to environmental protection. • Approval by a group of environmental experts	◦ Revision by a multidisciplinary team of all tender documents issued for the building of the structures (roads, dikes, dams, spillways, etc.) ◦ Drawing up of specific environmental protection standards for the James Bay projects
CONSTRUCTION • Building of the structures	• Supervision of construction activities from the environmental protection standpoint • Implementation of remedial measures	• Day-to-day supervision at the construction sites to ensure compliance with all environmental protection clauses included in the tender documents as well as government laws and regulations • Clearing of reservoirs, fish passes, reforestation of sand pits and quarries, diking of bays, etc.	• Ongoing presence on each of the site of a team of environmental protection supervisors • Plan for remedial measures at the La Grande Complex
OPERATION • Use of the structures	• Definition of operating and maintenance procedures for the various structures in the complex • Study of changes in the new habitats • Evaluation of effectiveness of remedial measures	• Drafting of an operating manual for the structures in the complex including technical constraints on operations required for environmental protection • Ecological monitoring network • Monitoring report on ecological measures	• Maintaining of a residual flow at all times to counter the inflow of salt water in the estuary of the La Grande Rivière • Monitoring network in operation since 1977 • Study in progress since 1980

impact by various committees created for this purpose. Representatives of the native populations and of the regional, provincial and federal governments comprise these committees.

The Agreement stipulates that any project, whether a work, undertaking, structure, operation or industrial process, exclusive of the operation and maintenance of such project after construction, must be the object of an environmental review. Such review is intended to minimize the negative impact of development north of Quebec's 49th Parallel on both the native people and the wildlife resources. However, the review mechanisms created vary north and south of the 55th Parallel.

a. South of the 55th Parallel

Under the James Bay and Northern Quebec Agreement, the James Bay Advisory Committee on the Environment has been created to review and oversee the environmental and social protection program south of the 55th Parallel, which includes virtually all of the La Grande project. The Committee includes representatives of the Cree tribe, the Government of Canada and the Government of Quebec.

The Agreement's environmental and social protection program provides that certain projects will be subject to an environmental impact assessment, based on whether the proposed project may have a significant impact on the native people or on the wildlife resources north of the 49th Parallel. When an impact assessment is required, the proponent of the project must prepare

an impact statement which identifies and assesses the environmental and social consequences of the project. The objectives of the impact statement are to ensure that:

- environmental and social considerations form an integral part of the proponent's planning and decision-making process;
- potential environmental and social impacts resulting from development are identified as systematically as possible;
- alternatives to the proposed action, including alternatives to individual elements of large-scale projects are evaluated with a view to minimizing, within reason, impacts on native people and wildlife resources and maintaining the quality of the environment; and
- remedial or preventive measures will be incorporated into proposed development so as to minimize, within reason, expected negative impacts.

Upon completion, the impact statement is analyzed by one of two separate Committees depending on whether the project falls within federal or provincial jurisdiction.

Procedures for public participation in the environmental review process allow interested Cree communities to make written representations to the reviewing committee through their local or regional Cree governments. These governmental groups can also authorize presentations by interested individuals who are not a party to the Agreement. Provincial law also allows the Deputy Minister to authorize public consultation.

On the basis of the impact statement and other information before it, one of the two reviewing committees recommends whether or not the development should proceed and, if so, under what terms and conditions. The final decision on the proposed project rests with the federal, provincial or local government designated to implement the Agreement.4/

b. North of the 55th Parallel

The area north of the 55th Parallel is subject to an environmental and social protection program similar to that program in place south of the 55th Parallel, except that the involvement of the Inuit, rather than the Cree, is guaranteed by the program.

Again, certain projects are subject to the environmental impact assessment process. If an impact assessment is required for a project within provincial jurisdiction, the Environmental Quality Commission decides whether or not to recommend approval of the project after consideration of the following factors:

- the beneficial and adverse environmental and social impact of the development;
- environmental impacts which cannot be avoided and the proponent's proposals to mitigate such impacts;
- reasonable alternatives to the development as proposed;
- the methods and procedures outlined by the proponent to monitor emissions of contaminants adequately or other environmental problems, where required; and

4/ With respect to those facilities that are needed to implement the Phase II Contract, a Certificate of Authorization was issued by the Deputy Minister of the Environment in November of 1986 for the portion of the dc transmission line and associated facilities that will be located north of the 49th Parallel.

- the relationship of proposed development to applicable existing or proposed environmental laws and regulation.

If the project is within provincial jurisdiction, interested persons, groups or communities have a right to make submissions to the Environmental Quality Commission.

For projects under federal jurisdiction which require an impact assessment, the assessment is submitted to the Screening Committee of the Environmental and Social Impact Review Panel. Again, native people, interested persons, groups or communities may make presentations to the Review Panel. On the basis of this impact statement and other information before it, the Review Panel recommends whether or not the project should proceed.

If the environmental assessment process concludes favorably, the project obtains an authorization which contains terms and conditions binding on the project's developer. Any deviation from the terms or conditions stipulated in the authorization would require the approval of the relevant committees and authorities.

c. Special Provisions

As originally signed in 1975, the James Bay and Northern Quebec Agreement exempted from the formal process of impact assessment the initial construction stage of the La Grande complex. This exemption occurred because at that time the environmental assessment program for that development had already been established in the Biophysical Agreement signed in November

1972. However, the possibility of future hydroelectric development was recognized in the Agreement. It was specifically agreed that the Nottaway, Broadback and Rupert Rivers Development (N.B.R. Complex) and the Great Whale, Little Whale, Coast Rivers Development (Great Whale Complex), as well as any additions and/or substantial modifications to the La Grande complex, if built, would be subject to the environmental review process specified in the James Bay Agreement.

2. South of the 49th Parallel

South of the 49th Parallel in Quebec, construction of the transmission lines and converter terminals related to the La Grande complex is governed not by the James Bay and Northern Quebec Agreement, but by a set of federal and provincial laws, supplemented by Hydro-Quebec's internal policies and procedures, for protection of environmental resources. These laws and policies are described briefly below.

a. National Energy Board

In 1959, the Parliament of Canada enacted the National Energy Board Act (Can. Rev. Stat. c. N-6). That Act established the National Energy Board as advisor to the federal government on all matters related to energy. It also authorized the National Energy Board to regulate power lines crossing the international border and exports of energy from Canada.

When considering an application for a license to export power under Section 81 of the National Energy Board Act, the Board is required to have regard for all considerations that appear to be relevant. While this authority gives the Board wide-ranging power to review, the Board's review is confined to the incremental physical plant and the incremental effects related to the granting of a power export license. In a letter dated 24 October 1984 pertaining to an application by Manitoba Hydro for a license to export electricity, the Board stated that its jurisdiction includes "the regulation of the social, economic and physical impacts resulting from advancement of construction and development activities associated with meeting a utility's export requirements." In addition, Section 6(2)(a)(a) of Part VI of the Board's Regulations specifically requires an applicant for a license to export power to furnish "evidence on any environmental impact that would result from the generation of power for export." Section 20 of the National Energy Board Act provides for public hearings to be held on Applications for licenses to export power. Section 11 of the Board's Rules of Practice and Procedure set forth the requirements for intervening in these licensing proceedings.[5/]

5/ The application for approval of the sale of energy under NEPOOL's Phase II Firm Energy Contract was made by Hydro-Quebec to the National Energy Board in December 1985. Public hearings are expected to occur in early 1987 and the license pursuant to this application is expected to be issued later in 1987.

As with applications for licenses to export power, the National Energy Board has broad jurisdiction with respect to applications for certificates for international power lines under Section 44 of the National Energy Board Act. Specifically, in considering such applications the Board must "take into account all such matters as to it appear to be relevant."[6/] Section 14 of the "Information Required with Applications for International Power Line Certificates," requires applicants to provide:

> "[a]n assessment of the probable environmental impact and a statement of the proposed measures to mitigate the environmental impact of the international power line including terminal facilities. The assessment shall satisfy the requirements of the National Energy Board's 'Guidelines on the Environmental Information Required with Applications for Certificates for International Power Lines.'"

Pursuant to the Board's "Guidelines on the Environmental Information Required with Applications for Certificates for International Power Lines," this environmental assessment must include:

-a description of the existing environment, including the habitats of waterfowl of recognized importance, spawning beds of fish of recognized importance, special areas such as ecological reserves, and water supply intakes;

-a description of the environmental standards that would be followed in the planning, design, construction and operation of the line;

-a description of the environmental impact of the construction and operation of the line and of any associated roads on land drainage

6/ Can. Rev. Stat. c. N-6, § 44.

and erosion, vegetation, wildlife, fish, and water supplies, and measures that would be taken to mitigate impacts;

-what supervision and inspection of environmental effects and protection would be provided during construction and operation; and

-a description of the alternatives considered to the proposed action.

Section 45 of the Act is of particular importance concerning the intervention of persons who may be opposed to the issuance of a certificate for an international power line. Section 45 stipulates that the Board must consider the objections of interested persons. The rights of parties who wish to intervene are spelled out in the Board's regulations. Section 32 of the Board's Rules of Practice and Procedure permits an interested party to file a written intervention which indicates, *inter alia*, the nature of the party's interest in the application and the issues which the intervenor intends to address at the public hearing. Section 34(1) of the Rules also allows any party to the proceeding to address requests for information to any other party to the proceeding. Finally, Section 33 of the Rules allows an interested person who does not wish to intervene at the public hearing but who wishes to make his views regarding the application known to the Board to file a letter describing his interest in the application and his views, as well as any relevant information supporting those views.

b. Province of Quebec

Pursuant to the Province of Quebec's Environment Quality Act (L.R.Q., c. Q-2) and regulations adopted thereunder, notably the Regulation respecting the administration of the Environment Quality Act (R.R.Q., 1981, c. Q-2, r.1) and the Regulation respecting environmental impact assessment and review (R.R.Q., c. Q-2, r.9), the Province of Quebec has created a legal framework for evaluating the environmental impact of major development projects which institutionalizes the participation of the interested persons.

Section 31.1 of the Act stipulates that no person shall undertake any construction, work, activity or operation, or carry out work according to a plan or program, in the cases provided for by regulation, without following the environmental impact assessment and review procedure. Section 2 of the Regulation respecting environmental impact assessment and review lists those projects automatically subject to environmental assessment. Included in the lists are:

- the construction and relocation of an electric power transmission line of 315 kV or more over a distance of more than 2 km and the construction or relocation of a control and transformer station of 315 kV or more; and

- the construction or increase in power of a station for the production of electrical power exceeding 10 MW, or the construction or increase in power of such a station resulting in an increase in the total power to 10 MW or more.

The regulations stipulate that an environmental impact assessment statement may contain, inter alia:

- a qualitative and quantitative inventory of the fauna and flora that could be affected;

- a list of positive, negative and residual impacts of the project on the environment, including indirect, cumulative, latent and irreversible effects;

- a description of options to the proposed action and reasons justifying the option chosen; and

- a list of measures taken to prevent, reduce or attenuate the deterioration of the environment before, during and after construction or operation.

Public consultation is provided for at Section 31.3 of the Act, which requires that all environmental impact assessment statements be made public. Responsibility for initiating a period of public information and consultation rests with the proponent of the project. The proponent must publish on two occasions, in specified newspapers, a notice to the effect that it is possible to consult the project file, including the environmental impact assessment statement. This period of consultation must last 45 days.

During this period, any person, group or municipality may make a written request to the Quebec Minister of the Environment for a public hearing on the project. Such a request must set forth the reasons for the request and the requestor's interest in the area affected by the project. The law does not specify the interest required in order to request a public hearing.

The rules of procedure relating to the conduct of public hearings (R.R.Q., 1981, c. Q-2, r. 6.6) describe the conduct of these hearings. During the first stage, the party that requested a public hearing must explain his reasons for applying for the hearing. The proponent of the project then summarizes and explains the project and, in particular, the impact assessment statement. During the first part of the hearing, any person may ask pertinent questions to complement the information already provided. During the second part of the hearing, persons who have submitted briefs or persons wishing to submit their opinions may make oral presentations.7/

3. Hydro-Quebec Environmental Policy

In 1984, the Board of Directors of Hydro-Quebec published a resolution regarding Hydro-Quebec's environmental policy (Hydro-Quebec Environmental Policy, March 1984). This policy, which supplements the environmental protection provisions of Canadian and Quebec law, is intended to guide Hydro-Quebec's

7/ With respect to those facilities that are needed to implement the Phase II Contract, Hydro-Quebec has completed the environmental and technical studies that are required by the Environment Quality Act. An application for a decree under Section 31.1 of that Act was filed in September of 1986. Public hearings on that application began in December of 1986 and a decree with respect to the proposed transmission line routing is expected in the spring of 1987. After that decree has issued, the Government of Quebec may issue an additional decree authorizing Hydro-Quebec to expropriate the required right-of-way, if necessary, and authorizing construction of the transmission line and terminal facilities. Subsequently, approval of the detailed plans and specifications for the facilities will also be required under Section 22 of the Environment Quality Act.

managers, employees and partners in formally integrating environmental protection and enhancement considerations into decisions and activities, including construction and operation of facilities, that have an impact on the social and natural environment. This policy also serves as the framework for development of more detailed guidelines to enable managers to translate the policy into action. Future development of the La Grande project, as well as operation of the existing facilities (including those facilities north of the 49th Parallel), will be guided by this internal policy and the associated procedures. Important components of this policy are described below.

First, Hydro-Quebec plans, designs and carries out its activities taking into consideration environmental implications. In carrying out its construction program, particularly at the preliminary and design-study stages, Hydro-Quebec analyzes and presents to interested parties the environmental implications of each project and justifies its project selection. Hydro-Quebec generally elaborates several project alternatives, analyzes the environmental implications of each, selects the most attractive alternative and justifies its selection.

Second, Hydro-Quebec attempts insofar as possible to manage at the source the environmental impact of its activities. This means that Hydro-Quebec designs, develops and uses practices, procedures, products and techniques that reduce or eliminate at source the negative impacts of its activities. Hydro-Quebec also takes into consideration the environmental implications of the entire cycle of a product or process when choosing among alternative preventive measures.

Third, Hydro-Quebec manages its activities utilizing practical mitigation measures. Initially, Hydro-Quebec identifies the impacts and the benefits of its actions, using with-activity and without-activity forecasts of conditions in the area affected. Mitigation measures are identified. Then, project alternatives are chosen after the mitigation options have been evaluated. Every three years, environmental mitigation and enhancement programs are reviewed. Based on this review, existing programs are continued or modified to ensure their effectiveness.

Finally, Hydro-Quebec encourages the participation of interested individuals, groups, and organizations throughout the study and design phases of its activities. This is done by a variety of means, including:

- collaboration with all levels of government by incorporation of government studies and development plans into its own planning and carrying out additional studies as needed;

- inviting individuals, groups and organizations to participate in its own studies, in particular through consultation programs, in order to benefit from their knowledge of the milieu, when identifying significant resources, determining impacts, and choosing activity alternatives and mitigation and enhancement measures; Hydro-Quebec may form a consultative committee for this purpose; and

- responding to the requests and viewpoints of individuals, groups and organizations throughout the process of activity planning.

Of particular relevance to migratory birds is the intent of Hydro-Quebec to concentrate its continuous program of environmental monitoring of areas affected by the development of the La Grande Complex on the coastal areas of James Bay. This will be done to ensure that the principal resources of the area's native communities, especially fish and waterfowl, will not be negatively affected by the discharge modifications brought about by development of the La Grande and Eastmain Rivers. (Hydro-Quebec, 1987.)

APPENDIX A REFERENCES

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MODIFICATIONS IN CONSTRUCTION AND OPERATION DUE TO PHASE II CONTRACT SALES TO NEPOOL

A. Modifications in Construction

Hydro-Quebec's current load growth forecast anticipates an average annual load growth rate of 3.3 percent from 1984 to the year 2001 (Hydro-Quebec, 1986). Based upon this forecast, Hydro-Quebec expects to meet the requirements of the Phase II NEPOOL Firm Energy Contract with surplus energy available from existing generating facilities until the mid-1990s. Thereafter, the power requirements of the Phase II Contract would be supplied by advancing the construction of generating facilities that have already been planned to meet the internal energy needs of the Province of Quebec. Specifically, sales under the Phase II Contract are expected to advance the need for the LG1 base load generating station and associated transmission facilities to 1997 from the year 2000, when they would otherwise be needed to meet Quebec's internal energy requirements.

In order to deliver the Phase II Contract energy, it will be necessary for Hydro-Quebec to construct a ± 450 kV direct current transmission line from Radisson, near the LG2 powerhouse, to Des Cantons, where it would connect with the northern end of the New England/Hydro-Quebec Phase I dc transmission line. It is also necessary to construct a 2250 MW ac/dc converter station at Radisson. The dc line would make it possible to isolate power for New England generated at the LG2 generating station from the

Hydro-Quebec ac power system. This would permit the reliable transfer of energy between Quebec and New England even in the event of a general power failure on the Hydro-Quebec ac system.

Without the Phase II Contract, a new 735 kV ac transmission line from James Bay to southern Quebec would have been required by 1994 for Quebec's power needs. The construction of a ± 450 kV dc transmission line from Radisson to Des Cantons would be capable of meeting internal transmission needs of Quebec in addition to transmission under the Phase II Contract. Thus, the additional 735 kV ac line otherwise planned for 1994 would not be needed.

At present, Hydro-Quebec is committed to building two new generating facilities to meet its own winter peak electricity requirements within the Province of Quebec. The first will have 990 MW of capacity and is under construction at the site of the Manic 5 generating station on the Manic River, a tributary of the St. Lawrence River. This facility is scheduled to be placed in service during 1989. The second involves the addition of 1998 MW of peaking capacity at the site of LG2. This facility, known as LG2A, is scheduled to be commissioned in two stages. The first 999 MW of capacity are expected to be placed in service in 1993, with the second 999 MW scheduled for 1994. None of these additional facilities are required to supply power under the Phase II Contract. As noted above, the Phase II Contract provides for firm energy; it does not provide for firm capacity.

Although the LG2A peaking units are not required to provide energy under the Phase II Contract, Hydro-Quebec plans to advance construction of these units to 1993/94 to take advantage of the ± 450 kV dc transmission line from James Bay that would be placed in service in 1990. Once this line has been constructed, it becomes feasible to advance the LG2A peaking units and to postpone the construction of other peaking units which otherwise would have been required to meet internal Quebec needs. Power from the LG2A units would be transmitted over the ± 450 kV dc transmission line from James Bay to Nicolet, outside Montreal, where a 2000 MW dc/ac converter terminal would be constructed.

In conclusion, therefore, the Phase II Contract will require only the following incremental construction: a ± 450 kV dc transmission line from Radisson (near LG2) to Des Cantons, and an ac/dc converter terminal at Radisson. No new generating capacity or dams will be required. In addition, Hydro-Quebec plans to advance by 3 years the already planned construction of LG1 and its associated 735 kV ac transmission line. Any other modifications in construction plans or schedule would be solely for purposes other than meeting sales to NEPOOL under the Phase II Contract.

B. Modifications in Operations

1. Introduction

The Phase II NEPOOL Firm Energy Contract provides for the delivery of 7 TWh of energy per year during the 10-year term of the contract. Under the Phase II Contract, a contract year means the period from September 1 through August 31 of the succeeding year. In advance of each contract year, Hydro-Quebec must furnish a schedule allocating the 7 TWh of energy deliveries under the contract among the months of the following year. These monthly allocations must fall within a range of minimum and maximum delivery amounts that are specified for each month in the Phase II Contract. These maximum and minimum amounts are highest in the winter and summer months, with lower amounts specified for the spring and fall. Once a monthly delivery schedule has been established, NEPOOL is responsible for scheduling the weekly, daily, and hourly energy deliveries.

The minimum and maximum monthly energy delivery amounts specified by the Phase II Contract are shown in Table B-1 below. Table B-1 also includes the estimated energy delivery schedule that has been used by NEPOOL in its economic evaluation of the project.

Table B-1

Month	Minimum Delivery	Maximum Delivery (in GWh)	Estimated Delivery
September	420	560	490
October	420	560	490
November	630	840	700
December	630	840	630
January	630	840	630
February	630	840	700
March	630	840	700
April	350	560	420
May	350	560	420
June	490	700	560
July	560	700	630
August	560	700	630
TOTAL			**7000**

The Firm Energy Contract also provides that Hydro-Quebec may limit deliveries, without economic penalty, under certain circumstances. Specifically, Hydro-Quebec may limit deliveries, up to an aggregate amount of 400 GWh per contract year, when it would be obligated to operate fossil-fired generating units or pumped-storage units or to purchase energy from a third party to meet the contract schedule. NEPOOL anticipates that Hydro-Quebec's use of this right to interrupt deliveries will be concentrated in the months of December and January, when Hydro-Quebec's peak loads occur.

The energy to be sold to NEPOOL under the Phase II Contract would not be generated at any specific generating station dedicated to this task. Although a ± 450 kV dc transmission line would be constructed from Radisson to Des Cantons to ensure reliable transfer of energy to NEPOOL even in the event of a general power failure on Hydro-Quebec's ac system, this alone would not dictate dispatching decisions on the Hydro-Quebec system. Due to the interlocking nature of the reservoir system on the La Grande Riviere and the need to keep operations of the La Grande complex within limits on minimum and maximum river flows and reservoir drawdowns prescribed by the James Bay and Northern Quebec Agreement and by Hydro-Quebec operating permits, the La Grande complex would operate in substantially the same manner whether or not Phase II Contract sales were being made. Because of the interconnected nature of the power generation system in Quebec, the generating units that might be operated differently if Phase II Contract sales were being made might not be part of the La Grande complex at all. Therefore, when it is assumed here, for purposes of deriving a worst-case analysis responsive to the issues raised by Audubon, that generating operations would be different on the La Grande complex to meet Phase II Contract sales, this must be interpreted merely as a theoretical worst-case, and unrealistic, assumption.

Even assuming that the energy for Phase II Contract sales would be generated by operating the La Grande complex differently than otherwise, it is not possible for Hydro-Quebec to predict with any degree of certainty which of the La Grande hydroelectric stations, if any, would be operated differently in a given week or month in the future to generate the energy that NEPOOL would purchase under the Phase II Contract. Precise predictions are unnecessary, however, for purposes of analyzing

the possible impact of NEPOOL's Phase II energy purchases on migratory bird populations. This is because, in assessing the potential for incremental impact on migratory birds, the key question is how the additional energy production needed for export would affect the hydrologic regime of the La Grande Riviere and James Bay. Two factors in this analysis are how reservoir drawdown would be affected and what changes would occur in the river flows at the estuary of the La Grande Riviere.

2. Reservoir Drawdown

The existing reservoirs associated with LG2, LG3, LG4 and Caniapiscau are vast, fairly deep bodies of water, some of which are larger in area than the biggest lakes in Quebec. They therefore contain substantial volumes of water (Hydro-Quebec, 1985a). The LG2, LG3, LG4 and Caniapiscau reservoirs, combined, cover approximately 10,305 km^2 and have a total storage capacity of 194.9 billion m^3 of water (Hydro-Quebec, 1985b). Under current normal operating conditions, the reservoirs are full in summer and fall. From December on, the levels gradually drop to reach their minimum in late winter. Spring thaws cause the reservoirs to begin to fill again.

Although the commissioning of LG1 is expected to be advanced by 3 years as a result of the Phase II Contract, this generating facility had already been planned to meet demand for electricity within Quebec. Since LG1 will be a run-of-the-river generating unit, its construction will not involve creation of a significant reservoir. In total, the reservoir associated with LG1 will only cover an area of approximately 64 km^2, which area includes the present channel of the La Grande Riviere for the approximately 75 km between LG2 and LG1. The maximum variation of the water level within this reservoir will be 1.5 meters (m).

The projected average annual drawdowns for the reservoirs in the early 1990s, which include incremental drawdown, if any, necessary to generate energy for sales to NEPOOL under the Phase II Contract, are 0.9 m at the LG2 reservoir, 3.9 m at the LG3 reservoir, 10.1 m at the LG4 reservoir, and 3.7 m at Caniapiscau reservoir (Hydro-Quebec, 1985a). The minor portion of these projected drawdowns, if any, that could be attributed to Phase II Contract sales of energy to NEPOOL would be well within the normal range of drawdown for power generation for domestic Quebec consumption and other sales. The ranges of reservoir drawdown are prescribed by Hydro-Quebec's operating permits, as are the procedures and limitations on spillway operation. These legal requirements, together with the need to keep reservoirs ready to receive future runoff, dictate the constraints on reservoir management.

3. River Flow to James Bay (as Measured Near the Mouth of the La Grande Riviere)

a. Historic and Projected Flow Rates

Table B-2 displays historic river flows of the La Grande Riviere (as measured near the mouth of the river) before any development occurred on the river (from 1960-1978), actual and

Table B-2

HISTORIC AND PROJECTED MONTHLY FLOW RATES
(cubic meters per second [in thousands])

MONTH	Means from 1960 to 1978[1]			1985[1]	1986[1]	1987[2]	1990/91[3]		
	MEAN	MIN	MAX	MEAN	MEAN	MEAN	MEAN	MIN	MAX
January	0.80	0.67	0.97	3.76	3.85	3.97	4.05	4.05	4.05
February	0.59	0.53	0.66	3.65	4.11	3.93	3.85	3.51	4.05
March	0.48	0.45	0.52	3.49	3.88	3.87	3.60	3.13	4.04
April	0.49	0.44	0.71	2.76	2.81	3.59	2.68	1.52	4.03
May	2.29	0.75	3.91	2.09	2.97	3.14	2.36	1.26	4.02
June	3.48	2.89	3.92	1.90	2.59	3.19	2.55	0.90	6.09
July	2.50	2.19	2.86	2.94	2.38	3.04	2.64	0.95	5.32
August	2.20	2.16	2.26	2.30	2.41	3.35	3.33	1.70	5.25
September	2.14	2.09	2.25	2.41	2.72	3.23	3.47	2.13	4.76
October	2.33	2.22	2.37	2.74	3.17	3.31	3.99	2.79	5.77
November	1.90	1.57	2.20	3.29	4.08	3.90	3.80	3.11	4.64
December	1.27	0.97	1.56	3.52	4.11	3.93	4.05	4.04	4.05

[1] Source: SEBJ Actual Data.

[2] Source: SEBJ Projections.

[3] Source: SEBJ Projections (Hydro-Quebec, 1985a).

projected flows since development of LG2, LG3 and LG4 (1985-1987), and projected flows for 1990/91. Each of these data sets is discussed briefly below.

(i) 1960-1978 (Pre-La Grande Development)

Filling of the LG2 reservoir, the first hydrologic modification on the La Grande Riviere, commenced in late November 1978. Before development began, outflow from the river was less than it is today, since there had not yet been a diversion of waters into the La Grande. Average annual flow at the mouth of the La Grande was on the order of 1800 m^3/second (Messier et al., 1986), and generally peaked in the spring and reached its low point in winter.

(ii) 1985-1987 (After LG2, LG3 and LG4 Operational and Without Phase II Contract Sales)

After the last of the existing La Grande generating stations was placed in service in May 1984 (LG4), the average annual flow at the mouth of the La Grande Riviere increased to approximately 3400 m^3/second -- nearly a 100 percent increase in annual mean flow. The flow regime of the La Grande Riviere, as regulated by LG2, LG3 and LG4, is now also characterized by smaller monthly variations in outflow. As shown in Table B-2, the values for 1985 and 1986 are based on actual flows, while the 1987 values are projected. There has been a substantial increase in winter flow, and a slight decrease in spring flow. Before

development, discharge from the La Grande Riviere from December to April represented 20 percent of annual outflow. As of 1985, discharge occurring from December to April accounts for approximately half of all discharge (Hydro-Quebec, 1987.) In summer, mean monthly flow is similar to flows which occurred under natural conditions, except for short-term fluctuations caused by periodic opening of the LG2 spillway (Hydro-Quebec, 1987; Messier et al., 1986).

(iii) 1990/1991 (Projected Flows with NEPOOL Phase II Contract)

Projected flow rates for 1990/1991 include an average, long-term annual flow remaining at about 3400 m^3/second (Hydro-Quebec, 1985a). Mean monthly flows are projected to range from 2360 to 4050 m^3/second. (See Table B-2.) These projections include any changes in generation that might be associated with sales to NEPOOL under the Phase II Contract.

b. Projected Incremental Changes in Flows Due to Generation of Energy for Phase II Contract Sales to NEPOOL

(i) Base Case

In response to the concerns raised by Audubon, the relevant issue is whether there would be any incremental effect on migratory birds resulting from any changes in river flows associated with the generation of energy for sale to NEPOOL under the Phase II Contract. The assessment of any incremental effects should take as a base case the river flows for 1990/1991, excluding changes in flow regime due to Phase II Contract sales. The available 1990/1991 river flow projections, however, reflect the flows needed for all planned Hydro-Quebec generation on the La Grande complex, including any incremental generation of energy for sales to NEPOOL under the Phase II Contract. In other words, incremental changes in flows associated with sales to New England, even assuming there are any such changes, are some portion of these projections.

Even if one could calculate, using theoretical assumptions, the incremental changes in flows that would be caused by generation for Phase II Contract sales (and assuming that all such energy were traceable to power generation totally within the La Grande complex) and in effect subtract them from the 1990/1991 projections, the remaining flow regime (base case) would still be an underestimate of actual river flows during the 1990s without Phase II Contract sales. This approach would yield unrealistically low estimates of base case river flows because the volume of water theoretically associated with the generation of energy for Phase II Contract sales would likely be either spilled (if not used for generation) or used for generation of power for Quebec or for sales to other utilities, if sales under the Phase II Contract did not occur.

Thus, base case river flows, with or without the Phase II Contract in effect, are expected to be approximately the same. When it is assumed here, however, for purposes of deriving a worst-case analysis from the standpoint of the issues raised by

Audubon, that river flows would be different at the mouth of the La Grande Riviere as a result of generation of energy for sale under the Phase II Contract, this should be recognized purely as a worst-case, and unrealistic, assumption.

(ii) Estimating Incremental Changes to River Flows Due to Phase II Contract Sales

The differences between the 1985-1987 and 1990/1991 flow characteristics set conservative boundaries on the estimated incremental changes to river flows attributable to Phase II Contract sales to NEPOOL. Such differences (between 1985-1987 actual and projected flows and 1990/1991 projected flows) include not only the effects due to Phase II sales, but also those due to other sales initiated between 1985-1987 and 1990/1991 (such as new sales to non-Quebec utilities and Phase I Contract sales to NEPOOL) and increased energy usage within Quebec itself. Thus, any changes in river flows attributable to Phase II Contract sales alone, using worst-case assumptions, would be less (and perhaps significantly less) than the differences between the 1985-1987 data and 1990/1991 projections presented in Table B-2.

Nevertheless, certain conclusions can be reached even based upon the entire difference between current flows and 1990/1991 projections. First, the estimated change in annual average flow is negligible or non-existent, compared to 1985, 1986 or 1987 values. Second, the projected average flow for May-October (3.06 m^3/s in 1990/1991) is within the range of average flows for those same months under current operations (2.4 m^3/s in 1985, 2.71 in 1986, and 3.27 in 1987). In addition, the 1990/1991 projection for these same months is only 23% higher than the average of means for these months for 1960-1978 (2.49 m^3/s), prior to development, and approximates the average of mean maximum flows of those months for those years (2.93 m^3/s). Third, there are only three months out of the year (January, September, and October) when 1990/1991 projected monthly mean flows exceed the highest corresponding monthly mean flow for 1985-1987. For the other nine months of the year, the 1990/1991 projected monthly mean flow is within the range of flows being experienced under current operating conditions.

More precise estimates of modifications to river flows attributable only to Phase II Contract sales would be extremely difficult to determine. Difficulties arise because there are numerous independent and dependent variables, including weather, dispatching decisions, fluctuations in Quebec demand, and sales to other utilities. Nevertheless, even the total differences between current monthly flows and projected 1990/1991 monthly flows -- which would, as a worst-case assumption, include increased flows for Phase II Contract sales as some portion -- are minor. This analysis provides ample basis for concluding that, even under theoretical worst-case assumptions, generation at the La Grande complex for Phase II Contract sales would produce only very minor alterations in river flows.

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POTENTIAL EFFECT ON MIGRATORY BIRDS OF INCREMENTAL CHANGES ASSOCIATED WITH PHASE II CONTRACT SALES TO NEPOOL

A. Potential Impact of Modifications in Reservoirs Due to Phase II Contract Sales

Development of the La Grande complex began in 1974 with the initiation of construction for LG2, LG3, and LG4 and the diversion of the Eastmain and Caniapiscau Rivers to the La Grande Riviere. By the beginning of the Phase II Contract period in 1990, the storage reservoirs associated with the La Grande project will have been completed for over 5-10 years. By that time, adaptive processes in the storage reservoirs will have moderated construction impacts and the availability of the reservoirs as freshwater wildlife habitat will have been established.

As discussed in Appendix B, the generation of energy for sale to NEPOOL under the Phase II Contract would require the construction of no dams, reservoirs or generating capacity beyond what is already in place or planned to meet internal Quebec needs.

It is important to note that the freshwater habitat of existing reservoirs and other developed areas is very sparsely used by migratory bird species (Julien and Laperle, 1986). Moreover, incremental reservoir drawdowns for the generation of energy to sell to NEPOOL under the Phase II Contract would be minimal at best, as discussed in Appendix B, Section B.2, and would be within the range of variation in reservoir drawdowns anticipated even without Phase II Contract sales. Therefore,

there is no reason to conclude, on the basis of the information available, that any relatively minor incremental drawdowns used to generate energy for Phase II Contract sales, even assuming as a worst case that there would be any such incremental drawdowns, would have any effect, let alone a significant adverse effect, on freshwater migratory bird habitats.

B. Potential Impact in James Bay Resulting from Modifications in River Flows Due to Phase II Contract Sales

1. Existing Migratory Bird Populations and Habitats

In order to assess the potential impact on migratory bird populations or their habitat as a result of modifications of river flows associated with Phase II Contract sales to NEPOOL, it is necessary to consider the status of the existing migratory bird populations. A recent literature review (Rimmer, 1987), attached here as Appendix D, has been conducted on the significance of James Bay's environment for migratory birds.

James Bay can be considered, in the context of the much larger Hudson Bay ecosystem, as an important element in what has been described as "an immense, natural migratory funnel along which millions of . . . birds pass during spring and autumn migrations" (Rimmer, 1987). James Bay as a distinct habitat can be separated into three zones: the offshore habitat offered by the Bay itself; the eastern shore, on which the La Grande

Riviere's estuary is located; and the south and western shores, which are characterized by wide coastal marshes and intertidal flats of particular significance to migratory birds.

The offshore environment of James Bay is characterized as a relatively shallow marine environment (half of which is between 0 and 20 meters deep) with a surface area of approximately 8000 km^2 (Hydro-Quebec, 1987). The offshore environment is covered by sea ice for approximately 6 months of the year, generally from mid-November through mid-May. James Bay's offshore productivity is rather low due to lack of nutrient availability (Roff and Legendre, 1986) and lack of mixing and turnover (Roche, 1985a). The inflow of fresh water, particularly along the eastern shore, has the effect of diluting the salinity of surface layers and contributing to wide variances in salinity throughout the Bay.

The eastern coast of James Bay is characterized by a rocky shoreline with numerous coastal bays and small islands. Some of the bays contain eelgrass beds, which are major contributors to the overall biological productivity of James Bay. In addition to providing a principal attraction to migrating birds, the eelgrass beds may fill an ecological niche similar to algae in other coastal environments and function importantly at the base of the food web of James Bay (Miller and Mann, 1973). In addition to the eelgrass beds, the eastern coast of the Bay harbors benthic populations typical of subarctic regions, whose densities vary from 2,000-5,000 individuals/m^2. Although the eastern shore lacks broad expanses of shallow coastal marsh and

the richer benthic, plant and animal communities associated with them, the presence of polychaetes and molluscs in sand and mud flats may be of importance to migrating birds.

The southern and western coasts of James Bay offer a higher quality habitat for migratory birds. More data on migratory bird populations and distribution have been gathered on the west coast. The habitat value of the west coast can be attributed to a more diverse marsh environment due to the flat topography, wide tidal range, and less exposure to dominant wind. Plant communities characteristic of the west coast migratory habitat include, by zones, working inland: a frequently inundated salt marsh dominated by the colonizing grass *Puccinellia phryganodes*; a narrower saline meadow marsh, dominated by specialized rushes, forbs and arrowgrass; a poorly drained and brackish meadow marsh with scattered standing pools dominated by sedges; and finally, an only occasionally inundated willow thicket fen/marsh dominated principally by freshwater wetland plants.

The ecological and physical interrelationships between the east and west coasts, the inland rivers flowing to them, the offshore James Bay environment and neighboring Hudson Bay are complex and incompletely understood. The significance of the James Bay environment to spring and fall migratory birds, however, can be generalized as that of a "staging area." Seasonally abundant vegetation and invertebrate food supplies provide feeding opportunities which fuel long migratory flights. Waterfowl and shorebirds are the two significant groups of migrants utilizing the waters of the Bay.

Waterfowl. Geese and ducks use both the east and west coasts during their annual migrations. Their distribution and abundance, like that of shorebirds, has been well documented in the James Bay area. Species include Lesser Snow Geese, Canada Geese, Atlantic Brant, and several species of dabbling ducks and diving ducks. Atlantic Brant may constitute the species to which the James Bay environment is most critical, with perhaps 50 percent of the total species population migrating through the Bay annually. Brant are more closely identified with the marine environment than other waterfowl assessed in the literature search, and their distribution in the James Bay environment seems to parallel that of eelgrass, a preferred food source during fall migration.

Shorebirds. Because the west coast of James Bay offers a more attractive environment to shorebird populations, their distribution and abundance there is better documented than on the east coast. The predominance of headlands, bays and more steeply sloping terrain along the east coast does not provide the productive tidal flats and marsh environments preferred by the group. Shorebird species of importance include Semipalmated Sandpipers, Red Knots, Hudsonian Godwits, Dunlins and perhaps Eskimo Curlews. Both Red Knots and Hudsonian Godwits appear to be species to which the James Bay environment has especially critical

significance. Both have populations which are beginning to rebound after facing extinction. Both have habitat needs which relate them to the western shore of James Bay and its expanses of mud flats and diverse marsh vegetation and invertebrate associations. Both species also undertake long migratory flights to South America for which the staging area and high quality habitat availability are particularly critical.

In addition to waterfowl and shorebirds, raptor and passerine migratory species also utilize the James Bay environment. Unlike certain waterfowl and shorebirds (such as Atlantic Brant and Red Knots, respectively) for which an important link can be established between James Bay's habitat and dependence by a significant portion of the species population, only particular, and in some cases marginal, populations of raptor and passerine species can be associated with James Bay. For instance, Snowy Owls which frequent the James Bay environment are virtually circumpolar in distribution and, depending on lemming population cycles, may be found at some distance from their traditional feeding areas throughout the arctic and subarctic regions. Additionally, populations of passerine species such as the Red-eyed Vireo breed in the willow-alder thickets and marsh vegetation of the James Bay region, but are thought to be at ecologically marginal limits for their species. Passerine migrants, such as Lapland Longspurs, likewise avail themselves of staging habitat opportunities provided by James Bay. Considering the wide arctic and subarctic breeding range of that species, however, the abundance and distribution data for the species in the James Bay region is not substantial during migration periods (Rimmer, 1987).

In summary, the coastal James Bay environment has significance for certain species of migratory birds, with several species having an important association with the habitat and food resources of the Bay.

2. Modifications of Physical Parameters

Assuming that any incremental changes in river flow on the La Grande Riviere associated with energy generation for sales to NEPOOL under the Phase II Contract can be identified, see Appendix B, Section B.3.b, the question arises as to the environmental significance of those incremental changes with respect to migratory bird populations utilizing James Bay. Significance can be assessed by looking at physical as well as biological parameters.

In making this assessment, comparison can be made to the major changes in river flows in the past associated with the original development of the La Grande complex. These changes and resulting impacts, which have been studied, can then be used to evaluate the significance of possible incremental changes, if any, associated with Phase II Contract sales. First, physical parameters of possible relevance to impacts on migratory bird habitats in James Bay are discussed with respect to the La Grande

development to date. Second, possible changes in these same physical parameters associated with Phase II Contract sales are assessed.

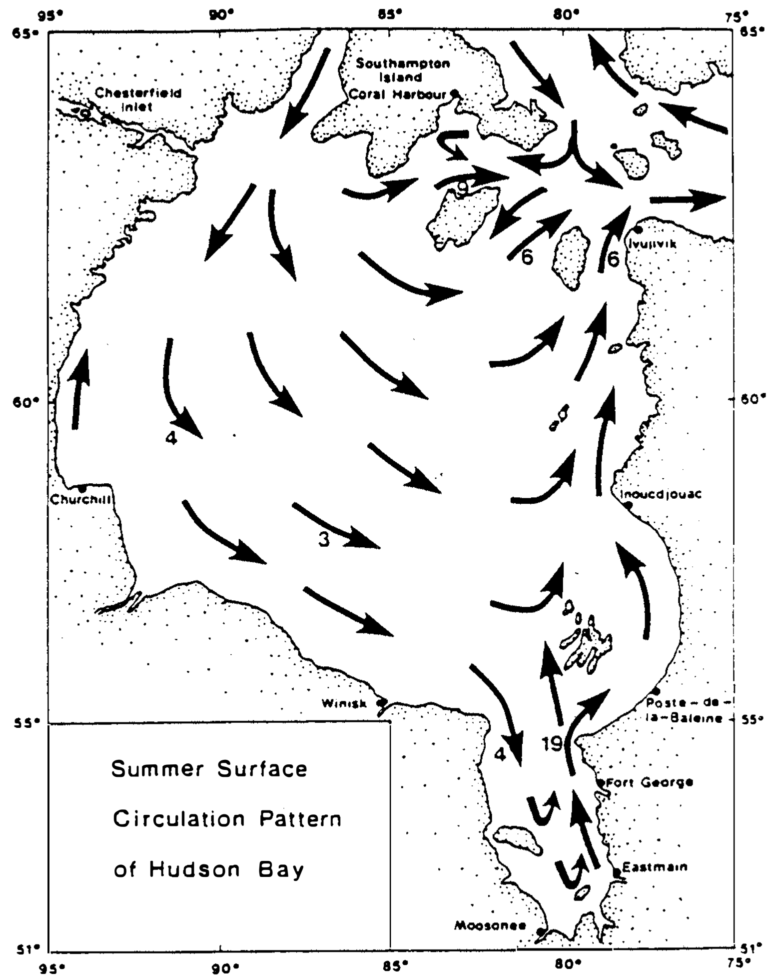
a. Past Changes in Key Physical Parameters in James Bay Associated with Changes in River Flows: La Grande Development to Date (1978-1985)

Changes in key physical parameters have been documented for the period of La Grande development to date.

(i) Changes in Circulation

The general pattern of circulation of James Bay and Hudson Bay is a cyclonic, or counter-clockwise, flow. (See Figure C-1.) Superimposed on this mean circulation is considerable variation due to changes in the regional winds. The mean wind stress (or surface force) tends to drive the cyclonic circulation. The flux of fresh water from the rivers also contributes to the cyclonic flow, by setting up a pressure gradient that is high at the sides and low in the center of the Bay. The effect of the earth's rotation causes the resulting flow to be cyclonic, just as in the case of an atmospheric low pressure system. At the entrance of James Bay this circulation pattern is characterized by the surface outflow (to Hudson Bay) of water that is less saline, northward along the east coast of James Bay (Prinsenberg, 1982; Freeman et al., 1982). This is balanced by a slower, broad, bottom inflow (from Hudson Bay) of saline water, southward along the west coast of James Bay. The strength of this circulation is

Figure C-1



Source: Prinsenberg, 1986.
(Numbers are observed velocity values in cm s^{-1}.)

directly related to the freshwater flux (Prinsenberg, 1982). Consequently, under natural conditions this circulation was less pronounced in the winter due to decreased fresh water inflows and, to a certain extent, ice cover.

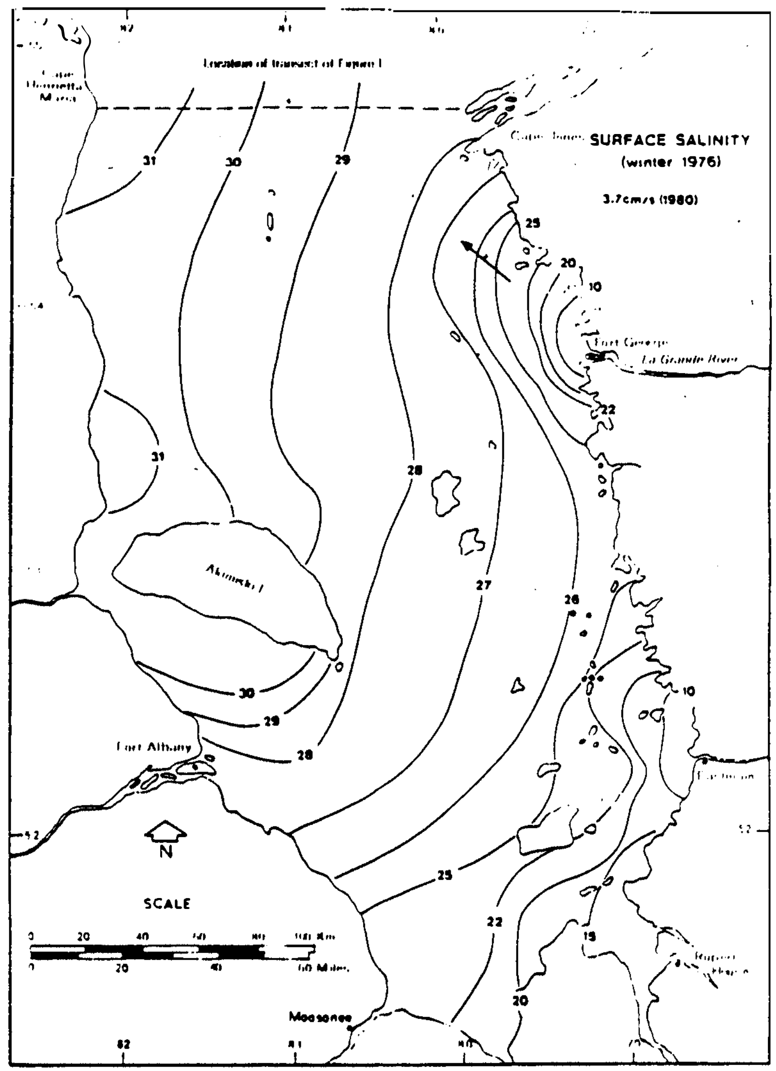
The increased flows from the La Grande Riviere during the winter as a result of the La Grande development to date should theoretically have strengthened this weaker winter circulation. However, data show no measurable increase in surface circulation except in the delta of the La Grande Riviere, where there is a noticeable increase in mean surface currents (Hydro-Quebec, 1987). During the summer, when winds can reverse the surface circulation (Prinsenberg, 1980) and biological activity is highest, outflows from the La Grande should be approximately the same after the La Grande development as they were before, thus resulting in few, if any, development-related changes in summer circulation.

(ii) <u>Changes in the La Grande Plume</u>

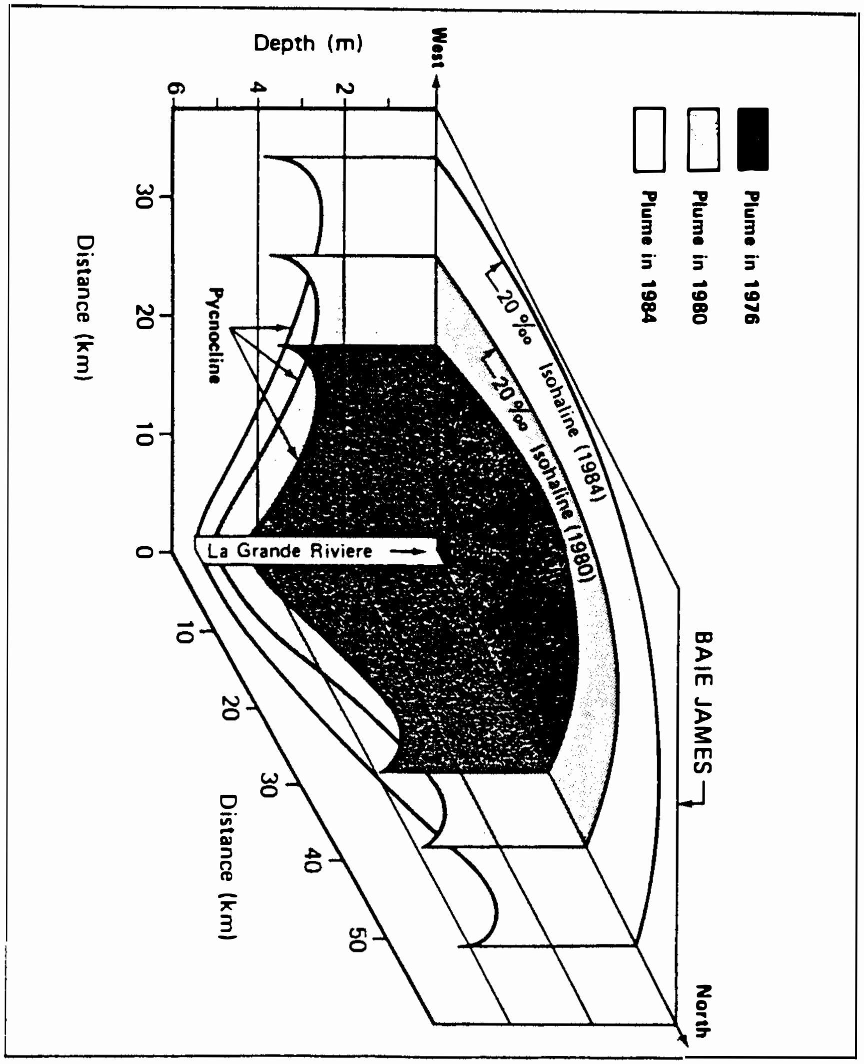
Messier et al. (1986) describes the La Grande Riviere plume prior to and after development of the La Grande complex. During the entire annual cycle, the discharge of the La Grande Riviere was and is still sufficient to generate a large plume in the adjoining coastal waters. For the natural flow regime, before the development of the La Grande complex, the plume was larger under the ice cover than in open water. The direct influence of the plume in open water was not as evident because of mixing induced by wind and wave action. The characteristics of the plume under winter and summer conditions are described below.

<u>Winter Plume</u>. Since the initiation of operations at the La Grande complex, the limit of the La Grande Riviere plume in winter has grown considerably in response to increased flow into James Bay. Figure C-2 (from Prinsenberg, 1982) shows surface salinity in James Bay in 1976. Figure C-3 (from Messier et al., 1986) shows the extent of the plume area (within the 20 parts per thousand [ppt] isohaline) from the mouth of the La Grande Riviere for the years 1976, 1980 and 1984. Plume area increased from approximately 750 km^2 under natural conditions (before development) to approximately 2300 km^2 by winter 1984. La Grande Riviere discharge during these periods was on the order of 500 m^3/s in 1976 and 3000 m^3/s in 1984 (Messier et al., 1986).

Prior to the operation of the La Grande complex, the plume was semicircular in shape close to shore, and quasi-rectangular for higher-valued isohalines, with the longer axis paralleling the shore. About 30 percent of the plume area was south of the mouth of the river. Plume shape has not been significantly affected by the increased winter discharge. The present winter discharge causes slight dilution of less than 1 ppt of the James Bay surface waters up to the entrance of Hudson Bay (Messier et al., 1986).



Source: Prinsenberg, 1982. Surface salinity contours as observe[d in] winter 1976 (Peck, 1978) with surface current meter data of winter [...]



The limit of the fast (fixed) ice zone coincides with the edge of the coastal shelf (0-20 m depth). Beyond the fast ice zone, large open water areas (10 to 20 percent cover) and ice flows (80 to 90 percent cover) occur. A comparative study has shown that increased La Grande Riviere discharge (1976-84) has not affected the fast ice limit because water depth, not the freshwater discharge, controls its location (Messier et al., 1986).

Summer Plume. Mean summer flow values for the La Grande Riviere as regulated by development prior to 1986 indicate a moderate decrease in the monthly mean summer flows from those found under natural conditions (Messier et al., 1986). The outer plume boundary is roughly rectangular, 40 km by 15 km. Its size and shape are essentially unchanged from what they were before development. Data from previous years show that the tidal influences can cause significant shifts in the location of the surface isohalines, which influence estimates of the plume area by as much as 25 percent. Thickness of the plume is variable, with a mean of 1 to 2 m. Mixing of fresh and James Bay waters occurs, as in winter, along the edges of the plume. The offshore limit of the plume usually coincides with the coastal shelf (0-20 m depth) (Messier et al., 1986).

(iii) Changes in Temperature

Change in the temperatures of the waters of James Bay as a result of the La Grande development to date have been minor. As part of a program of oceanographic studies undertaken to identify modifications to the coastal regions in James Bay associated with the La Grande project, over 20 water quality variables, in addition to temperature, were measured at the head of the La Grande Riviere estuary (approximately 38 km upstream of the river mouth) for natural conditions (1978) and during project operation (Messier et al., 1986). Since the initiation of operation of the project, mean winter water temperatures in the river have increased 1°C and mean summer water temperatures have decreased 3°C (Messier et al., 1986). These changes in river water temperatures are minimized still further in James Bay by the circulation and tidal mixing during the winter (ice-covered) months and additional wave and wind mixing during the summer (ice-free) months. In addition, these water quality data demonstrate that water quality of the La Grande Riviere since the initiation of operation of the project has returned to values comparable to those prior to project operation (Messier et al., 1986).

(iv) Changes in Ice Cover

The ice cover on James Bay has been minimally influenced by the change in discharge. Messier et al. (1986) indicates that ice cover in the La Grande Riviere has been reduced by 4 to 6 weeks, but that ice conditions in James Bay have been only slightly altered, near the mouth of the river.

This is not entirely unexpected, since the change of temperature data discussed above in Section B.2.a(iii) indicate that the mean winter water temperature at the head of the La Grande Riviere estuary has increased only 1°C over the pre-project natural conditions. This temperature differential would become still less significant as dispersal and mixing of this water occurs in the estuary and James Bay, because the slight excess heat of the river discharge is rapidly lost to turbulent mixing and heat conduction. At the mouth of the La Grande Riviere, the mean monthly temperature is 0°C from December to April.

Also of significance is the fact that the heat budget analysis carried out by Prinsenberg (1984) shows that 82 percent of the quantity of heat entering James Bay from winter to summer comes from exchanges at the surface of the Bay, with minor contributions from runoff and water transport. It is thus unlikely that changes in the discharge of rivers following development have had a significant effect on the total ice regime of James Bay.

(v) Conclusion

In conclusion, the substantial development of the La Grande complex between 1978 and 1984 has brought about significant changes in river flows (see Appendix B, Section B.3). Even these major changes, however, have had minimal effect on key physical parameters in James Bay. There has been no measurable increase in surface circulation outside the delta of the river, even in winter. While the winter plume of the river has increased in size due to the increased river flows, the size and shape of the plume in summer are essentially unchanged from what they were before development. The change in the temperatures of the waters in the river estuary as a result of the La Grande development to date has been minor, and effects in the Bay itself, if any, would have been less. Finally, the local ice conditions in James Bay have been only slightly altered near the mouth of the river. Therefore, even the significant changes in river flows from 1978-1985 have brought about only slight changes in these physical parameters in James Bay.

b. Assessment of Changes in Key Physical Parameters Due to Phase II Contract Sales

Even using theoretical, worst-case assumptions, the modifications to the outflow patterns of the existing La Grande complex due solely to the generation of energy for Phase II Contract sales would be minor and within the range of normal operations for the existing facilities. (See Appendix B, Section B.3.) As such, any changes to key physical parameters in

James Bay associated with the generation of energy for Phase II Contract sales would be within the range of changes which would be experienced for the La Grande complex with or without generation for Phase II Contract sales.

In addition, any changes in physical parameters in James Bay that might be expected due to modifications of river flows associated with Phase II Contract sales would be expected to be substantially less than the changes in physical parameters that occurred from 1978-1985. Therefore if, as will be discussed below in Section B.2, these historic changes in river flow have not produced significant adverse effects on migratory bird populations or habitats in James Bay, then any incremental changes even theoretically traceable to energy generation for Phase II Contract sales should not bring about significant adverse effects.

Therefore, the potential incremental impacts to key physical parameters of James Bay resulting from possible modifications in flow rates of the La Grande Riviere associated with generation of energy for Phase II Contract sales to NEPOOL should be minor, even under the worst-case assumptions set forth in Appendix B.

3. Potential Impact on Migratory Birds and Their Habitats

The significance of all the analysis in preceding sections is, of course, with respect to the potential for energy generation for Phase II Contract sales to have an adverse impact on migratory bird populations. Just as is the case with key physical parameters (see Section B.2.a. above), there exist historical data on biological effects of past changes in river flow regime. By reference to these past data, it is possible to assess the possibility of adverse effect due to generation for Phase II Contract sales. Therefore, this section first discusses available data (1978-1985) that are relevant, and then assesses possible incremental effects due to Phase II Contract sales.

a. Past Changes in Key Biological Parameters Associated with Changes in River Flow Rates: La Grande Development to Date (1978-1985)

Past changes in key biological parameters have been documented for the period of La Grande development to date.

(i) Changes in Nutrient Availability and General Productivity of James Bay

A study of the overall productivity of James Bay both pre- and post-La Grande development (Roche, 1985a) indicates that, due to a number of factors, including the presence of ice cover from December to June and the low amount of nutrients, there are probably spring outbursts of phytoplankton in these waters, followed by minor summer blooms that are highly localized and linked to the local dynamics of the waters. An outline of the distribution of primary summer production of phytoplankton in the surface waters of James Bay was constructed on the basis of the model by Griffiths et al. (1981), into which was incorporated the general interpretation of Pingree et al. (1975) on the interaction

between tidal fronts and phytoplankton. This study (Roche, 1985a), although qualitative, shows that the Bay as a whole offers poor productivity conditions. (Hydro-Quebec, 1987.)

The dominant microscopic algae of Hudson Bay have been found in considerable salinity, temperature and depth ranges, and freshwater forms are often encountered in the open areas of Hudson Bay (Roff and Legendre, 1986). No similar studies have been carried out in James Bay, but given the physical characteristics of the environment (lower salinity, greater stratification), algae production is likely to have been lower in James Bay than in Hudson Bay prior to the La Grande development and to remain lower today. (Hydro-Quebec, 1987).

Most of the dominant benthic populations identified along the eastern shore of James Bay are generally tolerant of the variations in salinity, temperature and production typical of James Bay (Hydro-Quebec, 1987). The mollusc Macoma balthica is a typical estuarine species that adapts to a wide range of salinity and temperatures (Roche, 1985b).

A typical concern associated with hydroelectric projects is that nutrients normally discharged by the project river to the receiving waterbody will be trapped behind the dams in upstream reservoirs and will result in a depletion of nutrients in the ecosystem of the receiving waterbody. To date, there is no indication that the new flow regime created by the La Grande complex has had a measurable effect on the James Bay coastal nutrient supplies (Hydro-Quebec, 1987). Even before development, as well as today, the La Grande Riviere does not provide nutrients to James Bay at levels that determine the productivity of James Bay (Messier et al., 1986). The La Grande Riviere has historically provided only minimal nutrient contributions to James Bay and project-related modifications to the hydrologic regime have had little effect on nutrient concentrations of James Bay (Freeman et al., 1982).

It is also appropriate, in this context, to take net development effects into account. Although increasing the discharge of the La Grande Riviere did cause a slight reduction in the marine environment near the river mouth (Messier et al., 1985), the reduced flow of the Eastmain River increased the marine environment near its mouth (Messier et al., 1986).

Another common concern is that changes in river flow patterns will affect the physical parameters (e.g., salinity or temperature) of the receiving water body and thereby harm the nutritive value of that water body and the ecosystems that are dependent upon it. While the surface salinity of northeastern James Bay has been reduced under the influence of the post-development winter plume of the La Grande Riviere, ecological effects of this change on the fauna and flora of the Bay are not thought to have been significant. The planktonic and benthic species present in the bay are very tolerant of variations in salinity. Also, this change is therefore not expected to influence the rest of the food chain, as demonstrated by the subsistence hunting and fishing success of the native people along

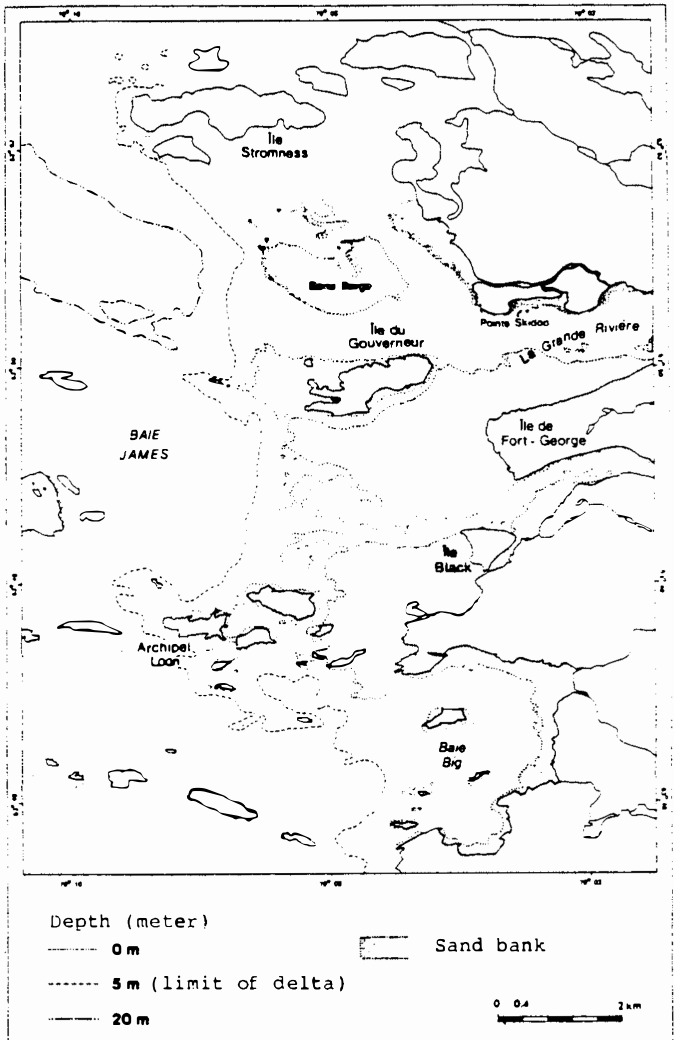
the James Bay coast (Hydro-Quebec, 1987). Further, winter is a period of minimal productivity. The La Grande Riviere freshwater plume has remained essentially unchanged during the summer, a period of maximum biological production (Messier et al., 1986).

While winter plume area has increased since the La Grande 2 generating facility went into operation, large plumes also existed under natural conditions, but during the months of May and June rather than in January and February, since the main tributaries of James Bay are in flood at a time when the bay itself is still covered by ice (Hydro-Quebec, 1987). From 1960 to 1978, the peak of the spring floods varied from 2400 to 6100 m^3/s and the maximum flow rates occurred between May 20 and July 20. It is unlikely that the reproductive cycle or the growing season of the main planktonic species in James Bay were closely correlated with spring floods of the La Grande Riviere, because natural fluctuations were too large before development of the La Grande Riviere (Hydro-Quebec, 1987).

Prior to development, the sandy delta of approximately 20 km^2 at the mouth of the La Grande Riviere (see Figure C-4) was a relatively nutrient-poor area. This delta was inhabited by only one species of mollusc (Macoma balthica), with a density of less than 100 individuals/m^2 (Hydro-Quebec, 1987). The strong currents, the generally low salinity conditions and the sandy substratum did not allow high benthic productivity in this area (Messier, personal communication). Since the development of the

Figure C-4

Sandy delta at the mouth of the La Grande Riviere



Source: Service hydrographique du Canada, carte no. 5820

La Grande complex, the delta is almost always in freshwater conditions and M. balthica has apparently disappeared (Hydro-Quebec, 1987).

Further offshore, at depths of 25 m, it has been observed that bivalves declined from 1982 to 1984. This change, however, likely reflects the mosaic-like distribution of these communities and is not a result of the La Grande development, since this deepwater area is not influenced by fresh water from the La Grande Riviere (Hydro-Quebec, 1987). Indeed, there are indications that aquatic communities have made positive adjustments to changes in river flows since development. In the case of the Eastmain River estuary, where freshwater discharge was reduced by 90 percent, phytoplankton biomass increased from the first year of cutoff (Ingram et al., 1985) and benthic communities have moved about 10 km upstream (Messier et al., 1986). The coexistence of planktonic and benthic forms of both fresh and salt-water origin in this environment is a reflection of the great tolerance of these species to salinity variations (Messier et al., 1986). Moreover, the number and abundance of benthic species on the east coast of James Bay increased from 1982 to 1984 (Roche, 1985b).

In conclusion, there is no evidence to date that project-related flow modifications of the La Grande Riviere (i.e., increased discharge in the winter and decreases of the spring freshet) have induced significant changes in the nutrient availability in or general productivity of James Bay.

(ii) Eelgrass

The presence and distribution of migratory birds along the east coast of James Bay, especially Brant, are very much influenced by the presence of eelgrass (Zostera marina), which constitutes their primary food source during migration periods. Eelgrass is a subtidal marine grass which flourishes in less than 2 meters of cool, clear saline water in areas protected from strong wave action or excess siltation, such as sheltered bays into which no significant streams enter and the leeward side of islands. Eelgrass is absent in river mouths where substrate instability limits its growth (Curtis, 1976). In the summers of 1974 and 1975, the Canadian Wildlife Service mapped the location of the major eelgrass beds along the east coast of James Bay. There were no eelgrass beds within 16 kilometers of the mouth of the La Grande Riviere (Skinner, 1974).

Eelgrass beds are important feeding areas for the Canada Goose and Atlantic Brant. In addition, other waterfowl feed in the eelgrass beds where organisms living on the surface of plants and a great number of invertebrates thrive. Eelgrass beds form an important base for major food webs in the James Bay marine ecosystem, and they stabilize sediments and provide shelter and feeding areas for fish and other forms of marine life. Since the shoreline of eastern James Bay is virtually lacking in major macrobenthic algae beds, probably due to the nature of the substratum, the eelgrass beds of James Bay probably fill the same type of role as algae in other coastal environments (Miller and

Mann, 1973). The coastal bays of eastern James Bay where these beds are found probably account for the greater part of the productivity of the eastern coast of the bay (Hydro-Quebec, 1987).1/

The distribution of eelgrass in coastal waters is dependent on salinity, water temperature, turbidity, depth, wave energy, and nature of substrate. A comprehensive study in Alaska indicated that "temperature is of prime importance to the growth and morphology of eelgrass" (McRoy, 1970). The study showed that eelgrass thrives in water temperatures of 10 to 20°C. Data on temperatures in the small bays along James Bay show that temperatures range in the summer between 10°C and 20°C. Because the range of salinity that is optimum for growth of eelgrass is between 10 ppt and 30 ppt, it is clear why the eastern James Bay coastline, where salinity varies between 14 ppt and 22 ppt, is a very good habitat for eelgrass (Lalumiere, 1986).

Studies undertaken by SEBJ show that, between 1982 and 1986, there was no evidence of a significant change in the density of eelgrass beds in areas that might be affected by the La Grande Riviere's freshwater plume (Lalumiere, 1986). These studies covered approximately 100 kilometers of eastern James Bay coastline, extending north and south of the mouths of the La Grande and Eastmain Rivers. Eelgrass has maintained itself in Tees Bay (inside the La Grande Riviere's freshwater plume) since

1/ On the other hand, the James Bay river estuaries, and especially those of the Eastmain and La Grande rivers, are not particularly attractive to waterfowl, in part due to their relatively sterile characteristics (Curtis, 1976).

the beginning of operations at LG2, further confirming that the winter decrease in salinity has not adversely affected the growth of the species (Lalumiere, 1986). These results confirm the assertion of Curtis (1976) that "serious alteration of coastal mark or eelgrass beds is unlikely."

(iii) Changes in Migratory Bird Populations

There are no data permitting a direct measurement of effects (if any) from the La Grande development directly on the migratory bird populations on James Bay. SEBJ has not taken direct counts of migratory birds in the James Bay region. Instead, SEBJ has relied upon monitoring of coastal habitat (such as eelgrass production) as a measure of possible effects on bird populations. This monitoring has provided no indication that the new flow regime created by the La Grande development has had any measurable effect on coastal habitats. This is because the tidal regime is principally responsible for the productivity of the James Bay coastal areas where migratory birds feed and this regime has remained basically the same, with the exception of a slight reduction in the marine environment near the mouth of the La Grande Riviere and an increase in the marine environment at the mouth of the Eastmain River (Hydro-Quebec, 1987).

Post-development, generalized data on distribution and abundance, also, indicate that migratory bird populations utilizing James Bay have not been adversely affected by the La Grande development. Indeed, relevant species, including the Canada Goose and Snow Goose, are increasing in population. (Hugh

Boyd, Canadian Wildlife Service, personal communication.) For example, in recent years (1980-1985) Canada Geese have reached unprecedented high population levels (North American Waterfowl Management Plan, 1986). As of 1985, the Canada Goose population in the Atlantic Flyway is reported as stable to slowly increasing (Migratory Bird National Resource Plan for the Atlantic Flyway Population of Canada Geese, 1985), and the United States Fish and Wildlife Service is predicting increased numbers of Canada Geese in the Atlantic Flyway in 1986 as compared to 1985 (1986 Status of Waterfowl and Fall Flight Forecast, 1986).

Atlantic Flyway Brant have also been increasing in population since the late 1970s. (Migratory Bird National Resource Plan for the Atlantic Flyway Population of Brant, 1985.) The population suffered significant winter mortality in 1976. These losses were attributable to vegetative changes caused by degradation of coastal estuaries in the eastern United States, coupled with severe winter weather in the 1970s (North American Waterfowl Management Plan, 1986). After remaining low for 1976-1979, the annual numbers of Atlantic Flyway Brant have increased steadily for the past six years and mid-winter populations reached approximately 146,000 in 1985. The January 1986 inventory showed a decline in Brant to about 110,000. The reason for this decline, however, was that major nesting areas were snow-covered until late June and July in 1985 in some northern areas, affecting breeding success (1986 Status of Waterfowl and Fall Flight Forecast, 1986).

Indirect evidence of lack of harm to migratory birds from the La Grande development also comes from the recent literature search attached here as Appendix D. That search disclosed no documentation in the public literature that any development to date has had a significant adverse effect on migratory bird populations utilizing James Bay.

Indirect evidence of lack of harm also comes from the native peoples. The area around the mouth of the La Grande Riviere is an important waterfowl hunting area for the Cree of Chisabisi. Harvesting statistics in the mid-1970s revealed that 25,000 Canada Geese were killed by Cree hunters each spring (Curtis, 1976). In the fall, another 25,000 were killed by Cree and 3,000 were killed by non-native sport hunters operating out of various hunting camps along the James Bay coast. Because the Brant is not a particularly sought-after food for the Cree, harvests were variable. The data indicate that the Cree killed about 3,000 Brant in the spring and 5,000 in the fall. The harvesting statistics show that native hunters killed 3,000 Lesser Snow Geese in the spring and 18,000 in the fall, and 12,000 to 15,000 "ducks" in the spring and another 15,000 in the fall (Curtis, 1976). SEBJ has received no indication that the native peoples have experienced changes in their hunting success due to the La Grande development.

In sum, there is no evidence of adverse effects from the La Grande development on migratory bird populations of James Bay between 1978 and 1985. In fact, what evidence there is suggests that at least two important migratory bird species have been increasing in numbers since the initial development began.

b. Assessment of Potential Impacts on Key Biological Parameters Associated With Phase II Contract Sales

As discussed above in Section B.3.a, the substantial changes in river flows from 1978 through the present associated with development on the La Grande Riviere have not adversely affected migratory bird populations. There is no evidence that the nutrient availability in James Bay or the general productivity of the Bay have been adversely affected. Moreover, monitoring studies show that eelgrass production has not declined, and the available data on migratory bird populations do not suggest any adverse effect. Any change in river flow regime due solely to generation of energy for Phase II Contract sales, even under worst-case assumptions, would be expected to have far less effect (if any) than the changes that occurred in 1978-1984. Therefore, it is reasonable to conclude, on the basis of all available data, that no adverse effects on migratory bird populations or habitats would occur as a result of Phase II Contract sales by Hydro-Quebec to NEPOOL.

Furthermore, in the coming years the environmental monitoring by SEBJ and Hydro-Quebec that has been underway in the James Bay area since 1978 will concentrate mainly on the coastal areas of James Bay in order to ensure that fish and waterfowl are not negatively affected by discharge modifications brought about by the La Grande development. (Hydro-Quebec, 1987.)

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A LITERATURE REVIEW ON

THE SIGNIFICANCE OF JAMES BAY TO MIGRATORY BIRDS

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January, 1987

INTRODUCTION

Migratory birds are often critically dependent on resources in widely scattered areas during their annual cycles. A direct connection exists between James Bay/Hudson Bay and breeding or wintering areas for many species that depend on food resources and habitats in one area to reach the other (Morrison and Gaston 1986). The coastlines of James and Hudson Bays constitute an immense, natural migratory funnel along which millions of subarctic and arctic breeding waterfowl, shorebirds, raptors, and passerine birds pass during spring and autumn migrations. The James Bay coast has been identified as an area of outstanding international importance for a number of species of waterfowl and shorebirds (e.g. Morrison and Harrington 1979; Martini et al 1980). The flat topography, relatively warm temperatures, moderate tidal ranges, and brackish conditions have resulted in wide coastal marshes and intertidal flats with highly productive vegetational and invertebrate food resources (Morrison and Gaston 1986). During migration these habitats attract huge concentrations of birds, which feed intensively and accumulate energy reserves that are indispensable to certain species in fueling subsequent stages of their long distance

flights.

It is the purpose of this literature review to synthesize and present available information on the use of James Bay by migratory birds. Emphasis is placed on the distribution and abundance of selected species, the identification of specific geographic areas that appear to be important, diets and feeding ecology, and overall migration strategies. A general assessment of the significance of James Bay to each species is provided where possible.

PHYSIOGRAPHY AND GENERAL ECOLOGY OF JAMES BAY

Glacial History, Geomorphology, and Sediments

The landscape and sea bottom of the James Bay region have been profoundly influenced by events during and since the most recent (Wisconsin) glaciation. Following retreat of the massive Laurentide ice sheet, the ancient Tyrell Sea covered what now constitutes the Hudson Bay Lowland. This area of some 324,000 km^2 on the south and west coasts of James and Hudson Bay extends from just east of the Quebec/Ontario border to near Churchill, Manitoba. The lowlands formed as a result of emergence from the Tyrell Sea beginning 7400 to 8000 years ago, due to isostatic uplift of the earth's crust. This dynamic rebound continues at a rate of 70-100 cm/century (Martini et al. 1980).

Two major types of coastline occur on James Bay (Morrison and Gaston 1986). The eastern shore is underlain by Precambrian rocks of the Canadian Shield. This coast is characterized by a broken, indented shoreline with rocky outcrops and numerous small bays and hilly islands. Intertidal areas and supertidal marshes are not prominent features of the east coast. Land on the western side of James Bay is underlain by Paleozoic rock. This low-lying, poorly drained coast is characterized by a uniform, gentle slope of 0.5 m/km and tidal ranges of up to 3 m, contributing to the development of extensive (several km wide) intertidal flats and salt or brackish marshes. Interior to this coastal strip is a vast inland muskeg consisting of freshwater marshes, fens, bogs, swamps, peatlands, and some upland boreal forest on the better-drained areas of old beach ridges.

James Bay is basically an estuarine ecosystem, covering some 8000 km^2. The east coast between Cape Jones and Rupert extends for 410 km, while the west coast between Rupert and Cape Henrietta Maria extends for 390 km. Mean depth of the bay is only 28 m (Curtis et al. 1976), and a slow marine current carrying much suspended clay and silt moves in a counter-clockwise direction (Martini et al. 1980). The high input of fresh water from rivers and streams, especially during the spring runoff, leads to a greatly reduced salinity in nearshore waters. The climate is characterized by cool summers and cold winters (July mean $60^{\circ}F$, January mean $-5^{\circ}F$ in southern James Bay), and sea ice covers the coast and bay for approximately six months of the year, from mid November to mid May (Curtis et al. 1976).

Maximum ice cover on James Bay occurs in early spring and is complete except for persistent shore leads along sections of both the east and west coasts (Morrison and Gaston 1986). Some open water usually persists south of Akimiski Strait throughout winter. Air temperatures significantly affect the timing of ice freeze-up and break-up of both lakes and rivers around James Bay, and thus dates at which associated habitats become available or unavailable to birds (Morrison and Gaston 1986). In southern James Bay, lakes do not generally become ice-free until about 1 June, while freeze-over typically occurs in early November. Ice break-up on James Bay itself usually begins in mid May and is complete by mid June (Morrison and Gaston 1986; pers. obs.).

James Bay has been regarded as a sedimentary sump for the center of the continent, due to the combined processes of river inflow, inflow via marine currents from Hudson Bay, and reworking of nearshore bottom deposits due to the land's isostatic rebound (Kranck and Ruffman 1982). A variety of sedimentary deposits characterize James Bay. These range from piled accumulations of boulders and pebbles that form raised beach ridges, to thick silty deposits that develop in poorly-drained flats and marshes

(Martini et al. 1980). Intermediate to these are the wide sand flats that evolve in more protected areas and are typically associated with extensive landward coastal marshes. Storm waves, wind, local currents, scouring by ice, chemical weathering, and the physical and biochemical actions of organisms all modify these sediments and contribute to the rapidly evolving, geologically and ecologically dynamic nature of this coastline.

Vegetation and Plant Communities

The salinity regime exerts an important control on vegetation in the James Bay coastal marshes (Martini et al. 1980). Despite the brackish salinities of nearshore waters, soil salinities in the marsh can be elevated, due to evaporation following storm tides, leading to the development of true salt marsh vegetation. Typical vegetation of the western coastal marshes is characterized by four major plant communities (Martini et al. 1980): 1) the Salt Marsh, which receives frequent tidal inundations and ice scouring, and is dominated at its outer zone by the colonizing grass *Puccinellia phryganodes*, whose rhizomes serve as an important food source for geese; 2) a narrow Saline Meadow Marsh, better drained and receiving less regular tidal inputs, which is dominated by the rush *Juncus balticus*, the forb *Lathyrus palustris*, and the arrow grasses *Triglochin maritima* and *T. palustris*; 3) a poorly-drained Brackish Meadow Marsh, with year-round standing water in pools and soft, silty substrates, dominated by the sedges *Carex paleacea* and *Eleocharis palustris*; and 4) a Willow Thicket Freshwater Fen/Marsh, inundated only by the highest autumn storm surges and dominated by vegetation typical of freshwater wetlands, including willow (*Salix* spp.), several sedges (*Carex* spp.), and the cattail *Typha latifolia*. This most landward plant community is marked by an increasing accumulation of peat, and the fen ecosystem extends inland for many miles, evolving into the large bogs of the Hudson Bay Lowlands.

Invertebrate Fauna

The intertidal flats are most densely populated by *Macoma balthica*, a burrowing bivalve mollusc. This invertebrate is a major food resource for several shorebird species, which typically select *Macoma* on the basis of size classes (Martini et al. 1980). Densities of up to 7300 individuals/m^2 have been recorded at intermediate tidal levels. The gastropod *Hydrobia minuta* is also widely distributed in sandy and muddy substrates, at densities of up to 10,000 individuals/m^2, as well as in rocky intertidal zones. This species is also an important shorebird food resource, particularly for the smaller "peep" sandpipers, such as the Semipalmated Sandpiper (*Calidris pusilla*), White-rumped Sandpiper (*Calidris fuscicollis*), Least Sandpiper (*Calidris minutilla*), and Sanderling (*Calidris alba*) (Martini et al. 1980). Invertebrate prey at lower densities on the flats include oligochaete worms (*Paranais* sp.), and various amphipods, as well as polychaetes and other gastropods (*Littorina* spp.).

The principal infauna of the short grass (*Pucinellia phryganodes*) salt marsh are dipteran larvae and oligochaete worms, the former of which are a major food of small sandpipers (Morrison et al. 1982). Insects are also seasonally abundant members of the coastal marsh fauna and provide an important food source for shorebird species, and possibly ducks, inhabiting the short grass and brackish central marsh zones (Martini et al. 1980).

The various ecological relationships that characterize the unique and rapidly emerging James Bay coast are doubtless complex. It appears that patterns of sedimentation and vegetation are strongly affected by both physical and biotic processes. Tide and ice movements scour and redistribute sediments. Melting ice cover provides a major source of fresh water in spring and may provide important nutrients to spring phytoplankton communities (Freeman et al. 1982). Burrowing invertebrates and plants modify deposits by trapping and bioturbating sediments, and accumulating organic matter (Martini et al. 1980). Insects improve soil fertility in the marsh through litter decomposition, aeration, transfer of organic particles, and as major secondary producers (Martini et al. 1980). Migratory birds impact vegetation and sediments through probing on flats, tramping and digging for rhizomes in the marsh, and feeding in or moving to

and from marsh pools (Martini et al. 1980). Salinity regimes and circulation patterns in James Bay are strong influences on the development and maintenance of plant communities. Although an integrated understanding of the web of processes affecting the coastal ecology of James Bay is only just emerging, major changes in one parameter could potentially produce significant impacts on the entire system.

HISTORY OF ORNITHOLOGICAL WORK ON JAMES BAY

Prior to the 1970's, most of the avifaunal survey work in the James Bay region was of an exploratory, general nature, focusing on documentation of occurrence rather than on distribution and abundance. Manning (1952) chronicles the history of ornithological work prior to his classic study, from which the following synopsis is drawn.

The earliest records of James Bay birds date from collections made by officers of the Hudson's Bay Company in the late 1700's. Many of the reported specimens are no longer traceable or were of dubious geographic origin and, in some cases, identity. Most of these records cannot be substantiated. Several specimens in the U.S. National Museum were collected from James Bay (Preble 1902). W. Spreadborough appears to have been the first ornithologist to systematically survey James Bay, travelling up the east coast in 1896 and along the west coast to within about 20 miles of Cape Henrietta Maria in 1904 (Macoun and Macoun 1909). Todd (1943, 1963) made at least nine collecting trips to James Bay beginning in 1908, concentrating on the east coast. Lewis and Peters (1941) spent three weeks recording bird observations on both coasts in 1940. The Royal Ontario Museum sponsored five James Bay expeditions between 1939-48, and Smith (1944) investigated waterfowl distribution and abundance in 1943 and 1944. Hanson conducted detailed studies of Canada Geese (*Branta canadensis*) in 1946 and 1947. This species' nesting and population ecology in the region are now well documented (e.g. Hanson and Currie 1957; Hanson 1962; Raveling and Lumsden 1977). In 1947, 1949 and 1950 Manning (1952) documented the avifauna of the west James Bay coast through collecting and observation. He conducted a similar survey of the east coast between 26 June and 2 September, 1950 (Manning and Macpherson 1952). Several ornithological expeditions visited Cape Henrietta Maria, the only region of tundra on the west James Bay coast, between 1949-70 (summarized in Peck 1972).

These early, generalized inventories clearly established the importance of the James Bay coast as a staging and breeding habitat for many species of migratory birds. During the 1970's and 1980's, more intensive and systematic surveys were conducted as part of the multidisciplinary Hudson Bay Lowlands Project, in response to proposals for regional hydroelectric development. Studies by the Ontario Ministry of Natural Resources (O.M.N.R.) investigated distribution, abundance and habitat use by geese species (see references in Thomas and Prevett 1982). From 1976-79 the Canadian Wildlife Service (C.W.S.) undertook 16 aerial surveys to document duck populations along the Ontario coast of James Bay (Ross 1982). Waterfowl surveys were also conducted by C.W.S. along the east coast from 1971-75 (Curtis and Allen 1976). Between 1974 and 1982 a large-scale shorebird banding project, collecting data on over 60,000 birds, was carried out by C.W.S. at North Point on the southwest coast (51° 29'N, 80° 27'W; summary in Morrison et al. 1982). Between May and November 1982, C.W.S. personnel conducted an intensive avifaunal inventory of the area centered at North Point (Morrison et al. 1982; Rimmer unpubl. data). In October and November, 1981 and 1985, R.D. McRae collected distribution and abundance data on all birds observed at Netitishi (Nattabisha) Point and East Point, respectively (Goodwin 1982; McRae, unpubl. data).

In summary, waterfowl and shorebirds are the only adequately studied groups to date. Although further detailed studies are needed on habitat requirements, feeding ecology, and migration patterns of most species in these two groups, their distribution and abundance along the James Bay coast have generally been well documented. However, knowledge of other bird groups using James Bay is fragmentary at best. Particularly lacking is an understanding of the importance of James Bay coastal habitats to loons, wading birds (herons, cranes, and rails), gulls and terns, raptors (eagles, hawks, falcons, and owls), and passerines. Although intensive

studies of selected passerine species have been conducted at North Point (Rimmer 1986; unpublished data), much remains to be described on the migration patterns and ecology of this group. Virtually nothing is known about bird distribution in the offshore waters of James Bay.

WATERFOWL

Both the east and west coasts of James Bay are heavily used by geese and ducks, primarily as a major staging area during the annual migrations, secondarily for breeding and molting. Although the coastal marshes and intertidal flats of the Ontario coast appear to support the densest concentrations of migrant waterfowl (Thomas and Prevett 1982; Morrison and Gaston 1986), several critical areas exist on the east coast, particularly for spring migrants (Curtis and Allen 1976). Extensive eelgrass (Zostera marina) beds in many of the numerous bays north of Old Factory (Vieux Comptoir) appear to constitute the most important habitat resource for waterfowl on the east coast (Curtis and Allen 1976). The overall importance of James Bay to migratory waterfowl lies in the immense value of its feeding and resting habitats. In spring, several arctic and subarctic nesting species obtain food resources along both coasts that may be indispensable in acquiring the physiological condition necessary for successful reproduction. During fall, the productive coastal marshes and nearshore marine habitats provide energy-rich foods that enable birds to recover and augment fat reserves depleted during nesting, prior to the major phase of their fall migration.

Geese

Lesser Snow Goose (Anser c. caerulescens) — The ecology of this species on James Bay has been intensively studied, primarily on the west coast. Nesting occurs only at Cape Henrietta Maria, where a rapidly expanding colony has more than quadrupled since 1957 to approximately 55,000 pairs in 1979 (Thomas and Prevett 1982). Most James Bay Snow Geese belong to the Hudson Bay population, estimated at about 3 million birds in fall. The James Bay and southern Hudson Bay coastal zone is a staging area for this entire population during both spring and fall migrations (Thomas and Prevett 1982).

The majority of these geese typically arrive at James Bay during the first week of May, after a direct flight from the prairies of Manitoba and North Dakota (Bellrose 1976; Thomas and Prevett 1982). The phenology of ice break-up and weather conditions dictates the pattern of their staging, which ranges from a brief delay to up to three weeks. During spring aerial surveys in 1973 and 1974, Curtis (1976) estimated 1.65 million and 2.11 million Lesser Snow Geese, respectively, using a narrow zone of ice-free coastline. Geese feed intensively in melt ponds and exposed marsh, primarily on perennating bulbs and newly exposed shoots of arrowgrass (Triglochin palustris; Prevett et al. 1979). These plant organs concentrate nutrients and are highly digestible, and adults are able to increase body weight, accumulate muscle protein, and maintain fat reserves (Wypkema and Ankney 1979; Thomas and Prevett 1982). These increased reserves are important determinants of reproductive success, especially for females.

During the fall, Lesser Snow Geese from Baffin Island colonies migrate southwards along the east James Bay coast from Cape Jones, some birds crossing over to rich tidal marshes of the west coast (Bellrose 1976). Most of the Hudson Bay population concentrates in southern and western James Bay. Between late August and late October, more than 1.5 million birds congregate on the coastal marshes, during which time they are highly selective feeders (Prevett et al. 1979). Although up to 40 plant species are eaten, 9 species comprise 90% of the identifiable food items. As in spring, bulbs of arrowgrass predominate, followed by sedges (Cyperaceae), horsetails (Equisetaceae), and grasses (Gramineae). A progressive shift in diet occurs as fall advances, from green aerial parts to underground roots, rhizomes and bulbs. This dietary change parallels the progressive translocation of plant nutrients into root systems (Prevett et al. 1979).

The fat reserves of adult and juvenile Lesser Snow Geese at James Bay increase significantly during fall (Wypkema and Ankney 1979; Thomas and Prevett 1982). These authors conclude that the fall staging period in James Bay is essential for the continued structural growth of juveniles, and that increased fat reserves in all age-sex classes are necessary to complete the southward migration.

Thus, the James Bay coastal marshes play a vital role in the ecology of Lesser Snow Geese, with important implications for reproduction and the pattern of fall flight. It appears that the entire, near-continuous strip of salt marsh between Rupert Bay and Cape Henrietta Maria is critical, as data suggest progressive weight gains from north to south in fall (Thomas and Prevett 1982). Lesser Snow Geese on the east coast probably rely on fewer, but equally critical, staging areas, since their preferred feeding habitats are more discontinuous there. Deteriorations of James Bay coastal marshes that reduce productivity and availability of food resources could have significantly adverse impacts on populations of this species.

Canada Goose (Branta canadensis) — Two main races of Canada Geese use the James Bay coasts (Bellrose 1976). Large-bodied Canada Geese (B. c. interior) nest throughout the Hudson Bay Lowland, although principally in the interior fens, and winter in the mid-Atlantic, the Tennessee Valley, and the Mississippi Valley. The small-bodied subspecies (B. c. hutchinsii) passes through the Lowland in spring and fall en route between arctic breeding areas and wintering grounds in Kansas, Oklahoma, and Texas. An unknown number of giant Canada geese (B. c. interior) make a molt migration to the Lowland each summer from nesting areas in southern Ontario and the northern U.S. (Zicus 1981).

The James Bay coast is important to many Canada Goose populations during the spring and fall migrations. B. c. interior nesting in the Hudson Bay Lowlands normally arrive on the southern James Bay coast in mid April, congregating in areas of open water before dispersing to inland nesting areas (Thomas and Prevett 1982). Limited feeding occurs during this time, as fat and protein reserves are accumulated during migration stopovers further south. In years of late thaw, loss of reserves due to delayed inland dispersal may cause declines in breeding success, as well as expose birds to more extended hunting pressure (Thomas and Prevett 1982). The east coast of James Bay concentrates tens of thousands of Canada Geese in spring, as they migrate northwards to breeding areas in northern Quebec (Curtis and Allen 1976) and the larger islands of eastern James and Hudson Bay (Freeman 1970; Manning 1981). Birds congregate in areas of open water, at rivermouths, along the tide edge, in melt pools, and in coastal bays. Small Canada Geese also pass through western James Bay during spring en route to Baffin Island, although their numbers and distribution at this time of year are not well known (Thomas and Prevett 1982).

Both coastlines of James Bay are also important as staging areas for Canada Geese during the fall migration. Although fewer data are available on their distribution, abundance, and migration ecology than for Lesser Snow Geese, Canada Geese feed on a variety of marsh or upland coastal vegetation, as well as eel grass (Curtis and Allen 1976). The small-bodied race tends to be more marine in behavior and diet than the large-bodied race, often feeding on marine plants and their adhering molluscs (Thomas and Prevett 1982). B. c. hutchinsii again moves through James Bay during southward migration. Aerial surveys in the falls of 1979 and 1980 obtained counts of 48,500 and 38,100 small Canada Geese, respectively, on the west James Bay and southern Hudson Bay coasts. This could represent up to one third of the total population of this subspecies (Thomas and Prevett 1982). Approximately 28,000 large Canada Geese are harvested on the east coast each autumn (Curtis and Allen 1976), but total population estimates are not available.

Atlantic Brant (Branta bernicla hrota) — It is probable that 50% or more of the entire Atlantic population of this high arctic breeding goose pass through the Ontario and Quebec coasts of James Bay each year (Thomas and Prevett 1982). This species has enlisted special concern during the past 50 years, following a drastic population decline in the 1930's due to massive reductions in its principal food, eel grass, along the Atlantic coast. Populations have rebounded considerably but continue to fluctuate

with the vagaries of weather on their arctic breeding grounds (Bellrose 1976). High winter counts on the Atlantic seaboard between 1976-80 ranged from 48,000 (1976-77) to 115,000 (1978-79) (A. Reed, pers. comm.). Recent winter counts indicate a continued increase, with 127,000 and 146,000 Brant estimated in January of 1984 and 1985, respectively (Chandler 1986). However, habitat degradation and loss due to development on mid-Atlantic wintering coastal grounds have generated renewed concern for the future of Brant (Chandler 1986).

Brant are more closely associated with the marine environment than other geese, both during migration and on the breeding areas. Their distribution in James Bay very closely patterns that of eel grass, their preferred food, particularly in fall. During spring they also feed on Puccinellia phryganodes when persistent ice on intertidal flats and nearshore areas may preclude feeding on eel grass beds (Thomas and Prevett 1982; Morrison and Gaston 1986).

The spring migration northwards through James Bay occupies some two to three weeks in the latter half of May and early June (Curtis and Allen 1976; Rimmer, unpubl. data). Between 3-9 June 1978, 10-20,000 Brant frequented the upper tidal zone 25 km west of Cape Henrietta Maria (Thomas and Prevett 1982). On 22 May 1982, 13,000+ were observed migrating north low over the broken sea ice off North Point (Rimmer, unpubl. data), and many more may have been missed.

The fall migration of Brant through James Bay has been more fully documented. Birds arrive in late August, and numbers peak in mid to late October. In mid September of 1971, 60,000 were estimated along the east coast near Fort George (Bellrose 1976), and up to 10,000 have been counted in Dead Duck Bay alone (Curtis and Allen 1976). On the west coast, Lumsden observed 42,000 Brant near Ekwan Point on 19 and 20 October 1973 (Bellrose 1976), while McRae counted 28,000 at Netitishi Point on 20 October 1981 (Goodwin 1982). Large numbers of Brant are also known to congregate along the northwest shore of Akimiski Island (Thomas and Prevett 1982).

The James Bay coastline is clearly a vital component of Brant ecology.

Like Snow Geese, Brant rely heavily on stored nutrient reserves during reproduction (Vangilder et al. 1986). Spring weather conditions on the arctic nesting grounds can substantially influence Brant reproductive success. Although birds appear to accumulate fat reserves prior to departing wintering areas, additional reserves must be accumulated at staging areas like James Bay in order for the birds to reproduce successfully. Vangilder et al. (1986) suggest that Brant following an inland route northward to James Bay may critically depend on the Bay's resources to replenish depleted reserves and maintain adequate physiological condition for breeding. During fall, following the rigors of reproduction, Brant may again rely heavily on resources obtained at James Bay to recover body condition before crossing the expansive ecological barrier of boreal forest to their mid-Atlantic wintering areas. Perturbations affecting the overall ecology of eel grass in James Bay from altered salinities, sediment loads, or other factors might severely impact a large segment of the entire population of this highly specialized feeder. Further studies are needed on migration patterns, population turnover, feeding ecology, and physiological condition of Atlantic Brant on James Bay.

Dabbling Ducks

Many species of dabbling (surface-feeding) ducks breed in inland areas adjacent to James Bay and occur in large numbers on the coast during molting and migration periods. Distribution is strongly correlated with the amount of broad coastal marsh; along the entire Ontario coast of James Bay, the area between the Albany and Attawapiskat Rivers accounted for 50% of all dabbler distribution on aerial surveys between 1976 and 1979 (Ross 1984). Spring distribution is concentrated in southernmost James Bay, but numbers are relatively low, as migrants disperse rapidly northward. Concentrations build through summer, as fledglings and molters move to the broad marshes and brackish coastal ponds. With the approach of autumn, dabbling duck numbers increase dramatically in James Bay as migrants funnel down the Hudson-James Bay system, reaching peak densities in southern James Bay (Ross 1984). Although usage of James Bay by dabbling

ducks is well documented, less is known about habitat requirements, patterns and mechanisms of habitat selection, feeding ecology, and migration strategies for different age and sex classes of these duck populations.

Black Duck (*Anas rubripes*) -- The Black Duck is the most abundant and widely distributed dabbling duck on the James Bay coast (Curtis and Allen 1976; Ross 1982, 1984). Spring migrants and local breeders arrive in mid April, with numbers peaking in early to mid May. Most nesting occurs on bogs and fens adjacent to the shore and on some of the larger islands in James Bay (Curtis and Allen 1976). Thousands molt along the Quebec coast, particularly north of Paul Bay, where they feed on *Potamogeton filiformis* and other marsh aquatic plants. As fall staging begins, numbers increase through September, when Black Ducks feed extensively on exposed invertebrates of the intertidal flats, and occasionally in eel grass beds (Curtis and Allen 1976). On the west coast, peak fall concentrations reach 139 individuals/km between mid September and mid October, particularly around river mouths and estuaries (Ross 1984). McRae (unpubl. data) recorded 450 birds in offshore rafts from East Point on 11 October 1985. It appears that James Bay Black Ducks utilize a variety of coastal habitats for feeding, resting, and molting.

Northern Pintail (*Anas acuta*) -- The Northern Pintail appears to be the second most common dabbling duck at James Bay. During the spring it is the most abundant species along all sections of the west coast, its numbers peaking in the first half of May (Ross 1984). Nesting occurs in freshwater marshes adjacent to the coast (Curtis and Allen 1976; pers. obs.). Molting birds congregate in flocks of up to 300 or more, mostly on large brackish pools along the southern Hudson Bay coast (Ross 1984). During fall migration, Northern Pintails are the most abundant duck species at North Point, a peak of 2500+ having been recorded on 12 September 1982 (Rimmer, unpubl. data). Migrants are found mainly in salt water habitats such as mudflats, tidal pools, and brackish ponds, where they feed and rest.

Other Dabbling Duck Species -- In order of decreasing abundance, other principal dabbler species using James Bay include Green-winged Teal (Anas carolinensis), Mallard (Anas platyrynchos), and American Wigeon (Anas americana). These species all nest in marshes and fens along both coasts, and concentrate most heavily on staging areas during the fall migration. Green-winged Teal congregate on mudflats near stream and river mouths, as well as on brackish ponds and stream channels in the coastal marshes (Curtis and Allen 1976; Ross 1984). On 14 September 1978, 10,000 were observed at Chickney Point, just north of the Albany River. Mallards prefer more freshwater habitats such as coastal marsh pools and creeks (Curtis and Allen 1976; Ross 1984). Counts peak in southernmost James Bay during the second week of September (29.12 individuals/km; Ross 1984). Wigeon prefer the rich brackish habitat associated with stream mouths, including mudflats and Triglochin meadows. Several thousand were present in southernmost James Bay during the second week of October 1978 (Ross 1984), and McRae counted 750 Wigeon at Netitishi Point on 20 October 1981 (Goodwin 1982).

Diving Ducks

Several species of diving ducks migrate along the James Bay coastline to and from arctic and subarctic nesting areas. The spring migration is brief, as breeding birds appear to disperse rapidly northward (Ross 1982; pers. obs.). Autumn concentrations are much greater, and many flights may occur offshore, causing abundances to be underestimated. Scoters of all 3 species and Oldsquaw (Clangula hyemalis) form the most dense aggregations, with lesser numbers of scaup (Aythya spp.), Common Goldeneye (Bucephala clangula), King Eider (Somateria spectabilis), and mergansers (Mergus spp.) using the Bay as a staging area. The bay and sea ducks appear to feed on benthic molluscs and crustaceans within 1/2 km of shore, while mergansers appear to prey on fish in shallows near the tideline (pers. obs.). The food resources obtained in the staging and molting areas used by these various diving ducks may be patchily distributed (Ross 1982, 1983) and could be of critical importance in providing energy reserves for further movements to southern wintering areas.

Black Scoter (Melanitta nigra) -- The breeding distribution of Black Scoters in interior North America is poorly known. Bellrose (1976) suggests that large numbers may nest in the Hudson and James Bay Lowlands. Ross (1983) documented dense congregations of molting Black Scoters off the Ontario coast of James and southern Hudson Bays. An aerial photographic survey on 26 and 27 July 1977 recorded 88,700 male Black Scoters, 45,000 on James Bay and 43,700 on southern Hudson Bay. Ross reported an additional 19,500 molting Black Scoters from July and August 1974 surveys along the northeastern James Bay shore. Many of these birds appear to stage in southeastern James Bay, as evidenced by a mixed scoter flock, including many Black Scoters, estimated by C.W.S. personnel at 100,000 birds on 12 September 1971. The dense flocks of flightless molting males may be distributed in relation to the distribution of their benthic invertebrate food source (Ross 1982). This concentration of Black Scoters on James and southern Hudson Bays may represent a major proportion of the entire Atlantic coastal wintering population (Ross 1983). These molting areas may be critically important to Black Scoters during this especially vulnerable period of their annual cycle.

Oldsquaw (Clangula hyemalis) -- Although systematic waterfowl surveys by C.W.S. during summer and early fall have missed this late migrant, James Bay appears to be a very important fall corridor and staging area. A few Oldsquaws nest at Cape Henrietta Maria (Manning 1952; Peck 1972), Cape Jones (Todd 1963), and on several of the northern James Bay islands (Manning and Coates 1952). Although spring migration has not been documented, late autumn movements on James Bay are pronounced. Much of the fall migration appears to occur offshore, making abundance estimates inexact. At Netitishi Point between 13 October and 24 November 1981, Oldsquaw ranked second in overall abundance to Brant, with 33,000 recorded, the peak count 14,800 on 28 October (Goodwin 1982). Similar totals were recorded at East Point in 1985, with later peaks of 8,700 on 5 November, 8,300 on 8 November, and 8,100 on 9 November (McRae, unpubl. data). At North Point 1,000+ Oldsquaw were observed on 20 October 1982, with many additional flocks believed to be of this species migrating too far offshore for positive identification (Rimmer, unpubl. data). Bellrose (1976) suggests that an important corridor for Oldsquaw extends from James Bay to Lake Ontario, then to the U.S. Atlantic seaboard. No information exists on residence times of migrant Oldsquaw on James Bay or on their feeding or staging ecology, but James Bay would appear to be of primary importance to the autumn migration of this species.

SHOREBIRDS

Shorebirds are one of the most highly migratory groups of birds in the Western Hemisphere. Several species undertake annual round-trip journeys of some 20,000 km between high arctic breeding grounds and wintering areas in extreme southern South America. The west coast of James Bay has been identified as a staging area of critical international importance for several shorebird species during their migrations (Morrison and Harrington 1979; Morrison 1983). The highly productive tidal flats and salt marshes provide concentrated food resources that are essential in enabling migrant shorebirds to accumulate large fat reserves required to fuel subsequent non-stop legs of their migrations. These direct flights often cross inhospitable "ecological barriers" such as boreal forest or open ocean, where feeding and resting are not possible (Morrison and Harrington 1979; Martini et al. 1980; Morrison and Gaston 1986).

The distribution and ecology of shorebirds along the east James Bay coast are less well known. The Precambrian bedrock underlying this coast has resulted in much hillier terrain, with numerous headlands, bays, and small islands. Coastal marshes are less extensive. However, the sea remains relatively shallow, and many of the bays have considerable areas of intertidal flats which attract large numbers of shorebirds (Morrison and Gaston 1986). With rockier coastlines, species such as the Purple Sandpiper (Calidris maritima) and Ruddy Turnstone (Arenaria interpres) are more common than on the west coast (Todd 1963; Manning 1976).

Shorebird distribution in James Bay appears to be directly related to

the distribution of preferred habitat and food abundance (Morrison and Harringtron 1979; Morrison et al. 1982; Morrison and Gaston 1986). Resource partitioning on the basis of habitat and/or food type or size is apparent throughout the migrant shorebird community (Martini et al. 1980). The combination of habitat selectivity and food resource distribution leads to a remarkable concentration of some species in a restricted number of locations. For instance, in southern James Bay, 71% of the small "peep" sandpipers recorded on aerial surveys in July 1977 occurred in only 10% of the coast (Moose River to Big Piskwanish Point). The three most heavily used sections of the coast (Moose River to Big Piskwanish Point, Big Piskwanish Point to Longridge Point, Chickney Point to Big Willow River) accounted for 88% of the birds in only 18% of its length (Morrison 1983, 1984). Although these critical staging areas include a relatively small fraction of the entire James Bay coastline, the presence of long, undisturbed stretches of habitat contribute to making the area especially attractive to birds (Morrison and Harrington 1979). The open, straight nature of this western shoreline suggests that any major ecological perturbations might affect long sections of the coast (Morrison and Harrington 1979).

Semipalmated Sandpiper (Calidris pusilla) — The Semipalmated Sandpiper is the most numerous shorebird in eastern North America, where the upper Bay of Fundy concentrates several hundred thousand migrants each autumn (Morrison and Harrington 1979; Morrison 1984). The west coast of James Bay is a staging area of major importance as well, supporting upwards of 12,500 birds during single aerial surveys in July (Morrison and Harrington 1979). The main fall passage of adults generally occurs from mid July to mid August, with the bulk of juveniles moving through James Bay between early August and early September. Spring migration is less pronounced, as birds disperse rapidly to subarctic and arctic breeding grounds from Cape Henrietta and Cape Jones northwards (Godfrey 1986), some bypassing southern James Bay completely.

Many Semipalmated Sandpipers increase their weight by 15-20 grams (60-80% of total body weight) during their stay of up to three weeks at

James Bay (Morrison et al. 1982; Morrison 1984). From James Bay, the fall migration appears to fan out to staging areas along the Atlantic seaboard, including the Gulf of St. Lawrence, the Maritime Provinces, southeastern Massachusetts, and coastal New Jersey (Morrison 1983). Harrington and Morrison (1979) have shown that Semipalmated Sandpipers staging at James Bay are from central and eastern Canadian Arctic breeding populations.

Most Semipalmated Sandpipers feed on the short grass (Puccinellia phryganodes) salt marsh, where peak abundances of their preferred dipteran larvae prey occur in July (Martini et al. 1980; Morrison et al. 1982). A shift to the lower tidal flats during August coincides with a declining abundance of dipteran larvae and oligochaete worms in the Puccinellia salt marsh and increases of Macoma balthica, Hydrobia minuta, amphipods, and polychaete worms at lower tidal levels (Morrison et al. 1982). This sensitive response to the distribution of food resources appears to characterize a number of shorebird species at several geographic levels, including locally (across a marsh transect at a single site), over intermediate stretches of coastline (10-15 km), and over a much broader scale involving several hundred kilometers of coast (Morrison 1983, 1984).

Although Semipalmated Sandpipers appear to rely on other coastal estuaries, such as the Bay of Fundy, more heavily than on James Bay, the resources obtained on the James Bay west coast are of critical importance to those central and eastern arctic breeders that use them. The fat reserves accumulated at James Bay must carry the birds to further staging areas on the Atlantic seaboard. The restricted portions of the James Bay coast between Moose River and Big Willow River (see introduction to shorebirds section) that Semipalmated Sandpipers appear to depend upon for feeding and roosting are thus a vital link in the species' annual cycle.

Red Knot (Calidris canutus rufa) -- The Red Knot is a species of special concern to conservationists. Following drastic population reductions in the days of market hunting, the North American race of Red Knot has recovered considerably and may now number nearly 200,000 individuals (Harrington 1982). However, the species is considered

vulnerable, as Red Knot have specialized food and habitat requirements, occur in large concentrations in relatively few traditionally-used locations, and are sensitive to disturbance (Morrison and Harrington 1979; Harrington 1982).

James Bay is a staging area of major international significance for the Red Knot (Morrison and Harrington 1979; Morrison 1983, 1984). This subspecies breeds in the central Canadian Arctic and winters principally along the Argentine coast of South America. The northward migration takes birds from Delaware Bay, where over 95,000 Red Knot have been counted on spring aerial surveys, inland to James Bay, where a large passage occurs in late May (Morrison 1983, 1984). Most of these birds appear to move rapidly through James Bay en route to arctic breeding areas, stopping briefly if at all (Morrison et al. 1982). During the return migration, over 7,000 Red Knot have been counted on July aerial surveys of the Ontario coast of James and Hudson Bays, and up to 5000 and 2500 have been recorded during peak migration periods at Longridge Point and North Point, respectively, on the southwest James Bay coast (Morrison and Harrington 1979). Like Semipalmated Sandpipers, Red Knot concentrate in particular coastal zones, particularly those northern and southern areas of the west James Bay coast characterized by extensive sandflats (Morrison and Harrington 1979; Morrison et al. 1980). Some 40% of the birds occur on only 11% of the entire west coast, rising to 70% of the birds on 22% of the southern James Bay coast (Morrison 1983, 1984).

Most Red Knot utilize the lower intertidal zone, concentrating in areas with extensive sandflats, where they feed on medium to large size classes of their preferred prey, Macoma balthica (Martini et al. 1980; Morrison et al. 1982). During late summer and early fall, Red Knot often use the upper tidal flats near the Puccinella colonization zone, apparently in response to seasonal peak abundances of small Macoma in this area, as well as of Hydrobia minuta and amphipods (Morrison et al. 1982). High tide roosts are typically located on raised beach ridges, often tightly concentrating hundreds of birds (pers. obs.).

From James Bay, Red Knot appear to fly directly to a few critical staging areas on the eastern seaboard, with a handful of sites in Massachusets and New Jersey accounting for up to 90% of the total censused population in any given year (Morrison and Harrington 1979; Morrison 1983, 1984). The fat reserves accumulated through intensive feeding on the west coast of James Bay are thought to be directly responsible for enabling Red Knot to complete this non-stop leg of their long distance migration. The feeding ecology of James Bay Red Knot is intimately linked to the distribution and abundance of Macoma balthica, at least on the west coast. Any major disruptions to the ecology of Macoma balthica could significantly affect the migration, and hence survival, of North American Red Knot.

Hudsonian Godwit (Limosa haemastica) — The Hudsonian Godwit has a spectacular migration system, perhaps eclipsing that of any other North American shorebird (Morrison and Harrington 1979; Morrison 1983). As recently as 40 years ago, the species was believed to be on the verge of extinction, owing to its extreme scarcity in eastern North America. However, large numbers have since been recorded on James Bay. Hagar (1966) reported flocks of 3-4000 Hudsonian Godwits during peak migration periods on the west James Bay coast. In July 1976, 3646 were recorded during an aerial survey of the Ontario coast of James and Hudson Bays, and an estimated 10,000 godwits were discovered north of the Albany River in early September 1974 (Morrison and Harrington 1979; Morrison 1983, 1984). In marked contrast, maximum counts from all North American east coast survey sites in 1976 totalled only 202 birds (Morrison and Harrington 1979). Evidence strongly suggests that Hudsonian Godwits make a direct, non-stop, transoceanic flight from staging grounds on the west James Bay coast to South America, a distance of at least 4500 km (Hagar 1966; Morrison and Harrington 1979). The next area in which godwits appear in significant numbers is Argentina, although arrival and departure dates imply an intermediate staging area in northern South America (Morrison 1983, 1984).

Hudsonian Godwits utilize sandflats in the lower intertidal zone for feeding, where they prey almost exclusively on medium and large size classes of Macoma balthica (Martini et al. 1980; Morrison et al. 1982). The Puccinellia salt marsh is used extensively for roosting at high tide,

and some feeding occurs in ponds on the outer edge of this zone when lower intertidal flats are covered (Morrison et al. 1982). These rich food resources underlie the outstanding international importance of the west James Bay coast as an area in which Hudsonian Godwits accumulate the large fat reserves required to fuel their non-stop, transoceanic flight to South America. Major negative ecological perturbations to this critical staging area, particularly those affecting invertebrate food productivity, might threaten the entire breeding population of this species.

Dunlin (Calidris alpina) — Dunlin have the shortest migration of regular migrant shorebird species using the James Bay coast. They are also unique in that they undergo a complete molt of flight and body feathers at James Bay before continuing migration to wintering areas on the Atlantic and Gulf coasts of the U.S. (Morrison et al. 1982; Morrison 1984). This relatively short migration is thought to be significant in enabling Dunlin to molt prior to migrating.

Dunlin breed along the northwest coast of James Bay (Peck 1972; Godfrey 1986). They are the most abundant spring migrants on the southwest coast, with a peak of 2500+ recorded at North Point on 20 May 1982 (Morrison et al. 1982). The southward migration of adult Dunlin is the most protracted of any shorebird species on James Bay, due most likely to physiological and aerodynamic restrictions imposed by their molt. Birds begin to arrive in mid July, and some individuals may remain through at least August (Morrison et al. 1982; pers. obs.). Adult numbers at North Point peaked at 1000 on 25 August 1982, at about the same time that juveniles started to appear. Overall Dunlin numbers at North Point peaked at 8000+ on 19 September of that year, with large concentrations present through October (7500+ on 1 October, 6000+ on 28 October) (Morrison et al. 1982).

Dunlin utilize several habitats on the west coast of James Bay, varying to some extent with time of year (Martini et al. 1980; Morrison et al. 1982). Most spring migrants use the Puccinellia marsh for feeding, and to a lesser degree the Triglochin meadows of the mid marsh. In summer and autumn, sandy and rocky substrates of the lower intertidal zone are preferred, with small size classes of Macoma balthica and some amphipods taken. In October heavy use is also made of mid and upper tidal flats, where seasonal peaks in abundance of small Macoma, as well as of Hydrobia minuta and amphipods, occur.

The significance of James Bay to Dunlin lies primarily in its use as a molting area where birds can acquire sufficient resources both to replenish energy reserves depleted during nesting and to meet the increased energetic demands of molt. It is likely that Dunlin accumulate fat reserves during the late stages of molt, enabling them to continue on to their eastern seaboard wintering grounds.

Eskimo Curlew (Numenius borealis) — The endangered Eskimo Curlew, considered to be on the verge of extinction for many years, may use the west coast of James Bay as a principal part of its migration route. Two were sighted at North Point on 15 August 1976 (Hagar and Anderson 1977), one of extremely few records in recent years (Godfrey 1986). If this species does still exist, James Bay may represent a critical staging area for its continued survival.

Other Shorebird Species — A number of other shorebird species use the productive coastal marshes and tidal flats of the west James Bay coast as staging areas during migration. Individuals of these species may rely on resources obtained at James Bay to fuel their migrations (Martini et al. 1980; Morrison 1984). However, it appears from the available data that whole populations of these species may be less critically dependent on the James Bay ecosystem than those shorebird species discussed above. Other prominent shorebird species using western James Bay include the Black-bellied Plover (Pluvialis squatarola), Lesser Golden-Plover (Pluvialis dominica), Semipalmated Plover (Charadrius semipalmatus), Marbled Godwit (Limosa fedoa), Whimbrel (Numenius phaeopus), Greater Yellowlegs (Tringa melanoleuca), Lesser Yellowlegs (Tringa flavipes), Ruddy Turnstone, Sanderling, Least Sandpiper, White-rumped Sandpiper, Pectoral Sandpiper (Calidris melanotos), and Common Snipe (Gallinago gallinago)

(Martini et al. 1980; Morrison 1984).

RAPTORS

Little is known about the use of James Bay coastal habitats by raptors. No studies have specifically focused on distribution, abundance, or ecology of James Bay raptors. However, enough data have been collected during avifaunal survey work to enable a preliminary assessment of the importance of James Bay to several migrant raptor species.

Northern Harrier (Circus cyaneus) — Northern Harriers breed along both coasts of James Bay (Godfrey 1986), but are apparently much more common along the expansive salt marshes of the west coast (Manning 1952; Manning and Macpherson 1952). Although few data exist on distribution and abundance of migrants, Rimmer (unpubl. data) recorded small numbers of Northern Harriers passing North Point almost daily during May, September, and October of 1982. It is probable that the west James Bay coast is a major corridor for spring and fall migrations of subarctic breeding populations of this raptor. Migrant Northern Harriers presumably prey on marsh-dwelling populations of small mammals and passerine birds. More detailed studies are needed to determine the migratory status and ecological requirements of this species at James Bay. Northern Harriers appear to be declining in parts of their North American breeding range and may be sensitive indicators of environmental change.

Northern Goshawk (Accipiter gentilis) -- This woodland hawk breeds north to the treeline in Ontario and Quebec (Godfrey 1986). Its fall migration appears to be concentrated along the west James Bay coast, where it hunts prey as large as Snowshoe Hare (Lepus americanus) and Sharp-tailed Grouse (Pedioecetes phasianellus) in the thickets and mixed woodlands adjacent to the coastal marshes. Rimmer (unpubl. data) recorded at least 37 individuals at North Point between 28 September-31 October 1982, with 13-14 observed on 27 October. McRae recorded a peak count of 12 Northern Goshawks at Netitishi Point on 1 November 1981 (Goodwin 1982). This species is not abundant anywhere in North America, and the west coast of James Bay may represent an important corridor in autumn. No information is available on Northern Goshawk movements along the east James Bay coast.

Rough-legged hawk (Buteo lagopus) -- This arctic and subarctic breeder nests at Cape Henrietta Maria and along the northeast coast of James Bay (Godfrey 1986). Large numbers have been recorded on the southwest coast during both spring and fall migrations. At North Point a conservative count of 315 Rough-legged Hawks was recorded between 1-20 May 1982, with 250+ on 7 May (Rimmer, unpubl. data). McRae (unpubl.data) observed 1112 individuals at East Point between 9 October-14 November 1985, the high count being 306 on 26 October. Only 61 were recorded at North Point during the fall of 1982 (Rimmer, unpubl. data), suggesting that Rough-legged Hawks may be irruptive migrants on the James Bay coast. Small mammal populations, known for their cyclic nature in northern breeding areas, probably dictate these movements. Rough-legged Hawks routinely hunt over the southwest coastal marshes during spring and fall. Prey obtained in spring may be critical in determining adult reproductive condition upon arrival on breeding grounds to the north. Prey resources in autumn may be important in maintaining the physiological condition necessary to reach suitable wintering habitats south of James Bay.

Peregrine Falcon (Falco peregrinus) -- The arctic-breeding tundrius subspecies of Peregrine Falcon is a fairly common spring and fall migrant along the southwest coast of James Bay. Peregrines migrate over the salt marshes, beach ridges, and intertidal flats, preying on migrant flocks of shorebirds and passerines. At North Point 16 were observed between 16-30 May 1982, and 33 were recorded on the return flight in late September and October of that year (Rimmer, unpubl. data). McRae (unpubl. data) recorded 15 Peregrine Falcons at East Point from 10-20 October 1985. The prey base of migrant shorebirds and passerines on the west James Bay coast may be an

important component in the spring and fall migrations of central arctic breeding populations of Peregrine Falcons.

Gyrfalcon (Falco rusticolus) -- This arctic breeder regularly migrates along the southwest James Bay coast in autumn. Some birds may attempt to overwinter, depending on prey availability. No Gyrfalcons have been recorded in spring, a possible indication that they move north before May. Fall migrants appear in mid October and have been observed pursuing Brant and other waterfowl along the tide edge. Rimmer (unpubl. data) observed 10 Gyrfalcons at North Point between 16-31 October 1982. McRae recorded 29 individuals at Netitishi Point between 20 October-20 November 1981 (Goodwin 1982), and 17 at East Point between 19 October-12 November 1985, including 7 birds on 9 November (unpubl. data). These concentrations may be the largest on record in North America for Gyrfalcons during migration, dramatizing the probable importance of James Bay as a staging and possible wintering area for the species.

Snowy Owl (Nyctea scandiaca) -- The status of Snowy Owls on the James Bay coast is not well documented, largely because observers have not been present during periods of their probable greatest abundance. The fall and winter movements of Snowy Owls are irregular in North America and dictated by population cycles of arctic lemming species, their staple prey items. During fall of 1981, McRae (unpubl. data) recorded 39 sightings of Snowy Owls at Netitishi Point, including 7 individuals on 12 November. At East Point in 1985, he did not observe a single bird (pers. comm.). At North Point, 2 Snowy Owls were seen on 31 October 1982, the last day of field observations that year. During spring of 1982, the only North Point record was of a single bird on 1 May, the first full day of field observations (Rimmer, unpubl. data). It is probable that in years of pronounced southward movement by Snowy Owls, the James Bay coast provides important hunting habitat, and possibly supports a wintering population as well.

PASSERINES

Few data are available on the ecology of passerine birds at James Bay. Existing published information has not prompted the identification by conservationists of any passerine species as being of special concern, due to dependence on James Bay's coastal resources. However, a review of unpublished data suggests that James Bay may play an important role in the ecology of several migrant passerine species.

Migrant Species

A number of passerine species breeding exclusively or predominantly to the north of or inland from James Bay stage in the southwestern coastal marshes and willow-alder thickets during migration (Rimmer, unpubl. data). Ground-dwelling, open-country species appear to use these habitats most heavily and may be dependent on food resources gained there to fuel subsequent legs of their migrations. Large tracts of suitable habitat are generally not available to these species for several hundred kilometers in any southward direction. Data exist only on distribution and abundance of these migrant passerines at James Bay. Further information is needed on habitat use, feeding ecology, population turnover, and overall migration strategies for these migrant populations.

Snow Bunting (Plectrophenax nivalis) -- This arctic breeder is an abundant migrant in drier portions of the west coast salt marshes. At North Point a flock of 2500-3000 Snow Buntings on exposed patches of the still-frozen marsh on 30 April 1982 migrated north with a warm front that night. Only 425 were seen the following day, and numbers steadily declined through late May (Rimmer, unpubl. data). Observations have not been recorded in any year before 30 April, and it is quite possible that peak concentrations of Snow Buntings typically precede that date. This species may well depend on seeds from the earliest exposed marsh plants to

replenish energy reserves depleted en route from its wintering areas to James Bay. Fewer Snow Buntings have been recorded in fall, probably in part because migrants are not concentrated on specific sections of the marsh as in spring. Peak counts are 825 on 21 October 1982 at North Point (Rimmer, unpubl. data) and 820 at East Point on 26 October 1985 (McRae, unpubl. data). The abundant food resources (herbaceous plant seeds) available during autumn may be critical in enabling Snow Buntings to continue their migration to open coastal or inland habitats far south of James Bay.

Lapland Longspur (Calcarius lapponicus) -- This species nests at Cape Henrietta Maria and along the northeastern edge of James Bay (Godfrey 1986). It is a very common spring and fall migrant on the southwest coast, often associating in mixed flocks of Snow Buntings and Horned Larks (Eremophila alpestris). Spring migration peaks in the latter half of May, with 800 recorded on 17 May 1982 at North Point (Rimmer, unpubl. data). Fall flights appear to be less pronounced, probably due to wider dispersal over the entire coastal marsh than in spring, causing underestimates of abundance. Peak autumn counts are 450+ on 24 September at North Point (Rimmer, unpubl. data) and 240 at East Point on 10 October 1985 (McRae, unpubl. data). Peck (1972) considered this species an abundant breeder at Cape Henrietta Maria. Given its broad arctic and subarctic breeding range, it is somewhat surprising that larger concentrations have not been recorded on the southern James Bay coast. Some Lapland Longspurs may stage further north than southwest James Bay. It is likely that James Bay migrants depend on food resources in the coastal marshes to carry them to wintering areas.

Horned Lark (Eremophila alpestris) -- Horned Larks breed in small numbers along both coasts of James Bay (Godfrey 1986). On the southwest coastal marshes and beach ridges they are very common spring and fall migrants, often associating with Lapland Longspurs and Snow Buntings. Spring migration peaks during the third week of May, the high count at North Point being 325+ on 22 May 1982 (Rimmer, unpubl. data). Peak fall concentrations at North Point occur during the second half of September, with 800 recorded on 22 September 1982 (Rimmer, unpubl. data). Like the previous two species, Horned Larks probably rely on the abundant seed production of marsh vegetation to accumulate fat reserves that fuel both spring and fall migrations.

White-crowned Sparrow (Zonotrichia leucophrys) — The southwest James Bay coast appears to be a very important spring staging area for both the leucophrys and gambelii races of this species. Although White-crowned Sparrows have not been documented as breeders in the area around North Point, they nest commonly northward from at least Fort Albany on the west coast (Manning 1952) and Paint Hills (Wemindji) on the east coast (Manning and Macpherson 1952). From 10-25 May 1982 this species was abundant at North Point along the interior edge of the salt marsh in willow-alder thickets. Several daily counts of 75-100 individuals were recorded, and 157 were banded, 134 leucophrys and 23 gambelii (Rimmer, unpubl. data). Many individuals remained at North Point for a week or more, during which time they steadily accumulated subcutaneous body fat and gained weight. Snow cover and weather conditions on their northern breeding grounds are unpredictable and may be severe at this time of year. The energy reserves stored at southern James Bay staging areas may be indispensable to White-crowned Sparrows, both in replenishing reserves depleted on earlier legs of their migration and in preparing them physiologically to cope with potentially harsh conditions further north.

Common Redpoll (Carduelis flammea) -- This species is a regular breeder along the James Bay coast, although its numbers appear to fluctuate annually. It is well known as an irruptive migrant, the extent of its southward movements in winter being largely dictated by variations in conifer seed crops. Common Redpolls can be exceedingly abundant on the southwest James Bay coast in autumn and are frequently seen either in migrating flocks or in willow-alder thickets along the interior salt marsh edge, where they feed on seeds of the cones of these deciduous shrubs. McRae (unpubl. data) recorded over 20,050 Common Redpolls at East Point between 9 October-14 November 1985, and daily counts of 250 were common at North Point during October 1982 (Rimmer, unpubl. data). Common Redpolls may

be less dependent on food resources from the coastal habitats of James Bay than the preceding passerine species, since they are capable of foraging on seeds from the more widely dispersed inland conifer trees. However, in years of poor conifer seed production, Common Redpolls may rely heavily on seed crops in the narrow coastal willow-alder band, either to fuel their migrations or as a winter food source.

Breeding Species

In addition to concentrating many species of passerines during both spring and fall migrations, the coastal marshes and thickets of James Bay support a diverse breeding passerine fauna. Many species nesting largely to the south reach their northern limits along the James Bay coast. Examples of the more abundant species in this category include Least Flycatcher (Empidonax minimus), Red-eyed Vireo (Vireo olivaceus), Philadelphia Vireo (Vireo philadelphicus), Black-and-white Warbler (Mniotilta varia), Ovenbird (Seiurus aurocapillus), Common Yellowthroat (Geothlypis trichas), and American Redstart (Setophaga ruticilla). These species all nest in the willow-alder thickets or balsam poplar (Populus balsamifera) stands immediately interior to the coastal marshes (Rimmer, unpubl. data). All are long-distance migrants; most winter in the neotropics. James Bay probably represents an ecologically marginal area for breeding populations of these species, since it lies at the northern periphery of their range.

SUMMARY AND CONCLUSIONS

A review of available literature and unpublished data strongly supports the assertion that large sections of the James Bay coast are of critical importance in the annual cycles of many migratory bird species. The significance of this unique ecosystem for migratory bird populations lies in its use as a staging area where seasonally abundant vegetational and invertebrate food resources are converted to fat and protein reserves.

These energetic stores are essential as fuel supplies, both to enable long, non-stop flights over broad ecological barriers to subsequent migration stopovers in fall, and to permit maintenance of body condition necessary for successful reproduction on subarctic and arctic breeding areas in spring. The major international importance of James Bay is underscored by the fact that large numbers of discrete populations of Lesser Snow Geese, Atlantic Brant, Red Knot, and Hudsonian Godwit use specific sections of the James Bay coast during spring and fall migrations. Significant ecological disruptions to this vital link in the annual cycle of these and other species could have far-reaching, adverse consequences.

At the present time, the coast of James Bay appears to have been little affected by man. Moreover, there is no documentation in the literature reviewed here that any human development to date has had a significant adverse effect on migratory bird populations using James Bay.

Within the limited scope of this literature review alone, it is not possible to predict specific impacts on one part of the complex James Bay ecosystem caused by changes in another. Baseline data have been collected on many aspects of James Bay's oceanography, geology, and ecology, but an integrated approach to understanding the factors that influence current distributions of sediments, vegetation, invertebrates, and vertebrates has yet to be developed. The literature reviewed here reveals gaps in knowledge of macro- and microhabitat requirements, mechanisms of habitat selection, diets and feeding ecology, population turnover, distribution of age and sex classes, local movement patterns, physiological condition during stopovers, and the relation of these to overall migration strategies.

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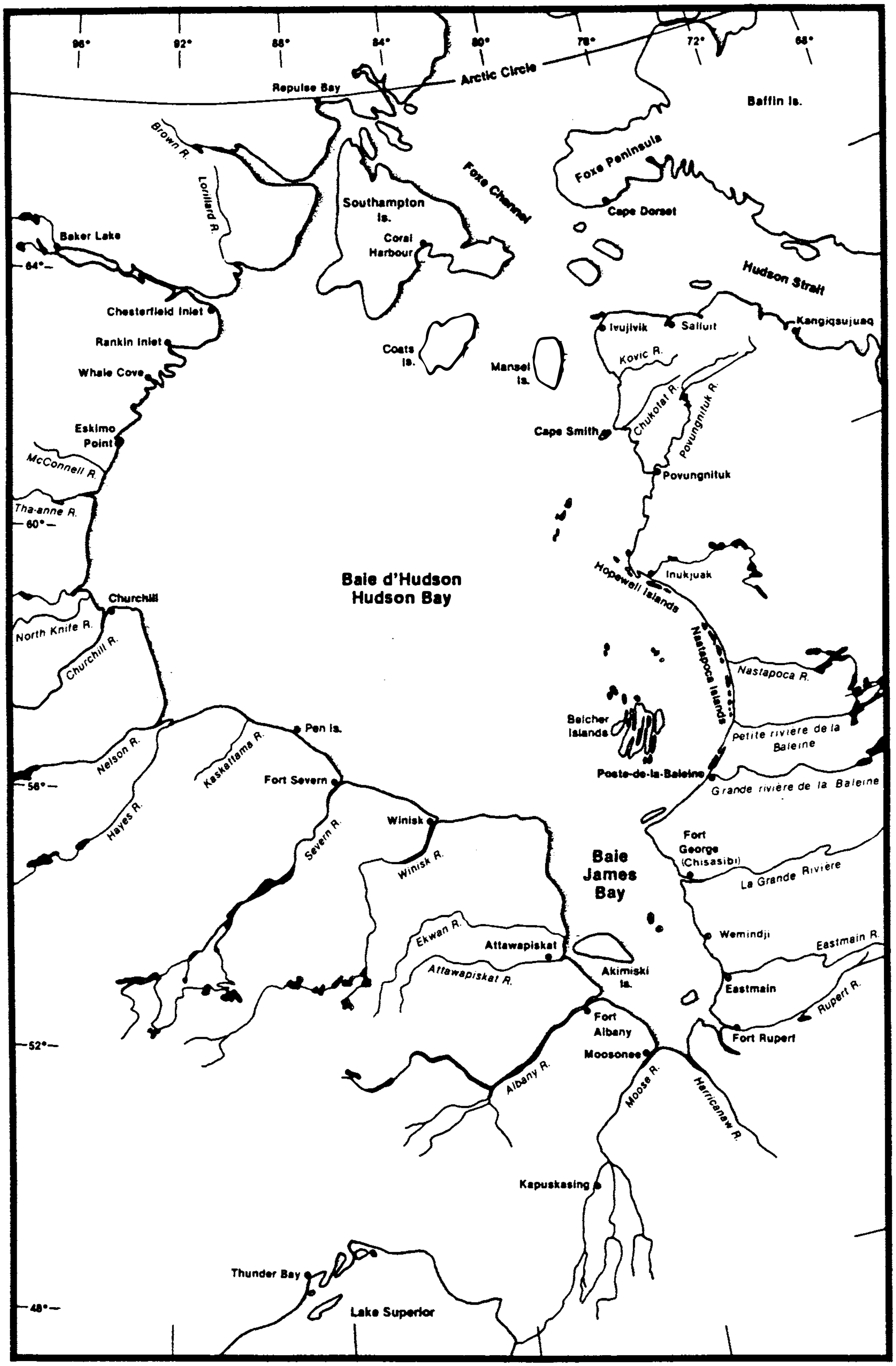
96°
92°
88°
84°
80°
76°
72°
68°
Arctic Circle
Repulse Bay
Baffin Is.
Brown R.
Lorillard R.
Southampton Is.
Coral Harbour
Foxe Channel
Foxe Peninsula
Cape Dorset
Hudson Strait
Baker Lake
64°
Chesterfield Inlet
Rankin Inlet
Whale Cove
Coats Is.
Mansel Is.
Ivujivik
Salluit
Kangiqsujuaq
Kovic R.
Chukotat R.
Povungnituk R.
Cape Smith
Povungnituk
Eskimo Point
McConnell R.
Tha-anne R.
60°
Baie d'Hudson
Hudson Bay
Churchill
North Knife R.
Churchill R.
Inukjuak
Hopewell Islands
Nastapoca Islands
Nastapoca R.
Belcher Islands
Petite rivière de la Baleine
Poste-de-la-Baleine
Grande rivière de la Baleine
Nelson R.
Kaskattama R.
Pen Is.
Fort Severn
56°
Hayes R.
Severn R.
Winisk
Winisk R.
Fort George (Chisasibi)
Baie James Bay
La Grande Rivière
Ekwan R.
Attawapiskat
Attawapiskat R.
Wemindji
Eastmain R.
Akimiski Is.
Eastmain
Rupert R.
Fort Albany
Fort Rupert
52°
Moosonee
Albany R.
Moose R.
Harricanaw R.
Kapuskasing
Thunder Bay
Lake Superior
48°

APPENDIX D. U.S. ARMY CORPS OF ENGINEERS REVIEW FOR APPLICABILITY OF SECTION 404(b)(1) GUIDELINES

APPENDIX D. U.S. ARMY CORPS OF ENGINEERS REVIEW FOR APPLICABILITY OF SECTION 404(b)(1) GUIDELINES

Additional power purchase by New England Power Pool would necessitate the construction of new facilities to transmit electricity to load centers in central New England. The proposed route would involve construction of 185 miles of transmission lines in New Hampshire and Massachusetts.

The following is an assessment of anticipated environmental impacts associated with fill activities in the proposed project for applicability of Section 404(b)(1) guidelines.

D.1 IMPACTS ON PHYSICAL/CHEMICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM

The project would:

(x) change the physical and chemical characteristics of the substance.
(x) change the substrate elevation or contours.
(x) cause erosion, slumping, or lateral displacement of the surrounding substrate.
(x) change water fluctuations.

These changes would affect:

(x) currents, circulation, or drainage patterns.
(x) suspended particulates and turbidity.

These changes would, in turn, affect:

(x) water quality (clarity, odor, color, taste, D.O. levels, nutrient levels, toxins, pathogens, viruses, etc.).
(x) water temperatures.
( ) salinity gradients.
( ) thermal stratification.

Exact locations for transmission structures have not been determined but, where possible, support structures will be placed outside of wetlands. However, placement of fill for some structures within wetlands is unavoidable. It is estimated that a total of 88 wetlands would be affected by new structural placement, existing structure removal, and/or forest clearing. This includes 33 wetlands in New Hampshire (ER, Vol. 8--Table III-6) and 55 wetlands in Massachusetts (ER, Vol. 7--Table III-6). Fill for new structures and access roads would cause, at the most, long-term loss of 19 acres of wetlands; 8 acres in Massachusetts (ER, Vol. 7--Table III-7) and 11 acres in New Hampshire (ER, Vol. 8--Table III-7).

Wetland impacts can be effected by clearing of vegetation, construction and improvement of access roads by filling, use of heavy machinery, and installation of structures. The potential effects resulting from these activities include disruption of drainage patterns, erosion and siltation, habitat destruction, changes in water temperature, increased public access, wildlife displacement, water level modification, and addition of chemicals. Swampy wetlands would be impacted more by long-term changes in water quality and water level, whereas marshy wetlands could be impacted by short-term modification (Darnell 1976). Fluctuations in water level might also be detrimental to vegetation located adjacent to wetlands (Boelter and Clare 1974). While emplacement of tower bases would result in the loss of some wetland habitat, they might prove to be preferred habitat for nesting waterfowl and calving deer (Thorsell 1976). Because the area of wetlands impacted by the project would be small relative to the total wetland area occurring in the vicinity of the Massachusetts/New Hampshire sites, the overall impacts to wetland habitat would not be of sufficient magnitude to cause localized extinction of any species. Additionally, the habitat that would be affected is not unique to the area. Impacts to wetland habitat would also be minimal because the majority of wetlands would be spanned, and construction activities (e.g., structure placement) would be minimized within these wetland areas.

Minimal disruption and filling of wetlands will take place and best management practices where filling and construction does occur will be imposed.

D.2 IMPACTS ON SPECIAL AQUATIC SITES

The changes presented in Section D.1 would occur in:

( ) sanctuaries and/or refuges.
(x) wetlands.
( ) mudflats.
( ) vegetated shallows.
( ) coral reefs.
( ) riffle and pool areas.

The special aquatic site provides benefits including:

(x) flood control.
(x) water purification.
(x) food chain production and nutrient export.
( ) storm, wave, and erosion buffers.
( ) aquifer recharge.
(x) habitat for fish and other aquatic organisms.
(x) wildlife habitat.

The wetlands in New Hampshire (ER, Vol. 8--Table III-1) and Massachusetts (ER, Vol. 7--Table III-1) were delimited using Corps of Engineers' criteria and classified using the U.S. Fish and Wildlife Service classification designation. To further assist in delineation, the U.S. Fish and Wildlife Service wetland inventory maps were screened. In addition, these wetland areas and the surface waters within the right-of-way were field checked.

In all cases the wetlands crossed are palustrine wetlands. The amount of wetland acreage within the right-of-way ranges from 0.1 acre of hardwood forest in Medway, Massachusetts, to 13.5 acres of palustrine scrub-shrub/emergent wetlands in Milford, Massachusetts.

The wetlands in the vicinity of the proposed route are dominated by diverse types of vegetation such as emergent vegetation, scrub/shrub vegetation, and forested vegetation.

Wetlands dominated by emergent vegetation (e.g., wet meadow and ponds) are basically wet grasslands containing plant species adapted to submerged soils (Darnell 1976). These habitats usually contain zoned gradations of plant species as follows (from shallow to deeper water): (1) emergent plants (e.g., reeds, cattails, bulrushes, sawgrasses, sedges, and arrowheads), (2) floating leafy plants (e.g., water lilies, pond lilies, smartweeds, spatterdocks, and some pondweeds), and (3) submerged plants (e.g., waterweeds, some pondweeds, muskgrasses, milfoils, coontails, bladderworts, hornworts, and buttercups) (Darnell 1976). Based on acreage of wetland types along the proposed route, about 32% of the wetlands contain predominantly emergent vegetation (ER, Vol. 7--Table III-2, Vol. 8--Table III-2).

Scrub/shrub wetlands or swamps are areas dominated by woody vegetation less than 6 m (20 ft) tall, including true shrubs, young trees, and trees and shrubs that are small or stunted due to environmental conditions (Cowardin et al. 1979). Dominant woody species include alder, willow, blueberry, sumac, winterberry, steeplebrush, sweet pepperbush, buttonbrush, red osier dogwood, spirea, labrador tea, bog rosemary, bog laurel, leatherleaf, and young trees of species such as red maple and black spruce. Sensitive fern and sedges are predominant herbaceous species (Cowardin et al. 1979; ER, Vols. 7 and 8). About 12% by area of the wetlands along the proposed route contains a predominant scrub/shrub vegetation community. About 51% of the wetlands contains a combination of emergent and scrub/shrub wetlands (ER, Vol. 7--Table III-2, Vol. 8--Table III-2).

The forested wetlands or swamps are dominated by living or dead trees that are at least 6 m (20 ft) tall. In the study area, forested wetlands are typically dominated by red maple, with black ash and grey birch also present. Coniferous species, which are less common, include larch, black spruce, Atlantic white cedar, and white pine (ER, Vols. 7 and 8). Shrub and herbaceous layers are dominated by the species common in the scrub/shrub wetlands. The presence of forested wetlands dominated by dead trees results from construction of man-made impoundments and beaver ponds, fire pollution, or insect infestation (e.g., spruce budworm outbreaks) (Cowardin et al. 1979). Only about 5% of the wetlands along the proposed route contains a forested component (ER, Vol. 7--Table III-2, Vol. 8--Table III-2).

D.3 IMPACTS ON BIOLOGICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM

The changes in Sections D.1 and D.2 would adversely impact:

- ( ) endangered or threatened species, or critical habitat for such.
- (x) fish, mollusks, or other aquatic organisms through:
  - ( ) removal.
  - ( ) temporary displacement.
  - (x) permanent displacement or lowered numbers through changes in overall suitability of habitat in terms of substrate, temperature, water quality, etc.
  - ( ) interfering with spawning migrations.
- (x) other wildlife in terms of:
  - (x) breeding and nesting habitat.
  - (x) escape cover.
  - ( ) travel corridors.
  - (x) food supplies.
  - ( ) competition from nuisance species.
  - ( ) reduced plant species diversity and interspersion of habitat types.

The emergent and pond wetlands contain a diverse and productive fauna, including various species of aquatic and terrestrial invertebrates, fishes, amphibians, and reptiles. The wetlands provide important nesting, brooding, feeding, migratory stopover, and overwintering habitat for waterfowl and shorebirds (Darnell 1976). They also provide habitat for such mammals as muskrat, short-tailed shrew, star nosed mole, eastern cottontail rabbit, beaver, meadow vole, and red fox (Godin 1977).

Animal life in scrub/shrub and forested wetlands is similar to that for marshy wetlands, but includes a more diverse bird and mammal species assemblage because of the increased habitat and food resources provided by understory and canopy vegetation. Waterfowl and shorebirds found in the marshy wetlands also frequent swampy wetlands; also present are such species as arboreal songbirds, birds of prey, and woodpeckers. Large mammals, such as white-tailed deer, occur in swampy wetlands, as do many smaller mammals such as mice, voles, squirrels, shrews, weasels, otters, lemmings, and bats (Godin 1977).

D.4 IMPACTS ON HUMAN USES

The impacts in Sections D.1, D.2, and D.3 would adversely affect human uses of the resources, through degradation of:

( ) existing or potential water supplies.
( ) recreational or commercial fisheries.
( ) other water-related recreational use.
(x) aesthetics of the aquatic ecosystem.
( ) parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves.

Transmission structures and access roads may change the aesthetics of the wetlands that are altered by filling and temporary disruption of native vegetation. Disturbed areas may be revegetated to lessen aesthetic concerns.

D.5 OTHER CONCERNS

The proposal will impact:

( ) energy consumption or generation.
( ) navigation.
( ) air quality.
( ) historic resources.
(x) noise.
( ) land use classification.

During construction activities, noise from equipment may displace animals. Following the completion of work, however, habitat use should return to normal.

D.6 EVALUATION AND TESTING OF FILL MATERIAL

(x) The project will use fill from a clean upland source. Therefore, no further evaluation under this section is necessary.

( ) The applicant proposes to discharge dredged material or use fill from other than a clean upland source. The following is an evaluation of the need for testing, testing performed, and evaluation of results.

D.7 REFERENCES FOR APPENDIX D

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APPENDIX E. LETTERS OF CONSULTATION

Massachusetts Natural Heritage Program

RECEIVED
MAIN
MAY 23 1984
Refer to ________

May 21, 1984

Leo T. Sicuranza
Charles T. Main, Inc.
Planning and Scientific Services
Prudential Center
Boston, MA 02199

Re: N.E. Power Co. transmission lines

Dear Mr. Sicuranza;

Thank you for consulting the Massachusetts Natural Heritage Program about the New England Power Company's proposed transmission line through nineteen Massachusetts towns in Middlesex, Essex, and Worcester Counties. Our staff has reviewed the routes marked on the U.S.G.S. quadrangle map copies, which you provided, for occurrences of rare plant and animal species populations or significant natural communities which should be considered in planning work in these areas.

As we discussed, the MNHP is presently aware of occurrences for three rare animal species and one rare plant species along the routes. These are marked on the enclosed maps, with details given about the species in the following table. Specific locations of current rare species populations should not be publicized to prevent inadvertent damage to their habitats through visiting or collecting. Occurrences since 1978 are considered current.

Quadrangle	Species, date	habitat	rarity, comments
Ayer, MA	Climbing Fern, 1980 and No date (*Lygodium palmatum*)	Semi-open edges of woods and streams	Threatened in Mass.
Nashua South, N.H. (Tyngsboro)	Southern Bog Lemming, 1976 (*Synaptomys cooperi*)	Sphagnum bogs, sedge meadows, less commonly in orchards, open grasslands	Endangered in Mass.
Holliston, MA	Blue-Spotted Salamander, 1978 (*Ambystoma laterale*)	Wooded swampy areas, moist woods. Breeds in ephemeral ponds in spring	Threatened in Mass. Two sites in this area.

Division of Fisheries and Wildlife
~~Department of Environmental Management~~ 100 Cambridge Street, Boston, Mass. 02202 (617) 727-31[illegible]

Quadrangle	Species, date	habitat	rarity, comments
Holliston, MA (continued)	Spotted Salamander, 1979 (Ambystoma maculatum)	Moist woodlands. Breeds in ephemeral ponds in spring.	Uncommon but apparently secure in Mass.

As soon as you become aware of New England Power Co.'s proposed actions in the vicinities of these sites, we would ask that you contact us again for management and protection recommendations, or information on the collection of field data for these species.

I hope this information is useful in your planning, and that you will contact us with any questions. Please note that our inventory expands through ongoing field work and research, so further data on these areas may become available in the future.

Yours sincerely,

Alison Sanders-Fleming

Alison Sanders-Fleming
Environmental Reviewer

ASF/mf
Enc.

Massachusetts
Natural Heritage
Program

29 November 1984

Leo T. Sicuranza
Charles T. Main, Inc.
Planning & Scientific Services
Prudential Center
Boston, MA 02199

Re: New England Power Company transmission lines

Dear Mr. Sicuranza;

Thank you for consulting the Massachusetts Natural Heritage Program for an update on known rare species sites near the New England Power Company's proposed overhead transmission line through parts of Middlesex, Essex, and Worcester Counties. As we discussed at our recent meeting, I had the rest of our staff review the routes marked on the USGS 7½' quadrangle map copies you provided. Aside from the four rare species occurrences described in the May 21, 1984 letter to you, we are unaware of any additional rare plant or animal populations or significant natural communities which would be adversely affected by the proposed transmission line.

We would like to offer updated information on the four occurrences mentioned above. Their locations were indicated in the May '84 correspondence. As you know, specific locations of rare species sites should not be publicized to prevent damage to their habitats through visiting or collecting.

Climbing Fern, 1984, (*Lygodium palmatum*); Ayer MA quadrangle.

While a location for this State Threatened plant species was confirmed in the 1984 fields season just south of the right-of-way, a field survey of the ROW itself did not reveal any Climbing Fern populations.

Southern Bog Lemming, 1976, (*Synaptomys cooperi*); Nashua South NH/MA quadrangle.

The Bog Lemming reported from this wetland in 1976 represents the most recent known occurrence of this species in Massachusetts, although it is believed that populations of this rare mammal do exist in suitable habitats in the state. The Bog Lemming has recently been reclassified as a Species of Special Concern on the Mass. Division of Fisheries Y Wildlife rare animals list revision presently pending final approval. No fieldwork has been conducted at this site since 1976, and it can be assumed that the species still inhabits the wetland provided that the habitat has not been significantly degraded. Should powerline installation here require disturbance to the wetland through piling relocation or other construction activities, the MNHP should be contacted to discuss possible fieldwork, and potential impacts and mitigation measures.

Blue-spotted Salamander, 1978 (*Ambystoma laterale*), and Spotted Salamander, 1979, (*A. maculatum*); Holliston MA quadrangle.

The Blue-spotted Salamander has been proposed for listing as a Species of Special Concern in Massachusetts. As noted in our May '84 correspondence, the

Division of Fisheries and Wildlife 100 Cambridge Street, Boston, Mass 02202 (617) 727-3160,-3151

Spotted Salamander is considered to be apparently secure in the state. Due to the recent abundance of data on this species from annual mole salamander surveys, this species has been dropped from the MNHP rare animals list. Its presence, however, especially together with the Blue-spotted Salamander here, is indicative of good quality amphibian habitat. This wetland area is north of the ROW itself, but care should be taken to prevent degradation to the area through runoff or other construction impacts to the wetland system.

I hope this information is useful in your planning, and that you will contact us with any questions. Please note that our inventory expands through ongoing fieldwork and research, so that further data on the area may become available in the future.

Yours sincerely,

Alison Sanders-Fleming

Alison Sanders-Fleming
Environmental Reviewer

ASF/lr

Massachusetts Natural Heritage Program

April 12, 1985

Mr. Leo Sicuranza
Chas. T. Main, Inc.
Prudential Center
Boston, MA 02199

Re: New England Power Company
Transmission Line in Dunstable

Dear Mr. Sicuranza,

As a follow up to the meeting with you and Robert Olsen in our office on March 20, 1985, I would like to restate the Natural Heritage Program's views regarding the impacts of the proposed transmission line in Dunstable on rare and endangered species. As previcus correspondence from our office has indicated (9/29/84 to you, 2/12/85 to MEPA), the Southern Bog Lemming (Synaptomys cooperi) was recorded in 1976 as occurring in a wetland along the transmission line in Dunstable. As you described the details and timing of the construction of the transmission line at this site (no footings will be placed in the wetland, etc.), there appears that the proposed project will have no deleterious impacts to the Bog Lemming or its habitat. Please contact the Heritage Program should you have furthur questions about this or other potential rare species impacts.

Sincerely,

Henry Woolsey

Henry L. Woolsey
Coordinator

HW:yt

Division of Fisheries and Wildlife 100 Cambridge Street, Boston, Mass. 02202 (617) 727-3160,-3151

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

Mr. Anthony J. Como
Coal and Electricity Division
Office of Fuels Program
Economic Regulatory Administration
Department of Energy
Washington, D.C. 20585

FEB 13 1986

Dear Mr. Como:

This responds to your January 23, 1986 request for information on the presence of Federally listed and proposed endangered or threatened species in conjunction with the Department of Energy's Environmental Impact Statement for the New England/Hydro-Quebec Phase II project in New Hampshire and Massachusetts.

Our review shows that except for occasional transient individuals, no Federally listed or proposed species under our jurisdiction are known to exist in the project area. Therefore, no Biological Assessment or further consultation is required with us under Section 7 of the Endangered Species Act. Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to endangered species under our jurisdiction. It does not address other legislation or our concerns under the Fish and Wildlife Coordination Act. With respect to our comments on the EIS, we have already participated in the scoping process, and will be reviewing the draft and final EIS when those documents are published.

Lists of Federally designated endangered and threatened species in New Hampshire and Massachusetts are enclosed for your information. Thank you for your cooperation and please contact us if we can be of further assistance.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor
New England Area

Enclosure

STATE OF NEW HAMPSHIRE

FISH AND GAME DEPARTMENT

FISH AND GAME

34 Bridge Street
Concord, N.H. 03301
(603) 271-3421

ALLEN F. CRABTREE, III
EXECUTIVE DIRECTOR

February 14, 1986

Anthony J. Como
Department of Energy
Coal & Electricity Division
Office of Fuel Programs
Economic Regulatory Administration
Washington, D.C. 20585

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
FEB 24 1986
POWER SUPPLY & RELIABILITY

Dear Mr. Como:

I am responding to your letter of 23 January requesting comments on potential impacts of the New England/Hydro-Quebec Phase II on endangered species and other wildlife in New Hampshire.

The only currently listed species which is likely to nest within the transmission corridor is the Whip-poor-will (Caprimulgus vociferus). Birds nesting within the corridor could be adversely affected by construction activities and by corona effects.

Listed species which could nest in woodlands immediately adjacent to the corridor include the Cooper's Hawk (Accipter cooperii) and Red-Shouldered Hawk (Buteo lineatus).

The Peregrine and Bald Eagle, both state and federally listed endangered species, have areas of activity near the corridor. A peregrine release site which is part of the northeastern peregrine restoration effort is located within 1.7 miles of the corridor in Benton, and will probably be operational for the next 2-5 years. The corridor is within hunting range of several other historical and potential peregrine nesting sites. The area of Bald Eagle activity is along the Connecticut River from Monroe to Dalton. Collision with towers or lines would be the most likely source of impact for these species.

As I believe you are aware, the state list of threatened and endangered species is currently under review, and a revised list will be published later this spring.

Other than the specific cases discussed above, our main concerns with the proposed project focus on potential effects on wildlife of electric fields and corona discharge, which are poorly understood at this time, and any construction impacts on wetlands. I would like to review the following publications which are listed in the implementation plan accompanying your letter:

"Biological Effects on High Voltage AC Transmission Lines", "Biological Effects of High Voltage Direct Current Lines", and "The Impact of a Proposed 500 KV Transmission Line on Waterfowl and Other Birds", and would appreciate information on how to obtain them.

Thank you for the opportunity to comment.

Sincerely,
Harold P. Nevers

Harold P. Nevers
Federal Aid & Endangered
Species Coordinator
NH Fish & Game Department

The Commonwealth of Massachusetts

Office of the Secretary of State
Michael Joseph Connolly, Secretary

Massachusetts Historical Commission
Valerie A. Talmage
Executive Director
State Historic Preservation Officer

September 9, 1985

Bradley Spooner
Air & Environmental Resource Programs
New England Power Company
25 Research Drive
Westborough, MA 01581

ATTN: Gordon Marquis

RE: Research Design for Cultural Resources Survey, Hydro-Quebec Project (Phase II)

Dear Mr. Spooner:

Thank you for submitting a copy of the proposed research design for the cultural resources survey of the Hydro-Quebec Phase II project. The purpose of this letter is to confirm the Massachusetts Historical Commission's comments on the research design, as stated in a telephone conversation between Brona Simon (MHC) and Gordon Marquis (New England Power) on July 23, 1985.

The MHC reviewed the research design and believes that it shall provide New England Power with the basic level of documentation required for the identification and evaluation of cultural resources which might be affected by the proposed power line project in compliance with 36 CFR 800, Advisory Council on Historic Preservation Procedures for the Protection of Historic and Cultural Properties. However, MHC recommends that the archaeological field testing program be specfically keyed into project design plans. The focus of the survey is to test areas where there will be project impacts, as specified in the project design.

MHC also recommends that the results of the intensive (identification) survey and the consultant's recommendations for additional investigation, be reviewed by this office.

MHC would like to remind you that a permit from the State Archaeologist must be secured before archaeological field work can proceed (950 CMR 70).

If you have any questions concerning these comments, please contact Brona Simon, State Archaeologist at this office.

Sincerely,

Valerie Talmage

Valerie A. Talmage
Executive Director
State Historic Preservation Officer
Massachusetts Historical Commission

cc: Ricardo Elia, Boston University, Office of Public Archaeology

VAT/dr

STATE OF NEW HAMPSHIRE
DEPARTMENT of RESOURCES and ECONOMIC DEVELOPMENT
OFFICE of the COMMISSIONER

603-271-2411

JOHN T. FLANDERS
Commissioner

105 Loudon Road
Box 856
Concord, N.H.
03301

Date: October 30, 1985
Re: Research Design for the Cultural Resources Assessment Survey of the Hydro-Quebec Hydro Project (Phase II) in NH and MA

Bradley H. Spooner, Manager
Air and Environmental Resource Programs
New England Power Company
25 Research Drive
Westborough, Massachusetts 01581

Dear Mr. Spooner:

I am writing to confirm that the NH State Historic Preservation Office received, reviewed, and approved the "Research Design for the Cultural Resources Assessment Survey of the Hydro-Quebec Project (Phase II) in New Hampshire and Massachusetts," prepared by the Office of Public Archaeology at Boston University. We concur that this is consistent with the cultural resources plan discussed with staff of your office on March 27, 1985, in Concord.

The one reservation expressed by the Historic Preservation Office was the coordination and scheduling of the historical overview to be prepared by the archaeological team (pg. 5) with the identification phase of the architectural component (pg. 9). Ideally, an overview should preceed the initial phase of the architectural survey. After discussions with Lynne Monroe, subconsultant, the staff concern was alleviated, as phased historical research to be conducted by Ms. Monroe will be adequate for the architectural survey.

The Historic Preservation Office has requested the use of New Hampshire's "Minimum Documentation Survey Form" and "State Historical Resources Survey Form" for the identification and evaluative phase, respectively of the architectural component. Lynne Monroe has agreed to this request with minor changes approved by this office.

Sincerely,

Gary W. Hume

for Joseph F. Quinn, Director
Recreation Services
Deputy State Historic Preservation Officer

JFQ:GWH:g
cc: Lynne Monroe, Consultant
Ricardo Elia

New England Hydro-Transmission

John W. Newsham
Vice President

Please reply
c/o New England Power Service Company
25 Research Drive
Westborough, Massachusetts 01582-0099
Tel. (617) 366-9011 TWX 710-390-0732
Cable: NEELECSYS WTBO

September 4, 1986

Ms. Linda R. Wilson, Director
New Hampshire State Historic
Preservation Office
P. O. Box 856
Concord, New Hampshire 03301

Dear Ms. Wilson:

RE: Cultural Resources Survey: New England/Hydro-Quebec
Phase II Transmission Facilities

Enclosed are two copies of the Cultural Resources Survey report for the New Hampshire portion of the New England/Hydro-Quebec Phase II Transmission Facilities project. The report describes a year-long survey conducted by the Boston University Office of Public Archaeology (OPA) to comply with Section 106 of the National Historic Preservation Act and its implementing regulations. This pre-construction survey, conducted in accordance with the Research Design approved by your office on October 30, 1985, consisted of both archaeological and architectural/historical components.

The report concludes that the proposed undertaking would not result in any adverse effects to properties that are listed in or eligible for listing in the National Register of Historic Places.

The United States Department of Energy (DOE) recently issued a Draft Environmental Impact Statement (DEIS) on the environmental aspects of the proposed project, including cultural resources. Since the comment period on the DEIS closes on September 29, 1986, we would appreciate an opportunity to meet with you during the week of September 22, 1986 to discuss the enclosed report and the substance of your comments to DOE.

To protect the integrity of cultural properties identified in the report, we are withholding binding, publication and further distribution of the document pending your recommendations.

Please contact Gordon E. Marquis, Senior Environmental Analyst, if you have any questions or to arrange the meeting suggested above.

Very truly yours,

John W. Newsham
Vice President

Enclosures

cc: R. J. Elia, OPA (No Enclosure)

The Commonwealth of Massachusetts
Office of the Secretary of State
Michael Joseph Connolly, Secretary

Massachusetts Historical Commission
Valerie A. Talmage
Executive Director
State Historic Preservation Officer

September 23, 1986

Mr. John W. Newsham
New England Power Company
25 Research Drive
Westborough, MA 01581

RE: New England/Hydro-Quebec Phase II, Transmission Facilities, Statewide
EOEA No. 5446

Dear Mr. Newsham:

Staff of the MHC have reviewed the report entitled "New England/Hydro-Quebec Phase II, Transmission Facilities, Cultural Resources Survey, Volume Two: Massachusetts," which was prepared by the Office of Public Archaeology in accordance with 950 CMR 70.

The archaeological survey identified 27 archaeological sites (12 prehistoric and 15 historic) within or directly adjacent to the project right-of-way. Since none of these archaeological resources was significant, no further archaeological investigations are required at any of the 27 sites. The MHC is encouraged by New England Power Company's concern for the protection of 17 of these archaeological sites and by their action to flag these site areas so that they will be avoided from project impacts.

The MHC is unable to complete its review of this project until the locations of all construction-related activities (e.g., access roads, laydown areas, erosion control measures and stream or wetland crossings) are known. The MHC requests the opportunity to meet with project proponents to review these plans once they have been prepared in order to evaluate the project's effects to important archaeological and historic resources. These comments are provided in compliance with Section 106 of the National Historic Preservation Act and Advisory Council Procedures (36 CFR 800).

The architectural survey inventoried 465 individual historic properties and 17 historic districts or areas that are within the project right-of-way or its proximity. The following two properties are listed in the National Register of Historic Places: Old Stone Church (Route 140) in West Boylston and John B. Gough House (215 Main Street) in Boylston (also a National Historic Landmark). The following five districts and 76 properties identified by the survey are considered to meet the criteria of eligibility for inclusion in the National Register of Historic Places:

OCT 2 1986

80 Boylston Street, Boston, Massachusetts 02116 (617) 727-8470

WEST BOYLSTON

Joel Morse House	19 Lancaster Street	No Adverse Effect
Oakdale Methodist Church	15 North Main Street	No Effect
Harrisville School	18 North Main Street	No Effect
Oakdale School	High Street	No Effect
Gothic Cottage	6 Green Street	No Effect
WEST BOYLSTON CENTER DISTRICT		No Effect
Andrew J. Scarlet House	148 Worcester Street	No Effect
Abel Bigelow House	8 Temple Street	No Effect
Bigelow/Temple Homestead	63 Temple Street	No Adverse Effect
Hartwell St. RR Bridge	Hartwell Street	No Effect
MDC Bridge I		No Effect
MDC Bridge II		No Effect
MDC Bridge III		No Effect
OAKDALE HISTORIC DISTRICT		No Effect

BOYLSTON

Jonathan Bond House	183 Main Street	No Adverse Effect

SHREWSBURY

Nurse House	Main Street	No Effect
District 5 Schoolhouse	Old Mill Rd. & Main St.	No Effect
Bungalow	87 Old Mill Road	No Effect
Isaac Stone House	165 Oak Street	No Effect
Nelson Homestead	543 Lake Street	No Effect

MILLBURY

Red Farm	Colton Road	No Adverse Effect
Millbury Substation #1	Providence Road	No Effect
Millbury Substation #2	Grafton Street	No Effect
McIntire House	27 Grafton Street	No Effect
Blackstone Canal	Cross Street	No Adverse Effect
Craftsman Cottage	59 Grafton Street	No Effect

SUTTON

Abraham Chase House	Chase Road	No Effect
Nehemiah B. Chase House	Chase Road	No Effect
Blackstone Canal	Blackstone Street	No Adverse Effect

GRAFTON

Haywood House	13 Fitzpatrick Road	No Effect
Jesse Farnum House	Providence Road	No Effect
Leland House	195 Providence Road	No Effect
OLD UPTON ROAD DISTRICT		No Adverse Effect

UPTON

Perley Lackey House	68 Westboro Road	No Effect
Deacon Samuel Forbush Hse.	84 Hopkinton Road	No Effect
Southland House	92 Elm Street	No Effect
Daniel Putnam Farmstead	East Street	No Effect
Ephraim Taft House	84 Taft Street	No Effect
Cottage	93 Mechanic Street	No Adverse Effect

TYNGSBOROUGH

Asa Thompson House	7-9 Locust Avenue	No Adverse Effect

DUNSTABLE

Dunstable Town Pound	Main Street	No Effect
Winslow School	Main Street	No Effect
Josiah Cummings House	Main Street	No Effect
Capt. John Cummings House	Westford Street	No Effect
Leonard Parkhurst House	Pond Street	No Effect
Peter Kendall House	Pond Street	No Effect

GROTON

Fitzpatrick Place	Dan Parker Road	No Adverse Effect
Capt. Moses Palmer House	270 Boston Road	No Effect
Levi Tufts Place	446 Boston Road	No Adverse Effect
Bennett House	653 Martins Pond Road	No Effect

AYER

Pierce House	46 Westford Road	No Effect
Abel Page House	7 Groton-Shirley Road	No Effect

SHIRLEY

Harris/Kilburn House	Great Road	No Effect
Little/Farnsworth House	Great Road	No Effect
Thomas Hazen Clark House	Clark Road	No Adverse Effect
SHIRLEY VILLAGE DISTRICT		No Adverse Effect

LANCASTER

Elisha Sanderson House	1964 Shirley Road	No Adverse Effect
Brick Tavern	Shirley Road	No Effect
Bungalow	2221 North Main Street	No Effect

STERLING

Flanagan House	70 Flanagan Hill Road	No Effect
Pratts Junction Substation	Pratts Jct. Road	No Effect
School No. 8	14 Pratts Jct. Road	No Effect
Legate Hill Saltbox	22 Legate Hill Road	No Effect
Silas W. Arnold House	258 Leominister Road	No Effect
Sholan Lodge	48 Rugg Road	No Effect
Sawyer Homestead	108 Maple Street	No Effect
S. Lawrence House	15 Chamberlain Road	No Adverse Effect
Bon Air Lodge	Campground Road	No Effect

MILFORD

Jesse Cheney House	254 Purchase Street	No Effect
North Purchase School	Purchase Street	No Effect
Daniel Corbett House	9 Haven Street	No Effect
Jones/Corbett/Sumner Hse.	26 Eben Road	No Adverse Effect
Colonial Revival Cottage	10 Eben Road	No Adverse Effect
Albert M. Sumner House	200 Purchase Street	No Effect
Ellis Sumner House	209 Purchase Street	No Effect
Braggville School	430 East Main Street	No Effect

MEDWAY

CLARK STREET/SOUTH STREET AREA		No Effect
Elias T. Fisher House	90 Milford Street	No Adverse Effect
Theodore Ritter House	75 Fisher Street	No Effect
Ebenezer Hill House	53 Fisher Street	No Effect
Timothy Hill House	68 West Street	No Adverse Effect

The MHC has reviewed this documentation and has determined that this project will have no adverse effect on the Old Stone Church in West Boylston and the John B. Gough House in Boylston, which are both listed in the National Register of Historic Places. Furthermore, the project will have no effect on 62 individual properties and districts and no adverse effect on 19 individual properties and districts that appear to be eligible for listing in the National Register of Historic Places (see previous list for specific property name).

A copy of these comments should accompany material submitted to the Advisory Council on Historic Places, 1100 Pennsylvania Avenue, NW, #809, Washington, DC 20004.

If you have any questions concerning this review, please contact Jordan Kerber or Brona Simon at this office.

Sincerely,

Valerie Talmage

Valerie A. Talmage
Executive Director
State Historic Preservation Officer
Massachusetts Historical Commission

xc: ACHP
Secretary James Hoyte, EOEA, MEPA Unit
Anthony J. Como, Office of Fuels Programs

VT/BS/JK/dr

New England Hydro-Transmission

John W. Newsham
Vice President

New England Hydro-Transmission
Electric Company, Inc.
25 Research Drive
Westborough, Massachusetts 01582
Tel. (617) 366-9011

September 4, 1986

Ms. Valerie A. Talmage, Executive
Director and State Historic
Preservation Officer
Massachusetts Historical Commission
80 Boylston Street
Boston, Massachusetts 02116

Dear Ms. Talmage:

RE: Cultural Resources Survey: New England/Hydro-Quebec
Phase II Transmission Facilities

Enclosed are two copies of the Cultural Resources Survey report for the Massachusetts portion of the New England/Hydro-Quebec Phase II Transmission Facilities project. The report describes a year-long survey conducted by the Boston University Office of Public Archaeology (OPA) to comply with Section 106 of the National Historic Preservation Act and its implementing regulations. This pre-construction survey, conducted in accordance with the Research Design approved by your office on September 9, 1985, consisted of both archaeological and architectural/historical components.

The report concludes that the proposed undertaking would not result in any adverse effects to properties that are listed in or eligible for listing in the National Register of Historic Places.

The United States Department of Energy (DOE) recently issued a Draft Environmental Impact Statement (DEIS) on the environmental aspects of the proposed project, including cultural resources. Since the comment period on the DEIS closes on September 29, 1986, we would appreciate an opportunity to meet with you during the week of September 22, 1986 to discuss the enclosed report and the substance of your comments to DOE.

To protect the integrity of cultural properties identified in the report, we are withholding binding, publication and further distribution of the document pending your recommendations.

Please contact Gordon E. Marquis, Senior Environmental Analyst, if you have any questions or to arrange the meeting suggested above.

Very truly yours,

J W Newsham

John W. Newsham
Vice President

Enclosures

cc: R. J. Elia, OPA (No Enclosure)

State of New Hampshire
Department of Libraries, Arts & Historical Resources
DIVISION OF HISTORICAL RESOURCES
Walker Building, State Office Park South
Box 2043
Concord, New Hampshire 03301
603-271-3483   603-271-3558

Shirley G. Adamovich, Commissioner
State Historic Preservation Officer

November 17, 1986

John W. Newsham, Vice President
New England Hydro-Transmission
c/o New England Power Service Company
25 Research Drive
Westborough, Massachusetts 01582-0099

RE: New England Hydro-Quebec Phase II
DEIS and Cultural Resources Survey

Dear Mr. Newsham:

In accordance with the National Historic Preservation Act of 1966 (P.L. 89-665), as amended, and federal Advisory Council on Historic Preservation "Procedures for the Protection of Historic and Cultural Properties" (36 CFR 800), the Division of Historical Resources/State Historic Preservation Office has reviewed the undertaking referenced above for potential effects on properties listed, or potentially eligible for listing, in the National Register of Historic Places.

Based upon the Draft Environmental Impact Statement prepared by the U.S. Department of Energy, dated August 1986, and the Cultural Resources Survey Volume One: New Hampshire, prepared by the Office of Public Archeology at Boston University, also dated August 1986, it has been determined that the undertaking as proposed will have no adverse effects on properties of known or potential architectural, historical, archeological, or cultural significance.

While we concur with the findings in the Cultural Resources Survey report, we recommend that the final report be revised to reflect the concerns of the Division as expressed at its meeting with NEPCO representatives on October 6, 1986. On page iii of the Management Summary, it is noted that "(n)one of the archaeological sites were determined to be eligible for the National Register of Historic Places"; what this means is that one site was determined not to be eligible, and that 18 other sites remain potentially eligible but that additional study is not required as these sites will be protected. Secondly, it should be noted that the term "architectural survey" is not intended to be restrictive, as the survey evaluated standing structures that were both architecturally as well as historically significant. Finally, there should be an addition on page 209 or on page 218, to indicate that special consideration was given to potential economic impacts on historic working farms, and to summarize the decisions of various review bodies with technical expertise, that address this concern.

For the purpose of compliance with the Advisory Council on Historic Preservation procedures (36 CFR 800), I request that this determination be construed as a finding of "No Adverse Effect," sugject to the revisions requested above.

Sincerely,

Shirley G. Adamovich

Shirley G. Adamovich, Commissioner
State Historic Preservation Officer

cc: Robert L. Davies, DOE
R. J. Elia, OPA

New England Power

New England Power Company
25 Research Drive
Westborough, Massachusetts 01581
Tel. (617) 366-9011

December 12, 1986

Ms. Valerie A. Talmage, Executive Director
and State Historic Preservation Officer
Massachusetts Historical Commission
80 Boylston Street
Boston, Massachusetts 02116

Dear Ms. Talmage:

RE: Cultural Resources Survey - New England/Hydro-Quebec Phase II Transmission Facilities

On October 30, 1986, Company representatives met with the Massachusetts Historical Commission's (MHC) Brona Simon and Jordan Kerber to discuss construction-related activities for the Hydro-Quebec project. The meeting was in response to your September 23, 1986 letter requesting an opportunity to discuss these matters.

At the meeting, we described activities such as access roads, laydown areas and erosion protection measures. We also described how protection of important archaeological and historic resources would be taken into account for these activities.

At the close of the meeting, MHC personnel suggested that we summarize our discussion in writing. MHC personnel also stated that you could issue a conditional "No Adverse Effect" determination, based on the Company's agreement to take the protective measures discussed at the meeting and described below.

Construction Schedule

Enclosed is a table, "Hydro-Quebec Phase II Massachusetts Construction Schedule." This table summarizes the schedule for the principal activities described at the meeting. It should serve as a useful reference for the following discussions.

Response to Consultant's Recommendations

To provide a convenient arrangement for addressing the construction activities, the following discussions are keyed to the specific recommendations in Section IV. (Recommendations) of the Cultural Resources Survey Report submitted to your office on September 4, 1986. We are also responding to other recommendations in the report that were not specifically discussed at the October 30, 1986 meeting.

A. Archaeological Recommendations

Recommendation No. 1: Protect 17 Sites

The report recommended that 17 archaeological sites (in 18 areas) be protected by: (1) flagging for avoidance or, (2) relocating previously proposed structure locations.

We have already flagged (using flagging tape or paint) most sites. The only exceptions are at Area 1 (an active cornfield) and Area 35-36 (a site with a gorge, steep terrain, within which we do not foresee the use of any equipment). Sites will be re-flagged as often as necessary to insure that they remain identified to construction personnel. Construction contracts will require that contractors avoid flagged areas.

We have already changed proposed structure locations as recommended in the report.

Recommendation No. 2: Adhere to Structure Locations

The report recommended that proposed structure locations within archaeologically sensitive areas be adhered to during construction, and that a consultant review the necessity to conduct further archaeological testing should structures have to be relocated within sensitive areas.

To date, we have determined, based on further engineering, that 12 proposed structure locations, of the original 326 within sensitive areas, need to be changed. A consultant (Office of Public Archaeology) has reviewed the new locations and conducted testing as warranted. No archaeological sites were identified during this review. We expect to submit a report of this activity to MHC in early 1987.

If further relocations of this nature are subsequently identified, we will conduct a similar review.

Recommendation No. 3: Access Roads, Laydown Areas, Other Activities

The report recommended that, when we had identified specific requirements for access roads, laydown areas and other activities, we should have an archaeological consultant assess the sensitivity of the areas and determine if archaeological testing is warranted.

Access Roads

Three types of access roads will be used for this project: (1) roads to reach the right-of-way from public ways; (2) existing access roads running along the right-of-way and, (3) access roads from existing access roads on the right-of-way to new structure locations. Each of the three types is discussed below:

(1) Access Roads - From Public Way to Right-of-Way

Up to 12 access roads from public ways to the right-of-way may be required. We expect to identify the locations of the roads by January 1, 1987. Where necessary, we expect to obtain the approval of the landowner for access by April 1, 1987. Between April 1, 1987 and the start of access road construction or use, we will retain an archaeological consultant to review and test, if necessary, the locations of the access roads. If a significant archaeological site is encountered, we will find another location for the road.

(2) Access Roads - Along Right-of-Way

An archaeological consultant (Office of Public Archaeology) has already begun to assess which of the 113 archaeologically sensitive areas along the right-of-way would need to be tested at existing access road locations. We expect the consultant to complete the assessment by January 1, 1987. By July 1, 1987, the consultant will test the necessary locations and designate any areas where avoidance is warranted. The consultant's work will take into account the present condition of the access roads and the likely extent of improvements.

(3) Access Roads - To New Structure Locations

Within each of the 113 archaeologically sensitive areas, we are already identifying the likely access from the existing access roads on the right-of-way to the new structure locations. The consultant is reviewing the identified access for necessary testing and will designate any areas where avoidance is warranted. We expect that this activity will be completed by July 1, 1987.

For all three types of access roads, if alternative access routes are subsequently found to be necessary in archaeologically sensitive areas, a consultant will review the alternative routes in the same manner as described above.

Laydown Areas

Between 5 and 11 construction assembly areas, each up to two acres in area, will be required. These areas will be on or immediately adjacent to the right-of-way. Such areas are normally identified by construction contractors after award.

We will require that construction contractors identify prospective assembly areas in advance of any activity there. We will have an archaeological consultant review each area and test, if necessary. If any area is determined to be an archaeological site, the contractor will be required to identify a replacement location. We expect to begin this activity in July 1987.

Also, four material storage yards, each five to ten acres in area, will be required. These yards will be in the general proximity of, but not immediately adjacent to, the right-of-way. We will seek to use locations such as gravel pits for this purpose.

We will identify prospective locations for the yards by the dates shown on the attached schedule. We will have an archaeological consultant review the locations. If any is archaeologically sensitive, it will not be used. We expect to complete this activity by March 1, 1987.

Other Activities

Other activities include measures to control erosion and protect wetlands, such as culverts, water bars and interceptor ditches.

(1) Culverts

Culverts will be placed where it is necessary to maintain the free passage of water when a new/upgraded access road would otherwise block the flow. Culverts will be placed on the stream beds, not in newly dug ditches. Therefore, potential archaeological impact should be minimal. Even so, we will have an archaeological consultant review the location of all culverts to be installed in archaeologically sensitive areas. Since this activity is directly related to access roads, we expect the review of this activity to be complete by July 1, 1987.

(2) Water Bars

Water bars are relatively narrow and shallow (typically 8" wide and 8" deep) lumber troughs imbedded across access roads on steep terrain. Their purpose is to divert rainwater running on and parallel to the access road, so the road is not eroded. Their necessity and locations are not determined until construction begins.

The evaluation of access roads described previously will serve to address the impact of the water bars, since the water bars are really part of the access road. Therefore, we expect the review of this activity to be complete by July 1, 1987.

(3) Interceptor Ditches

Interceptor ditches may be installed in steep terrain areas, either adjacent to structures, or across or adjacent to access roads. Their purpose is to disperse rainfall runoff over a wide area of undisturbed ground, so that the access road or structure location is not eroded. Their necessity and locations are not determined until actual construction.

Because interceptor ditches would generally be installed only on steep terrain, it is unlikely they would coincide with archaeologically sensitive areas. Also, the evaluation of access roads and structure locations described previously should serve to address their impact. Even so, during access road testing, we will have the archaeological consultant identify any particular locations where, if interceptor ditches are installed later, an archaeological test will be needed. We expect the identification to be completed by July 1, 1987.

(4) Other Erosion Control and Wetlands Work

Silt dams, made of hay bales, logs, stone or filter fabric, should have no archaeological impact. Likewise, the placement of riprap, jute mesh, gravel and seeding for erosion control (where not associated with access roads) should have no archaeological impact. Therefore, no independent archaeological assessments are planned for these erosion control measures.

The archaeological impact of bridges to cross streams will be accounted for in the assessment of access roads.

Recommendation No. 4: Stone Walls

The report recommended that the disturbance to stone walls be minimized during construction and that stone walls be reconstructed consistent with their original form when disturbance is necessary.

Our construction contracts will have a provision that requires the contractor to avoid or reconstruct stone walls.

B. Architectural Recommendations

Recommendation No. 5: Adhere to Structure Locations

The report recommended that proposed structure locations presented to the architectural historians at the time of the original survey be adhered to during construction. This applies to structures in the immediate vicinity of eligible properties where setting is an important factor in their eligibility.

For each relocated structure or structure taller than originally anticipated, we are reviewing the proximity of the structure to eligible properties where setting is an important eligibility factor. If the relocated or taller structure is proximate to such a property, and if a specific location or height was presented to the architectural historians as part of the original assessment, the new location or height will be reviewed by an architectural historian.

Recommendation No. 6: Access Roads With Clearing Required

The report recommended that, when vegetation clearing is required to construct new access roads in the vicinity of eligible properties where setting is an important factor in their eligibility, an architectural historian should review the effect of the clearing.

Clearing on the right-of-way for new transmission lines and access roads was taken into account in the original survey. Therefore, this recommendation applies to the access roads from public ways to the right-of-way as described in the discussion of Recommendation No. 3, Access Roads, Subpart (1) above. When we have identified such prospective access road locations, we will determine whether clearing is necessary and whether the location is near eligible properties where setting is an important factor. At this time, we do not expect that new access roads will be necessary for this purpose. Nevertheless, if the identified road requires clearing and is near such a property, we will have an architectural historian review the proposed location. We expect to complete this activity by April 1, 1987.

Recommendation No. 7: Vegetative Screens

The report recommended that we consider the use of vegetative screens where new structures would be particularly visible in the vicinity of eligible properties were setting is an important factor in their eligibility.

We are presenting a list of the appropriate eligible properties to our System Arborist. Consistent with commitments made to other regulatory bodies, our System Arborist will review locations in the list and other locations, determine where visual benefits are to be gained by planting vegetation, and plant compatible species which provide screening.

C. General Recommendations

Recommendation No. 8: Miscellaneous

The report recommended that we inform MHC of any changes in project scope and that we notify MHC when construction is about to begin.

We will advise MHC of any changes in project scope. We will also notify MHC when construction is about to begin so the recommended flagging of archaeological sites can be verified.

Recommendation No. 9: Discovery of Cultural Resources

The report recommended that, should cultural resources be discovered during planning or implementation, appropriate evaluations and mitigative measures be undertaken as required by Federal law and regulations.

Should any such discoveries occur, work will stop at these locations and we will take the recommended follow-up measures. Our construction contracts will specifically require that contractors stop work and notify us immediately upon making such a discovery.

Recommendation No. 10: Dissemination of Report

The report recommended that we consult with MHC regarding dissemination of the report. This is to protect the integrity of cultural resources identified in the report.

After making minor changes in the text to reflect the comments in your September 23, 1986 letter, we will provide the MHC with multiple copies of the report. We will refer requests from other parties for the report to you. In that manner, MHC will control dissemination of the report.

We will report to you periodically on the progress of the activities described above. We look forward to your determination of the project's effect, in response to this letter. Thank you for your continued cooperation on the project.

Very truly yours,

Bradley H. Spooner

Bradley H. Spooner
Manager, Air and Environmental Resource Programs

CONCURRENCE: Valerie Talmage

12/29/86

[illegible]
EXECUTIVE DIRECTOR
MASSACHUSETTS
HISTORICAL COMMISSION

BHS:gv

Enclosure

cc: B. Simon, MHC

xc: ACHP

Advisory Council On Historic Preservation

The Old Post Office Building
1100 Pennsylvania Avenue, NW, #809
Washington, DC 20004

FEB 19 1987

Mr. Anthony J. Como
Coal and Electricity Division
Office of Fuels Programs
Economic Regulatory Administration
Department of Energy
Washington, DC 20585

REF: New England/Hydro-Quebec Phase II Transmission Facilities

Dear Mr. Como:

On January 26, 1987, the Council received your determination that the referenced project would have no adverse effect upon properties included in or eligible for the National Register of Historic Places. We have reviewed your supporting documentation and agree with your finding, provided that the project permit is conditioned to ensure that:

> Mitigation measures outlined in the December 12, 1986, letter from Bradley H. Spooner to Valerie A. Talmage will be implemented in New Hampshire as well as Massachusetts.

If you agree with this condition, please sign on the concurrence line below, return this letter to us, and also send a copy to the Massachusetts and New Hampshire State Historic Preservation Officers. This provision will then be incorporated into your determination and compliance with Section 106 of the National Historic Preservation Act and the Council's regulations will be complete.

If you have any questions, please call Druscilla Null at 786-0505. Thank you for your cooperation.

Sincerely,

for Don L. Klima
Chief, Eastern Division
of Project Review

I concur:

Anthony J. Como 3/4/87 (date)

APPENDIX F. COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT AND STAFF RESPONSES

Copies of the letters of comment received during the Draft Environmental Impact Statement (DEIS) review period are included in this appendix to the Final Environmental Impact Statement (FEIS). In some cases attachments have not been reproduced. In general, the letters have been arranged chronologically in order of receipt. Each letter responded to by the staff has been assigned a letter code, and within each letter consecutive numbers have been used to designate individual comments and the corresponding staff responses. The letters and responses are placed side by side to the extent possible so the reader can easily locate the specific response to a given comment. The following index lists the letters and the code in the order they appear in the appendix.

NATIONAL SCIENCE FOUNDATION

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550
August 18, 1986

RESPONSES TO NATIONAL SCIENCE FOUNDATION

nsf

OFFICE OF THE
ASSISTANT DIRECTOR
FOR GEOSCIENCES

Mr. Anthony J. Como
U.S. Department of Energy
Economic Regulatory Administration
Room GA-093, RG-22
1000 Independence Avenue, SW
Washington, DC 20585

Dear Mr. Como:

The National Science Foundation has received your Draft Environmental Impact Statement (DEIS) on the "New England/Hydro-Quebec $\pm$ 450 kv Transmission Line Interconnection--Phase II". We have no comment on this DEIS.

No response

Sincerely,

Adair F Montgomery

Adair F. Montgomery, Chairman
Committee on Environmental Matters

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
AUG 19 1986
POWER SUPPLY & RELIABILITY DIV.

COMMONWEALTH OF MASSACHUSETTS, DIVISION OF FISHERIES AND WILDLIFE

The Commonwealth of Massachusetts
Division of Fisheries and Wildlife
Field Headquarters, Westboro 01581

August 19, 1986

Mr. Anthony J. Como
U.S. Department of Energy
Economic Regulatory Administration
Room GA-093, RG-22
1000 Independence Avenue, S.W.
Washington, D.C. 20585

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
AUG 25 1986
POWER SUPPLY & RELIABILITY

RE: DOE/EIS-0129D

Dear Mr. Como:

The Massachusetts Division of Fisheries and Wildlife has completed its review of the Draft Environmental Impact Report for the "New England/Hydro-Quebec ± 450 kv Transmission Line Interconnection -- Phase II" as requested. It is our conclusion that most of the impacts to fish and wildlife resources will result from construction activities and will be of short duration. Further, the DEIR describes measures which we feel will be adequate to mitigate potential disturbances to fish and wildlife populations. Our only specific request is that fishery experts of MDFW be kept informed of the schedule for crossing streams so that the more sensitive habitats may be identified and protected.

CMDFW-1

Thank you for consulting with the Division concerning this project. Please contact Bob Madore of my staff at (617) 366-4470/4479 if you have require additional information or assistance.

Sincerely,

Carl S. Prescott
Carl S. Prescott
Deputy Director of Field Operations

RESPONSES TO COMMONWEALTH OF MASSACHUSETTS,
DIVISION OF FISHERIES AND WILDLIFE

CMDFW-1

The request has been noted. In Section 4.1.10.4 the Staff has recommended two mitigative measures that address this concern.

BAY STATE GAS COMPANY

Bay State Gas Company

August 25, 1986

Mr. Anthony J. Como
U. S. Department of Energy
Economic Regulatory Administration
Room GA-093, RG-22
1000 Independence Avenue, SW
Washington, DC 20585

Re: DOE/EIS-0129 D
Draft Environment Impact Statement
New England/Hydro-Quebec $\pm$ 450 KV
Transmission Line Interconnection -
Phase II

Dear Sir:

Bay State Gas Company has reviewed the draft Environment Impact Statement prepared for the New England/Hydro-Quebec $\pm$ 450 KV Transmission line and believes that the statement is deficient in its treatment of impact on underground pipelines. The impact statement does indicate (pages 3-19 and 3-20) that the issue of increased underground pipeline corrosion is a concern which has been raised at the DOE hearing in Groton, Massachusetts on February 5, 1985, but the issue is not addressed in the text.

BSGC-1 According to a statement on transmission facilities (page 4-7) pipeline adjacent to the proposed line would not be affected because of the distant location of the DC line ground electrode. Our concern, as pipeline operators, is to what extent an earth path for current return will be used under unbalanced loading or during fault conditions. If any part of the ground-return current is picked up or discharged from an underground pipeline in an uncontrolled manner, the potential for corrosion becomes significant. Where interference problems are anticipated, cathodic protection systems should be designed and installed to counter the effects of any fault node current, prior to placing the HVDC System in operation.

Local gas distribution networks in the vicinity of the proposed DC line will be affected as well as transmission pipelines, but these lines are not even mentioned. The extremely brief notation that, "Studies indicate routine mitigative measures are possible, but further studies and field testing are planned", is insufficient.

As a local gas distribution utility with a transmission line subsidiary, Bay State Gas feels strongly that the aforementioned studies and field testing should be completed and results should be reported before the proposed DC line is

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BSGC-1

To prevent potential impacts (corrosion and coating disbonding) to underground pipelines (and other linear underground metallic structures), the Applicant will use an aboveground dedicated metallic return conductor. Thus, expansion of the Phase I ground electrode is no longer planned. Text revisions relating to the dedicated metallic return conductor have been made. In particular, refer to Sections 2.1.4.1 (Line Specifications and Dedicated Metallic Return Conductor), 2.1.4.2 (Dedicated Metallic Return Conductor), 2.2.8.7 (which discusses expansion of the ground electrode as an alternative to the dedicated metallic return conductor), and 4.1.2.3 (Transmission Facilities). Use of the dedicated metallic return conductor will eliminate issues of concern relative to gas pipeline companies. See also the response to Comment PPLC-1.

BSGC-1 (Cont)

approved. Along with these results, the routine mitigative studies referred to should be detailed, along with some recommendations as to which measures should be taken. We believe these issues should be addressed in a revised version of the environmental impact statement before the project is allowed to proceed.

Very truly yours,

Paul W. LaShoto,
Director, Operations

PWL/dap

See previous response page

MARY ELLEN BARRY

23 Forest Drive
Bedford, New Hampshire 03102
September 1, 1986

Anthony J. Como
Department of Energy
Economic Regulatory Administration
Office of Fuels Programs (RG-22)
10000 Independence Ave., SW
Washington, D. C. 20585

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 5 1986
POWER SUPPLY & RELIABILITY

Dear Mr. Como:

I am writing in response to your draft Environmental Impact Statement (New England/Hydro-Quebec ± 450 kv Transmission Line Interconnection--Phase II DOE/EIS-0129D) and its assessment of the environmental impact caused by the proposed high voltage DC power line. As a resident of Bedford, N.H., a residential area which would be very severely affected by the power line, I have the following comments to offer:

Affected Environment

MEB-1 -According to the draft,information concerning population in the affected area of Southern New Hampshire was based on 1980 data. How can a study of this magnitude ignore the rapid growth of this area? In Bedford, N.H.,alone the population has almost doubled in the period from 1976-1986. Surely this shows the haste and inattention to detail with which information was gatheredfor this study. Even using the 1980 data, the draft states "the average housing unit densities for all Hillsborough towns within the project study area are comparatively high..."(p.3-8)

MEB-2 -Bedford, N.H., also has three elementary and middle schools all of which are in close proximity to the proposed power line and one immediately adjacent (Memorial School). The study does acknowledge "...there are more than 40 athletic fields, 5 golf courses, and 2 gymnasiums adjacent to the proposed line in Hillsborough County, primarily in the towns of Goffstown, Manchester, and Bedford (Figure 2.3)."(p.3-5)

MEB-3 -Bedford also has the busy intersection of Routes 101-114 directly under the right-of-way. The right-of-way also crossed 114 at one point farther west. There are also many well traveled local roada that are traversed by the proposed corridor. None of these were even mentioned in the report.

MEB-4 -In Bedford we are constantly being told of impending increases in our electric utility costs. We are even told by some they will double. This proposal they promise will save New England a billion in energy costs over the next ten years. How much will the citizens of Bedford, N.H., save? We already know we have the most to lose in termsof our health and our environment.

Health and Safety

MEB-5 -The draft states, "Electric fields within the right-of-way for tha proposed DC transmission line would have intensities within the range of those reported to elicit physiological response in experimental animals."(p.4-26) In tests on mice over a relatively short period of time as opposed to the lifetime exposure of people living under the power line, some mixed results on blood counts and chemistry

RESPONSES TO MARY ELLEN BARRY

MEB-1

The density of housing units in towns to be traversed by the proposed transmission line, as presented in Section 3.2.7, is based on 1980 census data published in a 1983 document by the U.S. Bureau of the Census. That document is considered by the Staff to be a reasonable basis for discussion of residential land use in the vicinity of the proposed line. For additional information concerning housing units immediate to the proposed line, refer to the revised text presented in Section 3.2.7.

MEB-2

Schools within 300 m (1,000 ft) of either boundary of the proposed transmission right-of-way are identified in Section 3.2.7.

MEB-3

State Highways 101 and 114 are identified in Section 3.2.9.1. Additional information concerning the two highways is presented in Section 3.5.5.

MEB-4

Under base-case assumptions, the net cost savings to the New England region is estimated to be $948 million (in 1990 dollars) over the 10-year period of the Phase II contract. The distribution of these savings among the participating states and, further, within each state, is not within the jurisdiction of the Department of Energy and is not a subject for this EIS.

MEB-5

Position noted. The conclusion reached throughout Sections 4.1.8.1 (DC effects) and 4.1.8.2 (AC effects) are that the incidence of electrical effects would be intermittent, would primarily occur during bad weather, and would primarily occur directly under the transmission line at the point of maximum conductor sag. No individuals would be exposed to such conditions for extended periods of time. Additionally, conditions that produce effects in laboratory animals are more intense and of a much longer duration than the conditions to which humans would be exposed.

See previous comment page

MEB-5 (Continued)

Furthermore, the nearest inhabitants (residents, school children) would be far enough from the line and/or would be exposed to elevated levels for only brief periods of time such that health hazards or adverse physiological effects would not be created. It should be kept in mind that basing assessments of expected health effects to humans on laboratory studies values that elicit a response to small mammals is quite conservative. Laboratory animals are faced with stressful conditions just by being in the laboratory environment. Also, life span, body size, metabolism rate, and other physiological differences between a laboratory animal and a human must be considered when determining levels of effects to "free-roaming" people. In summary (as concluded throughout Sections 4.1.8.1 and 4.1.8.2), any effects from the proposed line would be within the range of variability of physiological effects that people experience from natural environmental conditions. Also, the effects that have been observed (mostly under laboratory test conditions) are not permanent (transient in nature, lasting only during the period of exposure).

The information presented in the EIS is abstracted from a very large literature source maintained by this Staff. It is not feasible to thoroughly discuss or abstract all of the literature within the pages of the EIS. Thus, the Staff has presented a conservative approach by (1) abstracting scientifically valid studies that report the lowest levels for which effects occur (e.g., lowest concentration of air ions reported to cause a physiological effect), and (2) stating the maximum values expected from the proposed Phase II operations (generally at point of maximum conductor sag and at the edge of the right-of-way). In all cases, the conclusions reached from this conservative approach are that no deleterious health effects would occur. Rather, at most only transient, reversible effects within the range of natural variability would occur under a select set of circumstances. A level of exposure at which hazardous effects might occur have not been demonstrated. Additionally, the available data do not demonstrate a dose-response or a time-course relationship. Refer to revised text Section 4.1.8.1 (Electric Field Effects).

MEB-5 (cont)

were found to exist. "Fischer (1973) found a 1000% increase in spleen plaque production, a 17% increase in spleen weight, a 58% increase in spleen cell count, and a 264% increase in hemagglutination."(p.4-26) If test results done over these short periods of time can affect mice as stated in the draft what might be the effect on people who must live under or near these lines for years? Can we risk the consequences?

MEB-6

-"Residents adjacent to the transmission lines should be informed of the possibility of induced shock and of the fact that the utilities would ground their equipment upon request. Pacemaker patients should be especially informed."(p.4-45) This cannot and should not be passed off lightly. The body does not experience the pain of electrical shock in a healthy environment.

MEB-7

-Constant audible noise will also be the fate of those who live under and near the power line with the peek times occuring during fair weather (when people are most likely to be outdoors), snowfall, or early rainfall. "Thus audible noise would be expected to be at or above normal background along the right-of-way."(p.4-35) The report says the noise level falls off as the distance from the line increases, but fails to mention how far one must be to no longer hear it? Are any studies available on the effects of constant exposure to such noise?

MEB-8

-The Vermont Electric Power Company(in their review of Phase I) recognized the danger and spent an extra $1.5 million to route the line around sensitive wildlife areas (e.g., a deer yard). Are deer and other wildlife in Vermont more important that people in Bedford, N.H., or other Southern New Hampshire towns?

Human Environment

MEB-9

-Towers to be constructed will be 75-115 feet high. This is much taller than existing lines and definitely will detract from the beauty of the countryside. Running through residential neighborhoods these structures will look particulary out of place and will not be able to be camouflaged by trees as the present structures are. (I know of no trees in this area that are 115 feet tall.)

MEB-10

-Erosion is also a problem that must be dealt with. We already have some areas of extreme erosion under existing power lines such as the gulley area near the Routes 101-114 intersection in Bedford and the "sand pits" along Back River Road in Bedford. What assurance do we have that in the future these problems will be dealt with in an environmentally sound fashion so as to prevent destructive erosion (especially by wind) and its unsightly effects.

MEB-11

-The atmosphere will also be affected. "During corona, photons emanating from the conductor surface may strike neutral atoms in the air. These energized atoms may than lose electrons, which when accelerated in the local electric field, may collide with neutral oxygen molecules causing dissociation and reassociation into ozone molecules (Hill et al. 1977)." (p.4-22) What are the effects of this increase in the ozone layer? Were any studies done?

Historic Landmarks

MEB-12

-Insufficient evidence is shown to prove that historic structures situated in proximity to the proposed right-of-way will not be adversely affected. I feel the final draft of this report should not be made until these studies have been completed. To say effects are unlikely to

MEB-6

As discussed in Section 4.1.8.1 (Proximity Effects), the potential to receive a carpet-like shock would only occur under an unusual set of circumstances. Thus, even people working directly under the proposed transmission line would probably not experience such mild shocks. People living and working at the edge of, and beyond, the right-of-way would not experience transmission line-related shocks.

MEB-7

The reference to audible noise in the comment relates to the proposed AC right-of-way, which will not be built in New Hampshire. The section applicable to the proposed DC right-of-way, Section 4.1.8.1. (Exposure to Audible Noise and Ozone), states that the maximum conductor noise levels directly under the point of maximum conductor sag would be 42 dB and 36 dB at the edge of the right-of-way. These values compare to the EPA standard of 55 dB as the level of outdoor noise identified to provide a margin of safety. Refer to the abovementioned section for a text addition concerning noise attenuation with distance. Also, see revised text in Section 4.1.8.2 (Exposure to Audible Noise and Ozone) for a discussion of noise levels at the edge of the right-of-way for the proposed AC system. Noise levels would be at or only slightly above ambient.

MEB-8

The rerouting of the Phase I transmission line around a deer yard in Vermont was done to keep an important wintering habitat for deer from being destroyed by the construction of the line. The rerouting was not done due to any expected physiological effects that wildlife would experience from the operation of the line. Because the proposed Phase II line would be located within existing rights-of-way, no construction-related impacts to a deer yard would occur. Since Phase I construction was for a new right-of-way, rerouting (while more costly) could be more readily accomplished without causing any incremental increases in impacts. However, Phase II construction would be within existing rights-of-way. Rerouting a portion of the proposed line would necessitate construction of a new right-of-way area. This would cause an incremental increase in impacts, rather than alleviate any impacts.

MEB-9

Position noted. Two points are pertinent. First, the structures for the New Hampshire segment of the proposed transmission line would mostly range from 22.9 to 35.0 m (75 to 115 ft) in height. However, a structure of 41.1 m (135 ft) and a structure of 38.1 m (125 ft) would be located in the

See previous comment page

MEB-9 (Continued)

Bedford area to span the Route 114/101 interchange and Bowman Brook and its associated wetland area, respectively. Otherwise, structure height would typically be about 27 m (90 ft) (ER, Vol. 3--p. 34). In the Bedford area, the proposed structures would be located between the two existing transmission lines supported on 18-m (60-ft) structures, thus creating incremental visual impacts. Secondly, the visual impacts related to the proposed line in southern New Hampshire (including Bedford) are described in Section 4.1.6.2 (Segment C). Accordingly, only 4 out of 151 observation points were identified as subject to ratings as high as moderate-high visual impacts. The visual effects of the existing transmission lines, the scattered larger residential and commercial structures, the fragmented patterns of vegetation, and the generally low quality of local landscapes tend to render the incremental visual impacts attributed to the proposed line of minor consequences.

MEB-10

Mitigative measures proposed by the Applicant to minimize erosion are presented in Section 2.1.5.2. Also, refer to the response to Comment SCS-1.

MEB-11

Sections 4.1.1 and 4.1.8.1 (Exposure to Audible Noise and Ozone) adequately discuss the increase in ozone production that would result from operation of the proposed Phase II transmission lines. As stated, concentrations would increase less than a few parts per billion (ppb) whereas ambient levels are on the order of 10 to 100 ppb, and health effects occur from exposure to 100 to 1000 ppb. Thus, there would be no health hazard associated with ozone production.

MEB-12

The cultural resources review process has been completed. The results of the study are that the impacts of the proposed action would not constitute significant adverse effects to historic structures.

MEB-12 (Cont)

exceed those of the existing right-of-way seems to ignore the fact that these new towers are approximately twice as tall and that they radiate a buzzing noise not associated with the existing structures.

Alternatives

No Action Alternative

MEB-13

-Seabrook I and II (in New Hampshire) seemed to have been totally ignored. In fact the draft states, "Currently, no new nuclear plants are under construction-license consideration by the U.S. Nuclear Regulatory Commission."(p.2-25) The No Action Alternative would still leave us with this alternative nuclear energy project.

Underground Transmission Line

MEB-14

-"Installing the transmission lines underground is a technically feasible alternative to construction of the proposed overhead transmission lines." (p.2-37) As stated in the draft,"Placement of the line underground would eliminate potential air quality changes that could occur with overhead transmission line operation (e.g. ozone increases)."(p.4-45) In addition the draft states, "Potential impacts associated with operation of overhead transmission lines (e.g., electric field, air ions) would be reduced or eliminated with an underground system."(p.4-49) This alternative seemsto eliminate most of the potentially dangerous health effects. "Faulty or dirty insulators and loose conductor fittings may also contribute to radio and television interference. Neither the alternative DC nor AC underground system would influence radio or television reception..."(p.4-50) As far as the effects on the environment a trench "1.2m(4ft.) wide and 1.5(5ft) deep"(p.2-37) seems more desirable than 75-115ft towers and suspended wires. Taking all the above points into considerationthis alternative appears to be the most environmentally preferrable alternative.

Alternative Routes

MEB-15

-The proposed routes appear to offer no viable alternatives to passing directly through Bedford, N.H. Other routes bypassing this highly residential community ought to be addressed in the final EIS.

MEB-14 (cont)

I feel that the above comments show that further consideration must be given to the underground transmission line for the town of Bedford, N.H., and other densely populated Southern New Hampshire communities. I think I have presented evidence that if this power line must exist this is the most environmentally preferrable alternative. The cost of people's health and safety cannot be estimated and therefore any additional cost for this alternative must not enter into the consideration process.

MEB-16

With many questions about the safety and desirability of the proposed power line still unanswered and the availability of an environmentally preferrable alternative, I ask that a public hearing to seek public comment be held in the town of Bedford, New Hampshire, at a time preferrably in the evening to accomodate working people. This hearing should also be publicized in a manor that the majority of Bedford residents will be make aware of it so that they too can express their concerns.

MEB-17

I also would like to lodge a formal complaint about the failure of the draft to give the exact date of the end of the comment period. Until some specific date has been set and the involved citizens have been informed of it with ample time to comment, this period should not end. Very little information seems to have filtered down to the victims of this power line

MEB-13

The fuel use figures in Table 1.5 and the reserve margin in Table 1.6 assume the installation of Seabrook I. Seabrook II is assumed to be cancelled.

MEB-14

While constructing the proposed line underground is a technically feasible alternative, it would have a number of environmental and economic disadvantages. Benefits to be derived by undergrounding (e.g., no incremental increases in audible noise, visual impacts, electric fields, air ions, etc., all concluded to be minimal and not a health hazard) do not justify the disadvantages. These disadvantages include increased erosion, greater impacts to wildlife, increased land acquisition, greater potential to impact surface and groundwater resources, increased right-of-way maintenance (e.g., increased use of herbicides), and greater impacts to wetlands. For more discussion refer to revised Sections 2.2.8.5, 2.3.2.2, 2.3.2.3, and 2.3.2.4. From an economic standpoint, the cost for an underground system would be about $460 million more than for the overhead system. Also, annual operation and maintenance costs would be $40,000 to $45,000 per mile per year for the underground system compared to only $5,000 per mile per year for the overhead system (ER, Vol. 4).

MEB-15

Comment noted. Refer to Section 2.1.2 for discussion of route selection criteria. The alternative routes were also selected with the same criteria. Therefore, the lack of availability of other suitable existing utility rights-of-way precludes alternative routes that bypass Bedford.

MEB-16

During the comment period, no new information was presented. The public has had adequate opportunity to express their concerns throughout the comment period. In addition, DOE has obtained copies of the transcripts of the adjudicatory and informational hearings held throughout New Hampshire and Massachusetts. Several requests for public hearings were denied in the response letters mailed by DOE on October 23, 1986.

MEB-17

Existing procedures preclude the designation of the comment period within the draft EIS. However, a Federal Register notice was published on August 22, 1986, announcing the start and close of the comment period. In addition, legal notices were placed in 10 local newspapers.

See previous response page

MEB-17 (Cont) either consciously or unconsciously and I think an effort should be made to see that ample time and adequate study go into a project whose consequences are so far reaching. I know I may be only one citizen but I stand for many who are unfamiliar with the intricacies of these studies and do not want to see a high voltage power line run through Bedford when there exist other more desirable alternatives.

Sincerely,

Mary Ellen Barry

Mary Ellen Barry

cc: R. Stearn, Office of Environmental Guidance, Wash. D.C.
E. Higgins, EPA, Region 1, Boston, MA
G. Beckett, USFWS, Concord, NH
K. Jackson USACOE, Waltham, MA
R. Bellmer USACOE, Waltham, MA

23 Forest Drive
Bedford, New Hampshire 03102
September 20, 1986

Mr. Anthony J. Como
Department of Energy
Economic Regulatory Administration
Office of Fuels Program (RG-22)
1000 Independence Ave., SW
Washington, D.C. 20585

RE: New England/Hydro-Quebec ± 450 kv Transmission Line Interconnection -- Phase II (DOE/EIS-0129D)

Dear Mr. Como:

MEB-18

Enclosed please find photocopies of two recent newspaper articles, one from the Nashua Telegraph (NH), September 18, and the other from the Manchester (NH) Union Leader, September 19, concerning the project which is the subject of the above referanced DEIS. It is with great dismay that I have learned that the Powerline Awareness Committee has signed a legal agreement (i.e., "settlement") with the the project proponent, New England Power Pool, to withdraw their opposition to the project in exchange for a promise to study and monitor the line. I have personally contacted an individual representing the Powerline Awareness Committee who was a party to the "negogiations" and that person has stated that the agreement legally binds their group from further opposition to the line and that some of the conditions can not be disclosed.

I believe that this sort of legal agreement is a direct violation of the spirit, if not the precise language, of the National Environmental Policy Act and the CEQ Guidelines implementing that Act as well as directing your office's preparation of the EIS. I do not object to negotiations or informal agreements with a project proponent (i.e., applicant) prior to construction and rightfully so that is probably the best time for such agreements or mitigation measures to be identified. However, I think it is unprecedented in the NEPA process for the project proponent to legally obligate opposition groups to withdraw all action against the project. This is clearly an attempt by NEPOOL to prejudice your office's impartial review of comments on the DEIS. How representative are the comments you will receive between now and September 29 (the end of the comment period) when a major opposition group has already been legally silenced by the project proponent?

I want to make it clear that in no manner does the Powerline Awareness Committee represent me and that the comments on the DEIS that I have previously sent you should be considered seriously and answered in the final EIS. For the record, I made one small donation to the Powerline Awareness Committee in early 1986 but I was never informed of these so-called secret negotiations between NEPOOL and the Committee. My first knowledge of this agreement was through the attached newspaper articles. It is difficult enough for a private individual, such as myself, to participate in the NEPA process without having a large and wealthy project proponent unduly influencing the review procedures.

MEB-18
Comments noted.

MEB-19 In additon to the above serious concern, the segmentation of this project, allowing NEPOOL to have nearly completed construction of Phase I in Vermont while the EIS process of Phase II is in progress, seems to be a direct contradiction of the NEPA process and recent federal court decisions concerning the "piece mealing" or "segmenting" of projects. This would appear to add undo pressure to your decision-making process since millions of dollars have already been spent on construction of Phase I.

MEB-20 Also not to be overlooked is the following quote from the September 19 Union Leader article: "The (Attorney General's legal) brief says PSNH's power requirements under an agreement with the region-wide New England Power Pool can be met without the Quebec power during the 1990's. Other supplies, including power from the Seabrook Unit 1 nuclear plant and from small producers will fill the requirement, the brief says" Since the agreement signed by Hydro Quebec and NEPOOL also extends through the 1990's, there seems to be no demonstration of need for this powerline to be constructed along the 121 mile corridor through the center of New Hampshire farmland, forestland, and its densely populated southern tier.

Considering the seriousness of the above charges, I would very much appreciate your immediate attention to this matter. Would you also keep me informed of any action your office takes to respond to my concerns.

Sincerely,

Mary Ellen Barry

Mary Ellen Barry
Homeowner in Bedford, NH

cc: R. Stearns, Off. Environ. Guid., DOE
S. Merrill, NH Attorney General

MEB-19

The Phase I and Phase II projects are not considered to be segmented projects. See the response to Comment DOI-10.

MEB-20

Section 2.2 has been extensively revised to more adequately describe the need for Phase II of the interconnection.

Power Line Protesters Compromise

Merrill: Hydro Pact Bad Deal

By JOHN DISTASO
Union Leader Staff

CONCORD — The New Hampshire Attorney General's Office said yesterday the proposed second phase of a powerline project to tap New England into Quebec's vast electricity reserves is a bad deal for New Hampshire ratepayers.

At the same time, a group which has fought the project for about a year over health and environmental concerns withdrew all of its objections after winning commitments from the builder to study and monitor the line once it is energized.

The state Bulk Facility Site Evaluation Committee is scheduled to rule on the 121-mile, $600 million project by Oct. 8, and the Public Utilities Commission, by Dec. 8. Months of hearings on the plan ended last month.

In a final brief filed yesterday at the PUC, the Attorney General's Office asks the project be approved only if the deal be restructured more favorably to New Hampshire ratepayers and other conditions are met.

The brief says the builder, New England Hydro-Transmis-

HYDRO Page 8

Hydro line dispute resolved

By STEVE SAKSON
Telegraph Staff

CONCORD — Plans by New England utilities to import hydropower from Quebec moved a major step forward Wednesday with the settlement of a yearlong dispute over construction of a high-voltage line to carry the electricity through New Hampshire.

The Powerline Awareness Campaign — a citizens group that has maintained the line would damage the health of those near it — agreed to drop its opposition.

In exchange, the New England Electric Co. — which wants to build the line — promised to spend up to $1.25 million on two preliminary studies related to its health impact.

The first study will determine the precise measurements of the static electric, magnetic and air ion fields along the power-line route — both before and after it operates.

The second will determine the feasibility of doing a full-blown, long-term examination of the line's health effects.

The settlement does not require the company to actually perform

HYDROPOWER Page 16

Hydropower dispute

From Page 1

the examination, even if it is feasible.

That examination will remain a major, unmet goal of the 150-member Powerline Awareness Campaign.

Campaign Co-Chairman Hal Lynde of Pelham said last night that the settlement left him with "very mixed emotions."

"It's a certain amount of relief to have won some of the things we wanted to win. There's also a certain amount of disappointment in that we would have liked to achieve more."

New England Electric attorney Richard Couser called the settlement "a major breakthrough."

"We're pleased to be able to say we are leaving this shaking hands rather than with our backs turned to each other," Couser said.

The settlement doesn't actually guarantee that the line will be built through New Hampshire.

That decision still rests with the state Bulk Power Supply Site Evaluation Committee and the Public Utilities Commission.

Both sides agreed, however, that the absence of concerted opposition to the line will be a major factor in the decision of the state regulators.

New Hampshire is the last of three New England states that must pass judgment on the 450,000-volt line.

Construction of the Vermont portion is nearing completion and Massachusetts has given the go-ahead for its portion.

In New Hampshire, the line is planned, for the most part, along existing power company rights-of-way.

It would run 121 miles from Monroe in northern Grafton County to Hudson, is estimated to cost $547 million and is due for completion in 1990.

The power it is designed to carry is supposed to be significantly cheaper than that generated by oil- and coal-burning power plants, on which New England is heavily dependent.

During six months of state hearings, witnesses for New England Electric contended that the line remains economical even though the price of oil has plummeted in recent years.

They also insisted that there is no proof of any ill effects of such lines.

Campaign members cited cases in Minnesota in which people who live near a similar line suffered nausea, headaches and irritability and their farm animals experienced spontaneous abortions.

A turning point in the dispute occurred in mid-July when a scientist hired by the state testified that, while no ill health effects have been proven, the vast majority of the studies done on the subject so far are scientifically flawed.

In mid-August, just before the hearings concluded, the campaign and the company quietly began the settlement negotiations that ended Wednesday.

Campaign lawyer Michael Walker said he thinks that, even though New England Electric isn't obligated to fully examine the line's health effects, the company or some other utility group will do so if that examination is feasible.

"The utility industry in general would be interested in seeing it done. They want the confidence of people," Walker said.

Walker also noted that New England Electric agreed in the settlement to a series of environmental restrictions, including limitations on herbicide spraying necessary to keep the line free of vegetation; a promise to plant shrubs and trees to block the view of the line from nearby homes; and a promise to restore land disturbed by the construction.

"I'm impressed by what they did," Walker said.

Also included in the settlement is a complaint procedure under which New England Electric must, for five years, report all complaints about the line to the state, along with how they were handled.

The settlement leaves one remaining issue unresolved.

The state attorney general's office, which has participated in the power-line case as a neutral party, has reserved the right to dispute some of New England Electric's contentions on the economic benefits of the line.

PORTLAND PIPE LINE CORPORATION

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WALLACE R. McGREW
PRESIDENT

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ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 8 1986
POWER SUPPLY & RELIABILITY

September 5, 1986

Mr. Anthony J. Como
U. S. Department of Energy
Economic Regulatory Administration
Room GA-093, RG-22
1000 Independence Avenue, S. W.
Washington, D. C. 20585

RE: New England/Hydro-Quebec ± 450 kv Transmission Line Interconnection - Phase II, Draft Environmental Impact Statement, Publication Number DOE/EIS-0129D, August 1986

Dear Mr. Como:

PPLC-1

The following comments and proposed mitigation conditions are hereby submitted in the referenced matter by Portland Pipe Line Corporation ("Portland"). 1/ On July 15, 1985, Portland submitted a letter to you expressing its concern regarding the significant impact that the high voltage direct current transmission lines here involved will have upon the corrosion control of its underground pipelines. A copy of that letter is enclosed as Appendix A (omitting the four reference materials, discussed on p. 2 of that letter, which were enclosed therewith).

By way of historical background as to Portland, its construction came about after its designation as a National Defense Pipe Line by Proclamation of President Franklin D. Roosevelt on October 1, 1941 (Proc. No. 2517, 6 F.R. 5081, 55 Stat. 1691), under power granted to the President by the Act of July 30, 1941, Public Law 197-77, 77th Congress, Chapter 333, known as the Cole Act. Portland is subject to the Agreement between the United States of America and Canada: Transit Pipelines, signed on January 28, 1977, and entered into force October 1, 1977 (T.I.A.S. 8720 (1977)).

The referenced draft Environmental Impact Statement nowhere mentions or otherwise discusses the Portland concerns expressed in the July 15, 1985, letter and is, thus, defective in this respect. See, Lathan v. Volpe, 455 F2d 1111 (9th Circ. 1971) and the regulations of the Council on Environmental Quality ("CEQ"), 40 CFR § 1503.4. It is Portland's position that the Final Environmental Impact Statement (FEIS) should reference and discuss Portland's concerns as set forth in its July 15, 1985, comments. The FEIS should also consider, in this connection, a binding and enforceable contract between Portland and New England Electric Transmission Corporation ("NEET") which meets Portland's concerns. A copy of that contract, taking the form of a letter agreement (with three appendices) from the undersigned, as President and on behalf of Portland, countersigned and attested under seal by the President of NEET, is enclosed hereto as Appendix B. That letter agreement may be summarized as providing for the

1/ Comments are due on or before September 29, 1986, as stated at 51 Federal Register at 30107, Friday, August 22, 1986.

RESPONSES TO THE PORTLAND PIPE LINE CORPORATION

PPLC-1

Concerns noted. See the response to Comment BSGC-1 relative to the use of an overhead dedicated metallic return conductor instead of an expansion of the Phase I ground electrode. Additionally, the Portland/NEET agreement will be enacted. This includes NEET's commitment to purchase and install a rectifier system and a cathodic protection monitoring and maintenance system. This agreement will be in effect during the interim period while the dedicated metallic return conductor is being installed (when the Phase I ground electrode system has to be utilized).

Mr. Anthony Como
U. S. Department of Energy
September 5, 1986
Page 2

See previous response page

PPLC-1 (cont)

payment by NEET of the costs of purchase and installation of an underground rectifier system, the payment by NEET of the cost and installation of a cathodic protection monitoring and maintenance system, and the establishment of a system of responsibility for claims arising from the effects of the high voltage transmission line. This letter agreement was reached with NEET because it owns and operates the facilities in New Hampshire where the ground electrode is located.

Since the Portland/NEET Agreement addresses the serious environmental concerns raised by Portland in its July 15, 1985 comments, Portland believes that it should be incorporated by reference and imposed as a mitigating condition by DOE to the issuance of an amendment to Presidential Permit PP-76. Imposition of this condition would thus satisfy DOE's mandate under the National Environmental Policy Act and the DOE's regulations thereunder. See, 10 CFR § 1021.2, incorporating by reference the regulations of the CEQ, including 40 CFR § 1502.16(h) concerning mitigation.

Respectfully submitted,

W. R. McGrew
President
Portland Pipe Line Corporation

WRM:paj
Enclosures
cc: Vernon R. Walker, Esquire
Swidler & Berlin
Council for Applicant Vermont Electric Transmission Company

K. L. Ramsauer, Esquire
New England Electric Transmission Company
c/o New England Power Service Company
25 Research Drive
Westborough, MA 01582-0099

w/enclosures

WILLIAM AND DIANNE CARON

Sept. 13, 1986

William + Dianne Caron
51 Whippoorwill lane
Bedford, N.H. 0310[illegible]

Dear Mr. Como,

I am writing in regards to the N.E. Hydro-Electric power lines which are to begin construction in 1987, and will pass less than one mile from my home in Bedford N.H.

WDC-1 I understand, though not fully proven, that the health of my family could be affected by these lines in several ways. And

WDC-2 I also understand that there are alternatives to these lines such as underground lines. Why not put them under ground?

WDC-3 If the lines were re-routed around wild life in Vermont

WDC-1
Concern noted. See the responses to Comments MEB-5 through MEB-7 and MEB-11.

WDC-2
See the response to Comment MEB-14.

WDC-3
See the response to Comment MEB-8.

WDC-3 (Cont)

I would hope that the Dept of Energy would agree they should be re-routed around the children of Bedford N.H. ~~They would~~

Thank You for your time

Mrs Wm. J. Caron

See previous response page

RALPH KIRSHNER

Ralph Kirshner
Whortleberry Island
Star Rte. 62 Box 487A
Centre Harbor, N.H. 03226
603-569-1517

12 September 1986

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 19 1986
POWER SUPPLY & RELIABILIT

Mr. Anthony J. Como
U.S. Department of Energy
Economic Regulatory Administration
Room 3A-093, RG-22
1000 Independence Avenue
Washington, DC 20585

Dear Mr. Como:

This letter of comment pertains to the Draft EIS for the New England/Hydro-Quebec ±450 kV Transmission Line Interconnection--Phase II, publication number DOE/EIS-0129D. The Draft EIS contains serious errors and omissions which render it misleading and inapplicable in appropriately judging the environmental impact of the proposed project.

The primary problem is the failure to consider the environmental effects of the project as a whole. Instead, it looks at the construction of the transmission line as if it were a self-contained project, consisting of a middle with no ends. I do not know of unconnected transmission facilities anywhere. In this case, as in others, the project proposes power production facilities at one end and power consumers at the other. The environmental effects of this production and consumption are an integral part of the project and must be considered along with the effects of the line itself. Otherwise, this Draft EIS is as useful as the apocryphal 19th century EIS of the elephant by the six blind men. An analysis of the elephant's trunk or tail tells you very little about the nature of the beast., so it is with this Draft EIS and its analysis of just the transmission line.

RK-1 For example, the Draft EIS concludes in Sections 3-17 (3.4.4.2) and 4-17(4.1.4.4) that there are minimal effects on threatened and endangered species, since they are only transient users of the corridor. It totally ignores the effects of power production in the generating facilities' 4,600 square mile watershed (larger than Great Britain), where water level fluctuations, erosion and sedimentation, and other environmental changes have already increased the aquatic mercury concentrations to over four times allowable limits. Since many of these species are migratory, for example Eagles, Ospreys, and Common Loons, it cannot be concluded that Canadian environmental changes have no impact on American wildlife. While the Canadian facilities may be outside of DOE's jurisdiction, the wildlife does not recognize political boundaries. DOE is obligated by law, in any case, to analyze the environmental impact of the American portion of the line on endangered species. It is inadmissible to conclude this project would have a minimal impact simply because the effect of American construction may be felt up the line in Canada, with the species later returning to the U.S. Hydropower generation, for example, will result in greater unnatural discharge patterns from the dams, as a result of U.S. peak demand cycles taking precedence over climatologic cycles. These discharge patterns may seriously disrupt habitats, behavior, breeding, food availability and quality, and other factors critical to the survival of endangered and threatened species.

RESPONSES TO RALPH KIRSHNER

RK-1

See Section 4.1.4.5 for added discussion of NEPA requirements for considering international environmental impacts. Also, refer to Section 4.1.4.5 and, particularly, Appendix C for information on the impact of the proposed project on migratory birds.

RK-2 The DOE apparantly wants to ignore the environmental effects of the generation facilities by looking only at the transmission lines. This is as dishonest as a hangman ignoring the results at the end of his line and examining only the rope. Similarly, DOE should examine the U.S environmental effects of making larger quantities of electrical power available, reducing the need for conservation. The Draft EIS considers neither production nor consumption, and is therefore fatally flawed and not in compliance with NEPA. We do not allow the importation of products of endangered species from Canada, why should we allow the importation of a product called electricity produced to the detriment of those species, and possibly ourselves?

RK-3 The Draft EIS also makes unsupportable conclusions based on questionable assumptions and selective use of available data. For example, it says in Section 2-45 (2.3.2.8.) ". The levels of air ions, ozone, audible noise, electrical fields, and magnetic fields...are within levels that have been shown to have little or (more often) no biomedical or behavioral effects on animals and humans." No such showing has been made, although NEPOOL would like the public to believe so. Considerable scientific controversy exists on these points, which is unlikely to be resolved for at least ten years. It is again dishonest of DOE to make such statements unless it wants to lead the public to believe that an incestuous relationship exists with the applicant.

RK-4 The Draft EIS also makes unsupportable economic assumptions about alternative energy costs. It states in section 1-5: "...the projected price of fossil fuels must drop 60% from the base values before the Phase II project becomes a questionable economic choice....[this]would equate to $11/barrel oil and $33/ton coal prices in 1990..." Since this is very close to current projected 1990 prices, the conclusion can be drawn that the Draft EIS is based on inflated economic projections. In addition, it states in section 1-5 that using these base prices coupled with a 25% cost overrun in construction, not unusual in projects of this magnitude, would result in a net cost (not gain) to consumers of almost a quarter billion dollars. Such figures require a closer examination of alternative energy sources than is present in the Draft EIS.

It dismisses the possibility of alternative energy sources with erroneous statements like that found in section 2-26: "Members of NEPOOL are actively pursuing the development of alternative generation sources..." The biggest member of NEPOOL in New Hampshire, the Public Service Co. of N.H., where the major portion of this project would be built, recently went before the N.H. Public Utilities Commission to actively discourage alternative generation. P.S.C., citing the potential of over 500 Megawatts of alternative power potential in New Hampshire alone, which it would have to purchase at PURPA rates, asked for relief from these requirements since it would create financial difficulties in selling power from the Seabrook nuclear plant. When the question becomes economic rather than environmental, NEPA is very clear on priorities, and this Draft EIS fails to follow them.

RK-5 A related omission pertains to the economics of the Canadian-U.S. agreement on the price of power. It is now pegged to a percentage of the cost of power produced by fossil fuels, rather than the cost of production and transmission plus a reasonable profit. It should be noted that Hydro-Quebec has excess generating capacity available because it purchases hydropower from the Churchill Falls project at a few tenths of a cent a kilowatt, and has been unwilling to renegotiate its long-term contract with Labrador, which wishes to increase its revenues. Hydro-Quebec will be selling this power to the U.S. at a markup of several hundred or thousand percent, a nice deal for them, but questionable for approval of a Presidential Permit.

RK-2

Section 2.2 contains a discussion of alternatives to the proposed action, including the opportunities for conservation.

RK-3

See the responses to Comments MEB-5 through MEB-7 and MEB-11.

RK-4

Alternative generation sources are being actively pursued by NEPOOL. Section 2.2 (in particular Section 2.2.2.5) has been revised to better reflect this action by NEPOOL. Fuel price projections and project capital costs have been reviewed by the applicant since preparation of the draft EIS. The revised cost/benefit analysis in Section 1.3 reflects these changes.

RK-5

DOE does not have an economic criterion for issuing a Presidential permit. In addition, DOE does not regulate the importation of electric energy and, consequently, does not approve or otherwise pass judgment on the terms of the commercial arrangement.

RK-6 The Draft EIS similarly omits massive amounts of public input concerning this project merely because it was not presented to your agency. Section 3-19 (3.5.6) dismisses in 12 lines the very real concerns of the public, whether justified or not. The New Hampshire Bulk Power Supply Site Facility Evaluation Committee, which includes the P.U.C., has heard weeks of testimony from hundreds of people on this project. It is incredible that the DOE assumes it does not exist simply because the DOE chose not to be present. DOE arrogance landed it in serious trouble in New Hampshire recently over high-level nuclear waste — does it really want a repeat performance? Why not do the job right in the first place, rather than attempt a whitewash like this Draft EIS?

RK-7 Similar incredible conclusions can be found throughout the EIS. For example, it frequently states that any negative health effects will be minimal since exposure times will be limited. The proposed corridor is the most heavily populated of any high-voltage DC line yet built. On what is this conclusion based, therefore? The EIS ignores the presence of schools and similar public facilities adjacent to the line, and assumes that since laboratory effects on average have not been detrimental to healthy experimental animals, there will be no detrimental effects on possibly

RK-8 particularly susceptible *individuals* such as children, the elderly, or the infirm. Also, it ignores the undisputed health effects of the project on the native peoples of Canada, again considering the transmission line as a disconnected entity. Further comments on this issue are contained in a copy of my letter of 7 October 1985 to the New Hampshire Bulk Power Supply Site Facility Evaluation Committee, enclosed.

RK-9 Another example of selective use of data comes in various discussions of herbicide use on the right-of-way, such as in section 2-18. Whether or not right-of-way applications would be any different from present practices, it is not justifiable to conclude there are no adverse effects. Both New Hampshire and Massachusetts, according to table B-1 in Appendix B, permit cut stump applications of Krenite within wetlands; invariably some of it will enter the water cycle and food chain. The Draft EIS also concludes that since the U.S. Forest Service permits 2,4-D applications on USFS land, there are no problems with this chemical. It neglects to mention that the National Park Service in the Department of the Interior has banned the use of 2,4-D on NPS lands! If federal agencies differ, how can the public have any confidence? Few of these chemicals have ever been properly tested; the EPA is permitting them to remain registered while it retests a few a year, and anticipates the testing process will take at least another 20 years. By then, it may be too late.

The Draft EIS assumes that any problems created by the construction of this project can be resolved through the magic of "mitigation." Mitigation consists of putting Humpty Dumpty together again. As a wildlife biologist, I am all too aware of how little we know about the functioning of natural systems, and the effects of human interference with these systems. It is the ultimate in federal arrogance to assume these are simple engineering problems, where construction is no more difficult than destruction. We have been proved wrong time after time. Wouldn't it be appropriate to proceed with a little more caution for a change?

In conclusion, the Draft EIS cannot meet the requirements of NEPA without major revision, due to errors of omission and unjustified conclusions. I hope the DOE will make the effort to do the job right before a final EIS is issued, and save everyone a lot of legal hassles and expense. Thank you for your attention to these matters.

Sincerely yours,

Ralph Kirshner

Ralph Kirshner

RK-6

DOE has the available transcripts from the hearings and a copy of the favorable decision of the New Hampshire Bulk Power Supply Site Evaluation Committee.

RK-7

See the responses to Comments MEB-5 through MEB-7 and MEB-11.

RK-8

See response to Comment RK-1.

RK-9

As stated in Section 4.1.8.4, only herbicides registered by the U.S. Environmental Protection Agency and the states of New Hampshire and Massachusetts would be used. Additionally, the herbicides would be limited to those approved for rights-of-way management. Application would be in accordance with label directions and state limitations (the latter summarized in Table B.1). As discussed in Section 4.1.8.4, a large safety margin exists between reported chronic toxicity levels and exposure levels to the public or workers. Lack of injuries to workers from herbicide use, as contrasted to injuries from mechanical means of vegetation management, attests to the safety of currently designated herbicides when appropriately used.

The National Park Service (NPS) has not banned the use of 2,4-D on NPS lands. All pesticides for use on NPS lands are reviewed on an annual basis. Currently, 2,4-D is approved for use on a limited case basis.

FRANCES PROVENCHER

September 15, 1986

ECONOMIC REGULATORY ADMINISTRATION DOCKETED SEP 19 1986 POWER SUPPLY & RELIABILIT

Mr. Anthony J. Como
Department of Energy
Economic Regulatory Administration
Office of Fuel Programs (RG-22)
1000 Independence Avenue
Washington, D.C. 20585

RE: New England/Hydro-Quebec ± 450 KV Transmission Line Interconnection--Phase II DOE/EIS-0129D

Dear Mr. Como:

As a resident of Bedford, New Hampshire who lives about 1/8 of a mile from the proposed power line, I am concerned.

FP-1 There seems to be so many unanswered health issues about the proposed line. I have been following the progress of the proposed line and became increasingly concerned when I read that the Vermont Electric Power Company spent a extra $1.5 million to reroute the line around sensitive wildlife. Shouldn't human beings be given the same considerations? I understand such a line has never been run through such a populated area. Why do we have to possibly risk our health for the sake of electricity? Such things as induced shock, hair standing on end, audible noise levels, increase in ozone levels to say nothing of the reports from the Minnesota farmers of the effects the line out there has had on their livestock and themselves remain unanswered. In some areas where the line is proposed, children get on and off the school bus under the line. Will it take a serious accident before other alternatives are considered?

To me, these are issues which need to be studied and answered to the satisfaction of those people who live near the proposed route of the line. I would like to request a public hearing to be held here in Bedford (the most populated area the proposed line to to past through) so the residents can voice their concerns.

Thank you for your consideration.

Sincerely,

Frances Provencher

Frances Provencher
24 Gault Road
Bedford, N.H. 03102

RESPONSES TO FRANCES PROVENCHER

FP-1

Concerns noted. See the responses to Comments MEB-5 through MEB-7 and MEB-11 relative to health and safety issues. Also refer to the response to Comment MEB-8 in relation to routing of Phase I around a deer yard.

JANE C. BLAIS

20 Forest Dr.
Bedford, N.H. 03102
September 10, 1986

Anthony J. Como
Department of Energy
Economic Regulatory Administration
Office of Fuel Programs (RG-22)
1000 Independence Ave., SW
Washington D.C. 20585

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 22 1986
POWER SUPPLY & RELIABILIT.

Dear Mr. Como,

I am writing in reference to the Environmental Impact Statement Deadline concerning the New England/Hydro-Quebec ± 450 KV Transmission Line Interconnection Phase II DOE/EIS-0129D.

JCB-1

According to the draft, residents adjacent to the transmission lines should be informed of the possibility of induced shock and that utilities will ground their equipment upon request. Pacemaker patients it states should be especially informed. This truly does not sound like a healthy environment to be living adjacent to. I am a Bedford, N.H. resident who lives less than 1/10 of a mile from the existing power line. I also must go under these power lines at least four times a day. Does this mean I will be receiving a carpet like shock each time I go under these lines? I also care for my dad who has a pacemaker. This new power line is definitely going to have an effect on my dad.

RESPONSES TO JANE C. BLAIS

JCB-1

See the response to Comment MEB-6 relative to shock effects. Also, as stated in Section 4.1.8.1 (Cardiac Pacemakers), the maximum DC electric fields would be 100 times lower than necessary to affect pacemakers. Cautionary concern exists for pacemaker patients relative to the AC lines (see Section 4.1.8.2 [Cardiac Pacemakers]). However, risk to pacemaker patients would be extremely small and then only to those who would be within the right-of-way. The Staff has proposed a mitigative measure (Section 4.1.10.6) relative to pacemaker concerns.

JCB-2 According to the draft there will be an audible noise at or above the normal background level along the line. What kind of studies have been done on such constant exposure to noise?

JCB-3 The draft also states that there would be an increase in the ozone level. What effects will this increase in the ozone level have? Have any studies been done?

JCB-4 I also understand that the tower designs will be 75-115 ft. high. These lines certainly will not be camouflaged by trees like current structures are.

JCB-5 Erosion is already a problem especially in two areas in Bedford, N.H. (ex. the gulley near Rte 101-114 intersection and the sand pit area on Back River Rd.) [which is adjacent to where I live] What steps are being taken to prevent this in the future?

JCB-6 In Bedford, N.H. all three schools are less than one mile away from the existing powerline. Once again, according to the statements in the draft that electric fields within the right-of-way will have intensities within the range reported to elicit physiological response in experimental animals. Can we just ignore these results? What effect will this have on our school children and their teachers? Memorial School is less than 1/10 of a mile from the line. Peter Woodbury School is

JCB-2
See the response to Comment MEB-7.

JCB-3
See the response to Comment MEB-11.

JCB-4
See the response to Comment MEB-9.

JCB-5
See the response to Comment MEB-10.

JCB-6
Schools within 300 m (1,000 ft) of either boundary of the proposed transmission line right-of-way are identified in Section 3.2.7. The McKelvie and the Kellog-Peter Woodbury schools are located 1.2 km (0.75 mi) and 0.4 km (0.25 mi) from the proposed right-of-way, respectively. Even the closest schools are far enough removed from the proposed line that school children would not be exposed to conditions that have been found to produce effects in laboratory animals. Also, the duration of exposure to children would not approach that to which laboratory animals have been exposed. Also see response to Comment MEB-5.

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 22 1986
POWER SUPPLY & RELIABILITY

JCB-6 (Cont) less 1/4 mile from the line. I have two children presently enrolled in Peter Woodbury. What type of physiological effects will this have on my children.

JCB-7 Bedford, N.H. is a residential community with no heavy industry. The potentially dangerous health affects combined with the 75-115 ft. towers will definitely affect the property values in our town. A comprehensive study done by an independent real estate company should be done before EIS is submitted. The draft shows no evidence of any previous study being done.

JCB-8 The Vermont Electric Power Company (in their review of Phase I) recognized the dangers and spent an extra 1.5 million to route the line around sensitive wildlife areas. Are the wildlife in Vermont more important than the people in Bedford N.H.?

JCB-9 There are other alternatives that exist. The underground transmission line for example eliminates most of the potentially dangerous health effects and is a feasible alternative according to the draft. Trenches approximately 4 ft. wide by 5 ft. deep, also seem environmentally preferable to 75-115 ft. towers and suspended wires. Routing around high density population areas like Bedford, N.H. is another unexplored possibility. More in depth studies of alternatives should

JCB-7
A study has been conducted for the Applicant by a New Hampshire real estate broker (Lamprey 1986). The study concluded that the existing power lines have not affected nearby properties, although they may have influenced market depth. The study also concluded that the addition of the proposed DC transmission line would not adversely affect local property values [see Section 4.1.5.] The DC line would be an incremental addition to an existing right-of-way. Therefore, property values would have already been impacted by existing lines.

JCB-8
See the response to Comment MEB-8.

JCB-9
See the response to Comment MEB-14.

See previous response page

JCB-9 (Cont)

and must be pursued before the final EIS is submitted. With many questions about the safety and desirability of the proposed power line still unanswered and at least one environmentally preferable alternative (the underground transmission line), I ask that a public hearing be held in Bedford, N.H.

It is my hope that these concerns will not be overlooked and that they be considered before the final EIS is submitted.

Sincerely,

Mrs. Jane R. Blair
20 Forest Dr.
Bedford, N.H. 03102
603-669-5616

PHYLLIS AND EDWARD HICKEY

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 22 1986
POWER SUPPLY & RELIABILITY

50 John Goffe Dr
Bedford N.H. 03102
Sept 16, 1986

Anthony J Como
Dept of Energy
Washington DC

Re: Environmental
Impact Statement
N.E. Hydro-Quebec ±450 kv
Trans. Line Interconnection
Phase II DOE/EIS-0129D

Dear Mr Como,

PEH-1 We are very concerned about the above transmission line which is proposed for construction thru Bedford. The studies performed regarding the density of population are outdated. The power company specifically stated they would avoid highly populated areas & yet this line will be in close proximity to our schools & cut thru our residential sections.

PEH-2 The Vermont Power Company, in their version of Phase I, recognized the danger these lines posed, and spent $1.5 million to route the line around sensitive

PEH-1
See the response to Comment MEB-1.

PEH-2
See the response to Comment MEB-8.

2

PEH-2 (Cont)

wildlife areas. We feel the same consideration should be given to the people of Bedford.

PEH-3

Alternatives should be more extensively explored. The under-ground transmission line, for example, is a feasible alternative according to the draft.

PEH-4

We highly object to being invaded by an increase in ozone level, audible noise, induced shock, potential hazard to pacemaker patients, and the destruction of the

PEH-5

beauty of the area by these high towers.

PEH-6

In addition, what compensation are we to expect when, because of this line, our property value will decrease?

We pray to God that you will place the people's safety above all else when making your decisions.

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 22 1986
POWER SUPPLY & RELIABILITY

Respectfully,

Phyllis and Edward Hickey

PEH-3

See the response to Comment MEB-14.

PEH-4

See the response to Comments MEB-5 through MEB-7, MEB-11, and JCB-1.

PEH-5

See the response to Comment MEB-9.

PEH-6

The Staff believes that the addition of the proposed DC line is unlikely to have any significant adverse effect on nearby property values. Lamprey (1986) reports that properties located along the existing transmission lines consistently sell for prices comparable to those of properties located away from the right-of-way. Although sample size was small, the same study found no significant differences in values for properties located along an existing right-of-way before and after the addition of a new transmission line. See also revised Section 4.1.5.

DAVID A. MURPHY

Bath N.H.
Sept 20, 198C

U.S. Dept. of Energy
1000 Ind. Ave SW.
Washington D.C

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 24 1986
POWER SUPPLY & RELIABILITY DIV.

Dear Mr. Como

I have read your report sir on the 450 KW Transmission line from Quebec thru Vermont and N.H to Mass.

I am very much in favor of procuring Hydro-Electric Energy from Canada or energy from any other source I think it could very well prove to be absolotely essential to the future growth of the Northeastern section of our country

DAM-1 & 2 However I am appalled at the ~~slight~~ slight attention you have

RESPONSES TO DAVID A. MURPHY

DAM-1

See the response to Comment MEB-9 in regards to aesthetics. Also, refer to Section 4.1.6.2 (New Hampshire - Segment A) for discussion of visual impacts related to the proposed transmission line in the Bath area.

DAM-2

See response to Comment PEH-6.

DAM-1 & 2 (Cont)

to the aesthetic and economic impact that this aerial highway will have on the State of New Hampshire

DAM-3

The proposed 90' to 115' high towers are relics of bygone ~~days~~ era as such they destroy the economic land growth and the development and preservation of our quality of life but there is another way to prevent the depredation of ~~the~~ Mother Natures beauty of the northcountry and that is to locate this energy highway underground in as many areas as possible

I am retired after having spent 40 yrs as a piping design draftsman, designer and design engineer power plants, oil

DAM-3

See response to Comment MEB-14.

DAM-3 (Cont)

refineries, underground systems exotic piping & chemical piping.

I am therefore quite aware of the problems putting this system underground but I am also very aware of the tremendous benifits attained by doing so.

This will erase once and for all the worry about health problems the appearance of the countryside will be saved the land nearby could be used much more advantageously than otherwise. The dollar value of as many as 80,000 acres would be increased five fold

Not to consider this would be absolutely negligent on the part of all concerned,

I therefor submit the proposal of putting this energy transmission line underground.

See previous response page

DAM-3 (Cont)

See previous response page

If this proposal is accepted the Increase in land value will undoubtably be greater than the additional construction cost.

Respectfully awaiting your comments and reply I am

David A. Murphy
RFD #1 Box 42
Woodsville N.H.
03785

VIVIAN R. FLECCHIA

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 25 1986
POWER SUPPLY & RELIABILITY DIV.

Vivian R. Flecchia
9 Hazen Road
Bedford, NH 03102

September 18, 1986

Anthony J. Como
Department of Energy
Economic Regulatory Administration
Office of Fuel Programs (RG-22)
1000 Independence Ave., S.W.
Washington, DC 20585

Dear Mr. Como,

VRF-1

I am writing this letter to protest the construction of the hydroelectric power lines slated to pass through my neighborhood here in Bedford, N.H.

Enclosed is a statement mentioning many issues that have not been explained (to many of us) satisfactorily to eliminate our fears of health hazards, etc.

I realize that politics and money supercedes the average persons fears, and if we are forced to have the power lines against our wishes, perhaps the alternative could be that the lines be buried. Thank you,

Vivian R Flecchia

RESPONSES TO VIVIAN R. FLECCHIA

VRF-1
See the responses to Comments MEB-5, MEB-6, and JCB-1.

Send letter to: Anthony J. Como
Department of Energy
Economic Regulatory Administration
Office of Fuel Programs (RG-22)
1000 Independence Ave., SW
Washington D.C. 20585

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 25 1986
POWER SUPPLY & RELIABILITY

Concerning: Environmental Impact Statement (New England/Hydro-Quebec ± 450 kv Transmission Line Interconnection--Phase II DOE/EIS-0129D)

Issues: The draft states that electric fields within the right-of-way will have intensities within the range reported to elicit physiological response in experimental animals. Can we just ignore these results?

VRF-1
- According to the draft, residents adjacent to the transmission lines should be informed of the possibility of induced shock and that utilities would ground their equipment upon request. Pacemaker patients it states should be especially informed. Is this a healthy environment?

VRF-2
- Audible noise at or above the normal background level will exist along the right-of-way. What studies have been done on such constant exposure to noise?

VRF-3
- Increase in the ozone level. What effects will this increase in the ozone level have? Have any studies been done?

VRF-4
- Towers will detract from the beauty of the countryside, rising 75-115 feet high. These will not be able to be camouflaged by trees like current structures are.

VRF-5
- Erosion (primarily by wind) already is a problem under some existing power lines (e.g. gulley near Route 101-114 intersection Bedford, N.H., sand pit BackRiver Road, Bedford. N.H.). What steps are being taken to prevent this in the future?

VRF-6
- Memorial School adjacent to proposed power line.

VRF-7
- Effect on Historic Landmarks not adequately studied. An in depth study should be done in this area of concern before the final EIS is published.

VRF-8
- The potentially dangerous health affects combined with the 75-115 ft. towers will definitely affect the property values in towns such as Bedford, N.H. which is a rapidly growing residential community with no heavy industry. A comprehensive study done by an independent real estate company should be done before the final EIS is submitted. The draft shows no evidence of any previous study being done.

VRF-9
- The Vermont Electric Power Company (in their review of Phase I) recognized the danger and spent an extra $1.5 million to route the line around sensitive wildlife areas. Are the wildlife in Vermont more important than the people in Bedford, N.H.?

VRF-10
- Other alternatives do exist. The underground transmission line for example eliminates most of the potentially dangerous health effects and is a feasible alternative according to the draft. Trenches approximately 4 ft. wide by 5 ft. deep also seem environmentally preferable to 75-115 ft. towers and suspended wires.

VRF-2
See the response to Comment MEB-7.

VRF-3
See the response to Comment MEB-11.

VRF-4
See the response to Comment MEB-9.

VRF-5
See the response to Comment MEB-10.

VRF-6
Refer to revised text in Section 3.2.7.

VRF-7
See the response to Comment MEB-12.

VRF-8
See the response to Comment JCB-7.

VRF-9
See the response to Comment MEB-8.

VRF-10
See the response to Comment MEB-14.

DEPARTMENT OF THE INTERIOR

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Project Review
1500 Custom House
165 State Street
Boston Massachusetts 02109

IN REPLY REFER TO:

ER 86/1074

September 26, 1986

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 29 1986
POWER SUPPLY & RELIABILITY

Anthony J. Como
Department of Energy
Economic Regulatory Administration
Office of Fuels Programs (RG-22)
1000 Independence Avenue, SW
Washington, D.C. 20585

Dear Mr. Como:

This is in reply to your request for this Department's review comments on the draft environmental impact statement for the New England/Hydro Quebec ± 450 kv Transmission Line Interconnection Phase II.

Due to the nature of this proposal, the preparation of our comments on it will take longer than the allowed review time. For this reason we are requesting a time extension sufficient to permit our comments to reach you by mid-October. This request is based on our belief that certain aspects of the proposal may merit additional attention.

Thank you for your consideration of this request.

Sincerely,

William Patterson

William Patterson
Regional Environmental Officer

No response.

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Project Review
1500 Custom House
165 State Street
Boston Massachusetts 02109

IN REPLY REFER TO

ER 86/1074

October 9, 1986

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
OCT 16 1986
POWER SUPPLY & RELIABILITY

Mr. Anthony J. Como
Department of Energy
Economic Regulatory Administration
Office of Fuels Programs (RG-22)
1000 Independence Avenue, SW
Washington, DC 20585

Dear Mr. Como:

This is in response to your request for a Department of the Interior review of the draft environmental statement for the New England/Hydro Quebec ± 450 kv Transmission Line Interconnection Phase II (ER 86/1074).

In general the environmental statement identifies many of the issues and environmental impacts associated with the proposed project. However, the analysis of these issues and effects is generic in nature as opposed to being site specific and to that extent detracts from the document's ability to accurately define the exact nature and degree of impacts which the project may generate.

DOI-1 In addition there arises the question of the use of the EIS to justify prior decisions. The EIS notes that NEPOOL has signed a ten year contract with Hydro-Quebec. This was done shortly after Phase I was approved in 1984 and project design began in 1985. Apparently, a number of significant actions affecting the environment have been taken prior to the completion of the NEPA process. If this is not the case then the FEIS should include some clarification of this situation.

DOI-2 The no action alternative (page 2-24) is based on the Applicant maintaining the status quo. An adequate no action analysis would need to include reasonably foreseeable actions of others, not limited only to the Applicant, during the period of analysis.

DOI-3 On page 2-24, the EIS provides a generic discussion of the conventional central station generation facility alternative which could be either nuclear or coal. The discussion of environmental effects associated with these alternatives is summarily dismissed on page 2-25 because these impacts would be highly site- and design-specific. However, on 1-11, the EIS states that NEPOOL plans call for the installation of 2,300 mw of nuclear capacity, the conversion of 1,100 mw of oil-fired capacity to coal-fired operation and the development of 1,000 mw of cogeneration capacity. This strongly suggests that NEPOOL has identified specific sites for the development of future generating capacity. If this is the case, then the generic discussion should be replaced or supplemented with site specific information.

DOI-1

Contract actions taken by NEPOOL and Hydro-Quebec were actions taken independent of those governed by the NEPA process. However, contract stipulations made allowances for decisions that could be made during the NEPA process and other permitting actions that could have a bearing on the project. For instance, the contract contains a clause that states that the contract becomes null and void if either NEPOOL or Hydro-Quebec fails to obtain required permits (federal, state, or provincial). Also, DOE does not evaluate or approve the contract. Thus, the contract is not part of the major federal action being evaluated in the EIS.

DOI-2

Section 2.2.2 has been revised to include reasonably foreseeable actions of others.

DOI-3

The capacity additions referred to in the comment are already under construction by the New England utilities. Alternatives such as a coal or nuclear plant would be in addition to those additions already mentioned. These alternatives also would need to be located at sites other than the ones mentioned in the comment. Since New England has no plans for coal and nuclear capacity beyond those already identified, no site-specific data are available because no additional sites have been identified. Also, new coal and nuclear alternatives were dismissed primarily because of cost and timing considerations. Section 2.2.2 has been revised, and includes more detailed information on construction and operation of a new, conventional facility (Section 2.2.2.1), refurbishment of older generating units (Section 2.2.2.2), and decentralized energy sources (Section 2.2.2.5).

DOI-4 On page 2-30, the EIS states that the Tewksbury Terminal would require construction in a floodplain and wetland area. However, the document does not provide any supporting data to substantiate this conclusionary statement. The tone of the discussion tends to indicate that the evaluation only considered lands currently owned by NEPOOL affiliates. We believe the analysis should also include uplands adjacent to this site even though they may not currently be owned by the Applicant at this time. This analysis is important because the Tewksbury alternative appears to have the least overall impact on fish and wildlife resources. It has about 160 acres less forest clearing, including forested wetlands, than the proposed route (page 2-43). Wetland and floodplain displacement is slightly greater for the Tewksbury alternative only because the terminal location has been sited in a floodplain/wetland area. We believe a reanalysis of this site specific terminal location is necessary to determine if it is possible to site the facility adjacent to the existing substation but substantially out of the floodplain. Alternatively, siting in the floodplain/wetland should be studied to determine if it is possible to develop the terminal without requiring substantial filling of these areas.

DOI-5 With respect to vegetation clearing and other construction and maintenance activities, we recommend that precautions such as time-of-year restrictions be included to protect migratory bird resources. All migratory birds, their parts, nests or eggs, are protected under the Migratory Bird Treaty Act 16 USC 703. Migratory birds are vulnerable to timber harvesting operations during their breeding season. Therefore, timber harvesting and other vegetation clearing or control practices should be prohibited during the primary bird nesting season of May-July. In addition, since some species such as raptors nest early in the spring, we recommend that areas proposed for clearing during this period be surveyed for raptor nests.

DOI-6 On page 4-14, the EIS discusses bird losses due to collisions with overhead wires. While most published studies may indicate (EIS page 4-14) that these losses are not biologically significant, it still could be construed as a "taking" as defined in the Migratory Bird Treaty Act. Therefore, we recommend that all reasonable attempts be made to design the transmission facilities to minimize the potential for migratory bird-overhead wire collisions. This appears to be especially significant in sections of Massachusetts where a large number of wires are present at different levels.

DOI-7 The discussion of impacts to the aquatic and wetland systems for the proposed project is generic in nature. To the extent that this differs from the site specific information needed to conduct an adequate environmental analysis, the EIS is deficient. This difference may well be appreciable and while making the EIS's adequacy questionable will probably, also, cause problems in any future interrelated permit applications. Data is not available, for instance, on the number of streams that would be forded, crossed via temporary bridges and culverts or permanent crossing structures. Site specific information is also lacking for access road and other construction activities in wetlands.

DOI-4

The Tewksbury alternative site was chosen as the most suitable of nine sites in the Tewksbury area. The text in Section 2.2.8.1 has been revised to more clearly explain this fact.

DOI-5

Comment noted. Additional material has been added to Section 4.1.4 concerning the Migratory Bird Treaty Act. Also, suggested mitigative measures have been added to Section 4.1.10.4 which, if adopted, would ensure compliance with the Act and provide additional protection for raptors.

DOI-6

All precautions possible have been taken to minimize bird losses due to collisions with wires. Most notably, wire heights would be lower than the height at which migratory species generally fly; the proposed transmission lines would be sited within existing rights-of-way (minimizing the incremental hazard that would result from isolated rights-of-way); and proposed structures would be constructed in line with existing structures where practical (resulting in wire heights within as close a range as possible).

DOI-7

The purpose of the EIS is to conduct an environmental analysis. This analysis, in part, is based on detailed information in the Applicant's Environmental Report. Only information deemed necessary to support the Staff's conclusions is included in the EIS. While the Applicant has not finalized the exact number of streams to be forded, crossed via temporary bridges, and so forth, the mitigative measures committed to by the Applicant and recommended by the Staff would be applicable in all instances. Several of the mitigative measures would apply to specific conditions (e.g., trout stream) and would be enacted on a case-by-case basis. General conclusions reached by the Staff are based on conservative estimates presented in the ER. Actual numbers of streams and wetlands to be affected by crossings would be less than estimated, and thus projected impacts would be quantitatively less. See the response to Comment EPA-1 in regard to wetland compensation.

DOI-7 (Cont)

While the EIS indicates that wetland impacts would be avoided whenever possible, there is no data to substantiate that this is, in fact, the case. The EIS also fails to provide any discussion on compensation for the 19 acres of wetlands to be used in project construction. During any subsequent permit review process the FWS will determine of the wetland losses are unavoidavle. If FWS concurs that they are unavoidable losses, they will most likely recommend that the Applicant provide replacement wetlands of the same type and value (i.e., forested wetland for forested wetland). If the wetland losses are determined to be avoidable, FWS will most likely recommend that the Applicant redesign or relocate the structures to avoid the wetlands impact. We recommend that coordination be maintained with the Field Supervisor, FWS, P. O. Box 1518, Concord, New Hampshire 03301, during any subsequent NEPA planning process.

DOI-8

Electric field effects are discussed but dismissed as insignificant on page 4-27 largely because the specific study species (livestock and people) are not continuously exposed to electric fields. However, the EIS fails to evaluate electric field effects on wildlife species that might be continuously exposed for long periods of time. We believe the analysis should be expanded to include nesting birds including eggs and flightless young birds, small mammals with restricted home ranges (such as voles) and certain amphibians and reptiles that have confined home ranges for part or all of their life cycle. In addition to determining the physiological, behavioral, and other effects associated woth electric fields on these wildlife species/groups, the EIS should also evaluate the impact on habitat carrying capacity, if any, for the various cover types in the transmission line ROW based on whatever information is currently available.

DOI-9

On pages 4-37 to 4-41, herbicide use is discussed in relation to human health effects and concluded to be environmentally safe. However, the discussion fails to provide any analysis of the effects of herbicide use on resident wildlife species using the transmission line ROW. We believe the EIS should analyze the chronic and acute effects of the various herbicides used for ROW vegetation management on resident wildlife species. This should include site specific studies on a variety of species and life stages to verify the conclusions that existing herbicide practices are indeed not causing acute or chronic toxicity effects or causing bioaccumulation of the herbicides or breakdown products and contaminants. Unless and until this data can be provided, we cannot concur with the DOE conclusion that herbicide is not causing or likely to cause significant environmental effects. Simply referencing studies conducted elsewhere is not sufficient unless it is possible to demonstrate very close similarities between vegetation, wildlife species, actual application procedures, time-of-year applied, study parameters, quality control, etc.

DOI-10

During the scoping process, we recommend that future expansion of this system that are reasonably foreseeable be identified a a secondary impact associated with Phases I and II. However, with the exception of a statement on page 1-9 indicating that such future expansions would be possible, the EIS is silent regarding this potential segmentation issue. The Phase II project will import about 900 mw of electricity power, However, the

DOI-8

Field studies on the electric effects to small and/or sedentary groups of animals are largely lacking. However, it is the Staff's opinion that impacts due to electric effects would not differ significantly from those experienced by small laboratory animals. Levels of exposure that cause effects to laboratory animals are generally at concentrations much higher than would occur within the proposed right-of-way (see Section 4.1.8). Thus, the Staff does not believe that impacts would occur to these groups of animals.

As discussed in Section 4.1.4.1, electric effects would not have appreciable adverse impacts to vegetative resources. Thus, electric fields would not impact the habitat carrying capacity for small mammals, certain reptiles and amphibians, nesting birds, and other wildlife that have restricted home ranges. Initial right-of-way clearing (where required) and routine right-of-way maintenance would therefore have a much greater impact on such wildlife than would electric field effects. Expected impacts from clearing and maintenance are discussed elsewhere in Section 4.1.4 and in Appendix B.

DOI-9

Discussion of herbicide use on resident wildlife is included in Section 4.1.4.1. Herbicide use for Phase II would be an incremental addition (area-wise) to that currently practiced within the existing transmission line rights-of-way. As existing herbicide use has not been found to cause significant environmental effects, it can be concluded that no significant environmental effects would result from the periodic use of herbicides to manage vegetation within the Phase II portion of the rights-of-way.

DOI-10

See the attached letter from the applicant attesting to the fact that no further expansion of this project is planned. Also, Phase I was economically justifiable even without Phase II.

See previous response page

DOI-10 (Cont) converter terminal is being constructed with an initial capacity of 1,800 mw. Given the fact that the Phase I and II projects are essentially segments of the same project, we believe that the DEIS should discuss the future expansions such as Phase III, IV, etc. Section 1502.4 of the CEQ Regulations requires that proposals or parts of proposals that are related to each other closely enough to be, in effect, a single course of action shall be evaluated in a single impact statement.

In summary the nature of the above noted deficiencies strongly recommends the consideration of issuing a supplementary environmental impact statement. We hope that these comments will be of assistance to you in the preparation of it.

Sincerely,

William Patterson

William Patterson
Regional Environmental Officer

New England Hydro-Transmission

John W. Newsham
Vice President

New England Hydro-Transmission
Electric Company, Inc.
25 Research Drive
Westborough, Massachusetts 01582
Tel. (617) 366-9011

February 26, 1987

Anthony J. Como
Office of Coal and Electricity
Economic Regulatory Administration
Department of Energy
1000 Independence Avenue, S.W.
Room GA098
Washington, D.C. 20585

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
FEB 26 1987
POWER SUPPLY & RELIABILITY

Re: Docket No. PP-76A

Dear Mr. Como:

In connection with DOE's preparation of responses to public comments on the draft environmental impact statement in the referenced docket, you have asked whether there is any plan to seek another amendment to PP-76 to increase the permitted level of energy transfer above the nominal power level of approximately 2000 MW being requested in PP-76A. Your inquiry, you have confirmed, is not with regard to any other Presidential permits that might be sought in connection with new international transmission lines, but solely with regard to future amendments of Presidential Permit PP-76.

As Project Manager for the last three years for both Phase I and Phase II of the New England/Hydro-Quebec Interconnection, I can assure you that I am not aware of any plans or proposals to seek any such further amendment to PP-76.

As you know, in connection with the "Phase I" project, DOE issued Presidential Permit PP-76 on April 5, 1984. The Phase I project was a complete, "stand-alone" project, which was not dependent for its usefulness or value upon any subsequent amendments to PP-76 or upon a subsequent Phase II. Phase I was justified, funded, and approved independently of whether any Phase II would come about. At the time that Phase I was being designed, however, it was recognized that the Phase I transmission facilities at the border might be utilized in connection with another independently justified project. For example, DOE was informed that the design capacity of the Phase I conductors was 2000 MW, even though a permit for only

690 MW was then requested (see the Phase I Environmental Report, Volume 3, Exhibit 3-5, and DOE's Final Environmental Impact Statement, p. 1-1 and Table 2.1). In recognition of the fact that this additional transmission capacity would exist, DOE assessed the environmental impacts of operation of the Phase I facilities at their full design limits, rather than at the lower operational level DOE authorized in PP-76 (see Presidential Permit PP-76, Article 12). Moreover, DOE specifically provided that if additional facilities would be required in the future for an increase in the operational level of the line, DOE would conduct a further environmental review.

Subsequent to the issuance of Presidential Permit PP-76, the New England Power Pool concluded that additional purchases of energy from Hydro-Quebec would be desirable, and the pending application was filed with DOE requesting amendment of PP-76 to allow an energy transfer of up to 2000 MW (nominal). The new facilities proposed in the pending application have been subject to a thorough environmental review. We have made every effort to provide to DOE, through the Phase I and Phase II Environmental Reports, a comprehensive view of the environmental impacts of both projects.

It may help in answering your inquiry to contrast the present situation with that existing at the time that a Presidential permit was sought for Phase I. At the time the permit was sought for Phase I, we were aware that a Phase II project was possible, we in certain ways allowed for that possibility in our design of Phase I facilities, and we kept DOE informed of such a possibility. At the present time, by contrast, I am aware of no plans or proposals whatsoever, beyond the one currently being requested from DOE, to seek any further increases in the energy transfer level permitted by PP-76.

I understand that you are not asking me to speculate about what might possibly occur in the future, and it would serve no purpose for me to so speculate. But I can and do give you now the assurances I have expressed above, and hope that these assurances adequately respond to your inquiry.

If I can be of any further assistance in this matter, please let me know.

Sincerely,

John W. Newsham

F-61

MRS. C. DALEY

RESPONSES TO MRS. C. DALEY

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 29 1986
POWER SUPPLY & RELIABILITY

September 24 1986
17 Brookview Terr.
Bedford, N.H.
03102

Dear Mr. Cone,

As a concerned resident of Bedford, New Hampshire I am writing to you in regard to the plans for the New England Hydro Quebec + 450 KV Transmission Line. The potential hazards are in my opinion outweighing the benefits of this "progressive" technical move. The purpose of progression is to better the world for the people. To make life easier. I feel the dangers in the ozone, the constant shocks and the atmospheric changes that our children and adult loved ones will be exposed to interfere with life itself and is not the best alternative for the people.

CD-1

Please reconsider the plans and either reroute the lines, place them underground or wait until studies come up with safer power options.

CD-2

Thank. Mrs C. Daley - Bedford NH.

CD-1
See the responses to Comments MEB-5 through MEB-7 and MEB-11.

CD-2
See the response to Comments MEB-5 through MEB-7 and MEB-14.

BERLE, KASS & CASE

BERLE, KASS & CASE
45 ROCKEFELLER PLAZA
NEW YORK, NEW YORK 10111
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RESPONSES TO BERLE, KASS & CASE

DOCKETED
SEP 29 1986

September 26, 1986

VIA FEDERAL EXPRESS

United States Department of Energy
Economic Regulatory Administration
Office of Fuels Programs (RG-22)
1000 Independence Avenue, SW
Washington, D.C. 20585

ATTN: Mr. Anthony J. Como

RE: Statement of BERLE, KASS & CASE on behalf of the National Audubon Society Concerning the New England/Hydro-Quebec ± 450 kv Transmission Line Interconnection -- Phase II DRAFT ENVIRONMENTAL IMPACT STATEMENT (EH-23)

The following comments on the above-referenced DEIS are hereby submitted on behalf of the National Audubon Society, 950 Third Avenue, New York, New York 10022. The National Audubon Society is a national organization of about 550,000 members, committed to the conservation of the natural environment with a particular interest in bird populations.

BKC-1 The DEIS is fundamentally flawed in several very serious respects. It fails to acknowledge that the proposed action would trigger changes in the operation of existing hydro-facilities and/or the development of

BKC-1

The proposed action would not alter the operations of existing hydroelectric facilities. Construction of one proposed hydroelectric project would be accelerated by three years. However, this would not adversely affect the environment of the United States and the James Bay region of Canada. Refer to Appendix C for a thorough discussion of this subject.

BKC-1 (Cont) several hydro-electric projects in and around James Bay, Canada, which may well have a significant adverse effect on the environment of the United States and the James Bay region. The DEIS fails to consider the effect this

BKC-2 proposed action may have on the migratory bird populations of the United States and Canada that currently use James Bay as a major staging area for their transcontinental migrations. There exists a very real possibility that these populations would be destroyed by the proposed James Bay hydro-electric developments that will be built or modified to provide the power that will be carried on the upgraded or extended transmission lines. In addi-

BKC-3 tion, the DEIS fails to consider any of the adverse environmental consequences this action could cause in and around James Bay itself.

BKC-4 As a result of these deficiencies, the DEIS as written cannot possibly serve as an adequate decision-making tool. The public, moreover, is denied the opportunity to comment on the analysis of the above-mentioned impacts since no such analysis now exists. The DEIS therefore does not qualify as a "draft" environmental impact statement. It should be withdrawn and redrafted. The new DEIS must carefully analyze the above-mentioned environmental consequences, and the public must be afforded an opportunity to comment, both at a hearing and in writing, on these issues.

The federal action that is the subject of this DEIS is a proposed amendment of Presidential Permit PP-76. The proposed amendment would permit the international power connection therein authorized to operate at greater power levels, and would also permit the construction of new transmission lines to distribute this power. A document published by Hydro-Quebec, a copy of which is attached hereto as Exhibit "A", indicates that the additional power would be supplied by Hydro-Quebec, a Canadian concern, from proposed hydro-electric modification or installations in and around James Bay and the

BKC-5 rivers and streams that feed the Bay. If the proposed actions goes forward (1) either existing hydro-facilities would be operated more in the winter, causing increased flows of fresh water into the Bay during the winter, or (2) new facilities would be built, also increasing the winter flows. In either case, the impact on the wildlife that relies on James Bay could be disastrous, as is discussed in greater detail below.

BKC-2

See Appendix C for a thorough discussion of historical and projected impacts to migratory birds related to hydroelectric development in the James Bay region. In summary, no significant adverse impacts have occurred or are projected to occur.

BKC-3

Changes (physicochemical and biological) to James Bay related to hydroelectric development are thoroughly discussed in Appendix C.

BKC-4

Private citizens and concerned groups (both from Canada and the United States) are afforded the opportunity for comment on proposed hydroelectric developments within Canada. Appendix C thoroughly discusses the environmental review process, including public inputs, established in Canada.

BKC-5

Impacts related to increased flows of fresh water to James By during winter operations are discussed in Appendix C. The resultant effect to James Bay would be minimal, and that attributable to the proposed Phase II project would be negligible.

BKC-6 The DEIS fails completely to recognize or address this concern. It fails to disclose at all the source of the additional power that will flow through the expanded transmission facilities. Nor does the DEIS

BKC-7 discuss the reliability implications of the expanded facilities for the U.S.-Canada electricity system. It has been brought to our attention that the ability to temporarily reroute power along the proposed transmission facilities during a system emergency may allow more power to be brought down from James Bay for users other than those located at the end of the transmission line. (Personal communication with Alex Karas, Director, Electric Power Branch, National Energy Board, Ottawa, Ontario, K1A OE5.)

BKC-8 Despite the failure of the DEIS to disclose the source of the power that would flow over the new or expanded transmission lines, either on a regular or emergency basis, it nonetheless appears from the enclosed information that the power would be generated either in existing James Bay hydro-facilities or in three hydro-electric plants which would be built in or around James Bay -- La Grande-Phase II, Grande-Baleine, and the Nottaway-Broadback-Rupert (NBR) Complex. (Hydro-Quebec Development Plan 1986-1988, Horizon 1995 at 45.)

BKC-9 The enclosed information acknowledges that Hydro-Quebec could not supply enough power for the proposed increased capacity transmission line without going ahead with these hydro-electric plants. Moreover, without the prospect of the export market to be made available by amendment of the permit, Hydro-Quebec would neither change the operation of existing hydro-facilities nor construct the three new hydro-electric plants. Thus, although the DEIS fails to disclose this crucial fact, it appears that the James Bay hydro-electric plants would not be built but for the amendment of this permit so as to provide a market for the additional energy.

BKC-10 If additional transmission facilities are part of Hydro-Quebec's overall plan, for which the present expansion is a first step, then a Programmatic Impact Statement would be called for. The environmental consequences that may flow from construction of these facilities are detailed below.

BKC-6

Hydroelectric sources for the proposed project are discussed in Appendix C.

BKC-7

The reliability impact of the proposed action is a separate criterion from the NEPA process for issuing a Presidential Permit. This aspect is not addressed in an EIS.

BKC-8

See the response to Comment BKC-6.

BKC-9

All hydroelectric developments proposed by Hydro-Quebec would be undertaken regardless of the proposed Phase II project. The only alteration would be an earlier scheduling, by three years, of one proposed hydroelectric facility. This is discussed in Appendix C.

BKC-10

Environmental analyses and reviews required by Canada for major projects within that country are discussed in Appendix C.

Migratory Birds

BKC-11

The brief discussion on the project's effect on migratory birds concentrates entirely on the destruction of the natural habitat along the right-of-way, and the possibility that the birds might collide with transmission poles and lines.[1] This important but hopelessly myopic discussion completely ignores a potentially devastating environmental consequence -- namely, that the construction of the James Bay developments may destroy several migratory bird populations of the United States and Canada.

The construction of hydro-electric power plants along the rivers and streams feeding James Bay could have disastrous effects upon millions of migratory shore birds and water fowl, which use James Bay as a major North American staging area. The Bay provides critical habitat for these birds. The staging area is where these birds feed for weeks before commencing their 15,000 mile migration. Many need to double their body weights during this time in order to survive the migration. James Bay is crucial to this activity because it is rich in nutrients and abundant in food. Few other areas have the necessary biological richness. Many of these birds would likely face extinction if their staging area were damaged or destroyed by these projects.[2]

---

[1]See DEIS at 4-12 through 4-13.

[2]A list of some of the species which use the area as a staging ground includes: Common Loon, Snow and Canada geese, Brant, Black Scoter, Rough-legged Hawk, Peregrine Falcon, Sandhill Crane, Black-bellied Plover, Lesser Golden-Plover, Semipalmated Plover, Ruddy Turnstone, Greater and Lesser yellowlegs, Whimbrel, Marbled and Hudsonian godwits, Red Knot, Sanderling, Semipalmated Sandpiper, Least Sandpiper, Common Snipe, Lapland Longspur and the Snow Bunting. Duck species involved include: Green-winged Teal, American Black Ducks, Mallard, Pintails, American Wigeon, Scaup. In addition, a number of endangered species use the area, including the critically endangered Eskimo Curlew, last sighted on
(Footnote Continued)

BKC-11

Effects of hydroelectric development on migratory birds in the James Bay region are thoroughly discussed in Appendix C.

BKC-11 (cont)

These developments would severely and permanently alter the ecosystem of the James Bay area. Among other effects, the developments would cause changes in salinity, nutrient availability, and the ice-melting patterns of the Bay. These changes could have very serious effects on the migratory bird populations, which, since they do not recognize international boundaries, are a part of the United States' ecosystem as much as Canada's.

If these populations are affected by the hydroelectric projects made necessary by the subject permit amendment, it will have a significant effect on the environment of the United States. The DEIS must consider these environmental consequences, although it now fails to do so.

James Bay

BKC-12

In addition to affecting adversely the environment of the United States, this proposed amendment would create significant environmental consequences in and around James Bay.

The impact on James Bay would likely be enormous. The dams that must be built across the Bay's feeder rivers and streams, the outright diversion of water, and the changes in water flows into the Bay would all contribute to a fundamental and permanent altering of the ecosystem of the Bay. As previously discussed, these activities would affect the salinity of the water, which is a major physical variable defining the James Bay ecosystem. Among other effects, changes in the salinity of the water, nutrient availability, and ice flows could seriously disrupt the food chain. These effects must be discussed in the DEIS.

(Footnote Continued)
the James Bay shore.

Upwards of 85% of the marbled and Hudsonian godwits stage there, and over 50% of the small peep sandpipers that breed in North America stage there before heading south. Without the James Bay staging areas, this extraordinary array of wildlife would be seriously at risk.

BKC-12

See the response to Comment BKC-3.

These environmental effects would be caused by the federal action that is the subject of this DEIS. The National Environmental Policy Act (NEPA) does not excuse compliance with its mandate simply because the effects of the action will be felt in Canada. To the contrary, the statute expressly provides:

BKC-13

> [All agencies of the Federal Government shall] recognize the worldwide and long-range character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment.

42 U.S.C. § 4332(2)(F). NEPA thus requires the federal agency to consider the extraterritorial environmental impacts of its major actions. See Lake Erie Alliance v. U.S. Army Corps of Engineers, 526 F. Supp. 1063, 1077-78 (W.D. Pa. 1981), aff'd mem., 707 F.2d 1392 (3d Cir.), cert. denied, 104 S. Ct. 277 (1983).[3] There particularly can be no excusing the failure to comply with the requirements of NEPA where, as here, the foreign environmental impact (on James Bay) would also seriously affect the United States environment (migratory birds).

CONCLUSION

For the foregoing reasons, the DEIS should be withdrawn. Any DEIS or FEIS on this proposed permit amendment must contain an appropriate discussion of the effect of the action on James Bay, and on the migratory bird population that utilizes the Bay before flying south to the United States and beyond.

As background information, a draft paper entitled, "Long-Term Threats to Canada's James Bay from Human Development," has been attached as Exhibit "B".

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[3] Other cases have assumed NEPA's applicability to extraterritorial environmental impacts. See, e.g., Sierra Club v. Adams, 578 F.2d 389, 391 n.16 (D.C. Cir. 1978).

BKC-13

A discussion of NEPA compliance, as it relates to developments outside the United States, has been added to Section 4.1.4.5. Also, see Appendix C for a discussion of the environmental review process in Canada.

Although this paper is presently out for review, and will no doubt be changed following comments from Hydro-Quebec and others, it can serve in its present form as an introduction to the environmental risks that are present at James Bay.

The concerns raised in this draft paper by staff members of the National Audubon Society were not recognized until the beginning of 1986, subsequent to the pre-DEIS public scoping meetings that were held in June of 1985.

Respectfully submitted,

BERLE, KASS & CASE
Attorneys for the
National Audubon Society

BY: Michael B. Gerrard
Michael B. Gerrard

cc: Dr. Robert J. Stern

[1005:001]

No response.

MR. & MRS. MAURICE HERBERT

RESPONSES TO MR. & MRS. MAURICE HEBERT

Sept 22, 1986
88 Forest Dr. RT. 9
Bedford, N.H. 03102

Dear Sir —

I cannot possibly express my terrible forebodings concerning the power lines going through my backyard.

We've been living here fourteen years now and have endeavoured to beautify our home and especially the yard in every way possible to disguise the existing powerline!

MH-1 To our dismay, we heard of the Canadian D.C. power lines being ram-rodded through — adding more ugly looking towers to the

MH-1
See the response to Comment MEB-9.

MH-1 (Cont)

already ugly looking ones we've had to put up with over the years!

MH-2

Of more concern to us is the fact that we often take care of our grand-children who play and run under these power lines on our property.

Frankly speaking — knowing what "effects" these humming, sizzling line give out — would you like to have your children or grand children any where near them? I doubt it!

MH-3

Please - either go underground or pick a less populated area to put these power line in — The health hazard is to dangerous to "take a chance"; (and) to "shove" these atrocities into our beautiful backyard!

Sincerely

Mr. + Mrs. Maurice Hebert

HEBECT

MH-2
See the responses to Comments MEB-5 through MEB-7 and MEB-11.

MH-3
See the response to Comment MEB-14.

MR. & MRS. MAURICE LAVOIE

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 29 1986
POWER SUPPLY & RELIABILITY

Dear Sir

I'm writing this letter to express my concern the proposed New England Hydropower lines.

ML-1 Since the lines run directly in my backyard I'm very concerned about the physiological effects this could have on my family. I'm especially concerned for the welfare of one of my sons, since he's on daily medication for a chemical imbalance. I've attended several hearing meetings in Concord and have not been reassured to my satisfaction that these lines are completely safe and without health hazards.

ML-2 I do hope that more studies are done on this matter and also hope that they will consider the alternate routes which

RESPONSES TO MR. & MRS. MAURICE LAVOIE

ML-1
See the responses to Comments MEB-5 through MEB-7 and MEB-11.

ML-2
Alternative routes were considered in the EIS. Refer in particular to Sections 2.2.8.3, 2.2.8.6, and 2.3.2.

ML-2 (Cont)

I understand is a possibility. The potentially dangerous health effects combined with the high

ML-3

towers will definitely affect our property value.

These are some of my concerns and I do hope that more studies are done before allowing New England Hydropower lines to be built here in our Community Thank You LAVOIE

Mr & Mrs Maurice Lavoie
96 Forest Dr
Bedford, N.H 03102.

ML-3
See the response to Comment PEH-6.

MARY F. DAMBACH

RESPONSES TO MARY F. DAMBACH

18 Horizon Drive
Bedford, New Hampshire 03102
September 22, 1986

Anthony J. Como
Department of Energy
Economic Regulatory Administration
Office of Fuel Programs (R.G.-22)
1000 Independence Avenue S.W.
Washington, D.C. 20585

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 30 1986
POWER SUPPLY & RELIABILITY

Dear Mr. Como,

After reading much information related to the New-England Hydro Transmission Corporation, health surveys etc., sent to me by Thomas J. King, District Manager for the Granite State Electric Company, I am still very much opposed to the 450 K.V. high voltage direct current transmission line project going through the highly populated town of Bedford, New Hampshire. Please do not allow this line to go

MFD-1 overhead through Bedford, N.H. If it did, it would run right alongside of Memorial School (550+ students), and less than 1/2 mile from Peter Woodbury School (470+ students) and McKelvie School (590+ students).

MFD-1

Schools identified as being in close proximity to the proposed transmission line in the town of Bedford have been noted. See the response to Comment JCB-6. Also, refer to the response to Comment MEB-5.

2.

MFD-2 There is not enough evidence that this could not cause health and safety problems etc., in the future years. As a school nurse in Bedford, I am very much opposed to this line. Most people in the town of Bedford are also very much opposed to this line. Please do not allow this to happen. It could and probably will lead to a class action suit against N.E.H.T.C. and P.S.N.H.

A public hearing should be held in Bedford N.H.

Thank you.

Sincerely,

Mrs. Mary F. Dambach

P.S. My husband, Robert A. Dambach, and my 16 children, are also strongly opposed to this line passing through Bedford, N.H.

MFD-2

See the responses to Comments MEB-5 through MEB-7 and MEB-11.

LOUISE AND DONALD PADFIELD

RESPONSES TO LOUISE AND DONALD PADFIELD

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
SEP 30 1986
POWER SUPPLY & RELIABILITY

Louise M. Padfield
6 Roosevelt Drive
Bedford, New Hampshire 03102

September 24, 1986

Dear Mr Como,

I am writing this letter to let you know that we are very much opposed to the New England Quebec Hydro Electric Power running through Bedford.

It will affect everyone in Bedford, since they will have to travel by them to go almost everywhere in Bedford.

LDP-1 Since there is an alternative to have the lines go underground, if it is necessary to go through Bedford, I urge you to put all the lines underground.

Thank you.
Sincerely
Louise & Donald Padfield

LDP-1
See the response to Comment MEB-14.

SOIL CONSERVATION SERVICE

United States Department of Agriculture

Soil Conservation Service

Federal Building
Durham, New Hampshire 03824

September 29, 1986

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
OCT 3 1986
POWER SUPPLY & RELIABILITY

Mr. Anthony J. Como
U.S. Department of Energy
Economic Regulatory Administration
Room GA-093, RG-22
1000 Independence Avenue, S.W.
Washington, DC 20585

Dear Mr. Como:

This provides the New Hampshire and Massachusetts Soil Conservation Service response to your notice of August 7, 1986 for the Department of Energy draft EIS publication number DOE/EIS-0129D, the New England/Hydro-Quebec 450 kv Transmission Line Interconnection -- Phase II.

We find the subject of erosion and sediment control to be addressed in broad terms only and ask that some specifics be added to the document at these locations:

SCS-1 2.1.5.2 - Land Features and Use - We suggest using existing soils maps to inventory the transmission line route to identify potential erosion areas. An erosion and sediment control plan should be developed for each erosive work area. These plans should address erosion and sediment control, road maintenance and future controls (gates, etc.) for off road vehicles.

SCS-2 2.1.5.3 - Hydrology, Water Quality, and Water Use - Transmission line work in or near wetlands, streams, or other water bodies have particularly important water quality considerations. Erosion and sediment control plans should be developed for each of these sites where water impacts are probable.

SCS-3 4.1.1.1 - Soils - Some parts of the route, especially the northern end, contain a considerable amount of steep slopes with a high potential for erosion when disturbed. The environmental consequences could be significant if sediment and erosion control plans are not technically sound <u>and</u> implemented.

SCS-4 Table 4.1 - Apparently, this table displays the worst-case scenario. We suggest the table be revised to also show the environmental consequences of adequately installed erosion and sediment control plans.

SCS-5 4.1.4.1 - The process of revegetating disturbed areas should be discussed to include recommended grass species, fertilization and vegetation management.

RESPONSES TO THE SOIL CONSERVATION SERVICE

<u>SCS-1</u>
Site-specific details for erosion and sedimentation control plans are not finalized. Refer to revised text relative to recommended mitigative measures presented in Section 4.1.10.

<u>SCS-2</u>
See the response to Comment SCS-1.

<u>SCS-3</u>
See the response to Comment SCS-1.

<u>SCS-4</u>
Table 4.1 of the draft EIS has been deleted from Section 4.1.2.2 of the final EIS. Refer to revised text in Section 4.1.2.2.

<u>SCS-5</u>
Revegetation procedures would vary depending upon site-specific characteristics, including soil type, slope, amount of disturbance, and habitat type. Appropriate grass species, fertilization, and vegetation management would have to be determined on a case-by-case basis. This is beyond the scope of the EIS. Construction of the Phase II transmission lines within established rights-of-way would greatly reduce the amount of disturbance to vegetation. Thus, areas that would actually require revegetation would be minimized. In most instances, only trees and large shrubs would be removed, with low-growing shrubs and herbaceous vegetation left undisturbed. Most areas would be left to revegetate on their own (with only erosion-control measures applied as necessary). Management and/or revegetation procedures for Phase II would basically involve an expansion of the rights-of-way management practices currently employed within the existing transmission line corridors.

No response.

Assistance with erosion and sediment control planning is available through the Conservation District offices in each county along the transmission line route. Thank you for giving us the opportunity to comment.

Sincerely,

/ acting for

David L. Mussulman
State Conservationist

cc: Rex Tracy, STC, Amherst, MA

U.S. ENVIRONMENTAL PROTECTION AGENCY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J. F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203

September 29, 1986

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
OCT 6 1986
POWER SUPPLY & RELIABILITY

Mr. Anthony J. Como
U.S. Department of Energy
Economic Regulatory Administration
Room GA-093, (RG-22)
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Re: D-ERA-B-08002-00

Dear Mr. Como:

In accordance with our responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act, we have reviewed the Draft Environmental Impact Statement (DEIS) for the proposed New England/Hydro-Quebec ±50 kV Transmission Line Interconnection Phase II, located in the States of New Hampshire and Massachusetts.

This EIS addresses the environmental impacts of a proposed DOE action to issue an amendment to Presidential Permit PP-76 to the Vermont Electric Transmission Company (VELCO) to operate the international interconnection at power levels above those stipulated in PP-76, and to construct new transmission facilities to distribute this power. The proposed transmission facilities consist of three principal elements: first, the extension of the Phase I ±kV DC transmission line between the town of Monroe, NH and the town of Groton, MA (133.2 miles); second, the construction of an 1800-MW DC/AC converter terminal at the terminus of the proposed DC line; and third, the construction of two new 345-kV AC transmission lines with a combined length of 51.8 miles, terminating at an existing substation at West Medway, Massachusetts.

EPA-1 From the standpoint of EPA's areas of jurisdiction and expertise, we do not object to the proposed project. We do, however, have one concern regarding wetland loss which should be given consideration during further planning for the project. While many of the 217 wetlands within the 185 mile transmission line alignment will be traversed overhead, placement of support structures within wetlands may not be entirely avoidable. Support structures located in wetlands may be directly embedded within a 3 to 7 foot diameter excavation, attached to concrete foundations, or attached to piles driven into the ground. The DEIS indicates that the long-term wetland loss from new structures and access roads would be at most, 19 acres (page B-5). EPA Region I policy is that unavoidable impacts to special aquatic sites should be mitigated on at least a 1:1 value basis. Mitigation of unavoidable wetland losses through creation

<u>EPA-1</u>

The Staff acknowledges EPA Region I policy on mitigating wetland impacts on at least a 1:1 value basis. The Applicant has committed to conditions stipulated in the Corps of Engineers General Permit, as well as those of state and local regulations related to all work in wetlands. Some compensation would result from the removal of a number of existing towers. Also, the estimate of 19 acres of wetland lost is a conservative estimate. Actual acreage of wetland loss will be somewhat less as design modifications and siting within the corridor is refined. For example, a higher than normal tower structure will be located near the town of Bedford to allow a wetland area to be spanned (see the response to Comment MEB-9).

See previous response page

EPA-1 (Cont)

of wetlands and enhancement of existing degraded wetland within the transmission line rights-of-way or creation of wetland offsite should be explored. Due to the limited size of wetland impacts at individual wetlands, it may be more appropriate to consider several large mitigation areas.

Finally, we would like to commend the ERA on the high quality of the DEIS. EPA's concerns raised on the Phase I portion of the New England/Hydro-Quebec project are thoroughly addressed in the DEIS, and the applicant has committed to a broad spectrum of mitigative measures to reduce the impact of construction, operation and maintenance of the proposed project.

In accordance with our national rating system (see enclosed explanation), we have rated this EIS LO, lack of objections. Please contact Donald Cooke of my staff at 617/565-3426 (or FTS 835-3426) should you have any questions regarding our comments.

Sincerely,

Elizabeth A. Higgins

Elizabeth A. Higgins, Assistant Director
for Environmental Review
Office of Government Relations and
Environmental Review

Enclosure

cc: Gene Crouch, Regulatory Branch, COE
Vern Lang, US FWS
Steve Davis, Acting Director, MEPA Unit
George Mollineaux, Office of the Governor, NH

No response

SUMMARY OF RATING DEFINITIONS
AND FOLLOW-UP ACTION

Environmental Impact of the Action

LO--Lack of Objections
The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC--Environmental Concerns
The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

EO--Environmental Objections
The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU--Environmentally Unsatisfactory
The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

Adequacy of the Impact Statement

Category 1--Adequate
EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2--Insufficient Information
The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

Category 3--Inadequate
EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

Figure 4-1

SARAH BASBAS

10 Forest Dr.
Bedford, NH 03102

ECONOMIC REGULATORY ADMINISTRATION
DOCKETED
OCT 6 1986
POWER SUPPLY & RELIABILITY

Mr. Anthony J. Como
Dept. of Energy
Economic Regulatory Commission
Office of Fuel Programs (RG-22)
1000 Independence Ave. SW
Washington D.C. 20585

Dear Mr. Como:

I am writing regarding the Environmental Impact Statement recently issued on the New-England/Hydro-Quebec ±450 kv Transmission Line Interconnection

I am very concerned that this will add one more environmental hazard to our lives.

No response.

Moustakis
Candy Shop
220 Essex Street
Salem, Mass. 01970
Chocolate Works
5 Derby Square
Salem, Mass. 01970
Candy by Mail

SB-1 The report states that there will be electrical shocks experienced by humans when standing near or under the power line. You may not find this objectionable, but I do. These shocks may not be any worse than carpet shocks, but I wonder about the effect this would have over time.

SB-2 I am also concerned about the possibility of an increase in the ozone level. Have any studies been done on this?

2

SB-1
See the response to Comment MEB-6.

SB-2
See the response to Comment MEB-11.

Moustakis
Candy Shop
220 Essex Street
Salem, Mass. 01970
Chocolate Works
5 Derby Square
Salem, Mass. 01970
Candy by Mail

SB-3 The Vermont Electric Power Company (in their review of Phase I) recognized the danger and spent an extra $1.5 million to route the line around sensitive wildlife areas. Are the wildlife in Vermont more important than the people in Bedford, N.H.

We have all grown up with electric power lines and telephone poles, which are not especially pretty. I don't think the aesthetic aspect of this issue is important. I object to being

SB-3
See the response to Comment MEB-8.

Moustakis
Candy Shop
220 Essex Street
Salem, Mass 01970
Chocolate Works
5 Derby Square
Salem, Mass 01970
Candy by Mail

asked to accept one more potential hazard in our environment. We have radon in the rocks, the possibility of a nuclear waste dump in our state, all kinds of chemicals in our water supply from waste dumps, a nuclear power plant and all its hazards. I am not satisfied that the economic savings are worth the

SB-4 risks. The power line could be buried and reduce the possibility of any danger. I do not think this solution has been adequately considered

Sincerely,

Sarah Barbara

SB-4
See the response to Comment MEB-14.

DEPARTMENT OF THE ARMY, NEW ENGLAND DIVISION, CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

REPLY TO ATTENTION OF

September 30, 1986

Regulatory Branch
NEDOD-R

ECONOMIC REGULATORY ADMINISTRATION DOCKETED OCT 14 1986 POWER SUPPLY & RELIABILITY

U.S. Department of Energy
Economic Regulatory Administration
Attn: Mr. Anthony J. Como
Room GA-093, RG-22
1000 Independence Avenue, S.W.
Washington, DC 20585

Dear Mr. Como:

These comments are in reference to your Draft Environmental Impact Statement for the New England/Hydro-Quebec 450 KV Transmission Line Interconnection - Phase II.

COE-1 1) It is stated on Page 4-5 that less than 0.06% of the forest lands will be removed from Massachusetts and New Hampshire towns transversed by the proposed transmission lines. However, the discussion of the existing wildlife resources in Sections C. 4, C. 5 in ER Volumes 2 and 3 appears very general. This makes it difficult for the reader to access the degree of impact to wildlife habitat. In lieu of a habitat based evaluation of the impacted area the report should discuss the quality of the impacted area relative to the surrounding habitat. This will give the reader a feel for the degree of impact on a local and regional basis. The report should identify and describe specific unique or productive areas that may occur within or adjacent to the affected corridor (e.g. productive deer wintering habitat or waterfowl area).

COE-2 2) The scientific names of species mentioned could be included in an easily accessible part of the text.

COE-3 3) Section 4.13 should discuss in more detail the direct and long-term impacts to drinking water supply from the proposed project.

COE-4 4) It is stated on pg. 4-9 that herbicide contamination of groundwater would be minor if project structures are carefully sited. A more detailed discussion of the structures used and the area of placement should be described.

COE-5 5) Section 4.1.8.2 discusses health and safety effects of AC lines and concludes that no health or safety concerns would

RESPONSES TO THE CORPS OF ENGINEERS

COE-1

It is beyond the scope of the EIS to extensively evaluate the impacted area relative to the surrounding habitat, other than what has been done in the EIS (a more generalized discussion of potential construction- and operational-related impacts). As the proposed transmission lines would be routed within existing rights-of-way, no unique habitats (such as deer yards) would be impacted.

COE-2

The species mentioned in the EIS are mostly condensed from longer lists in the Applicant's ER or from various field guides. Thus, most species listed are the ones that most readers would be familiar with. Listing scientific names for these more commonly known species would not be overly informative. However, the Staff does acknowledge the importance of listing scientific names for threatened and endangered species and other species of special concern (e.g., important salmonid species). The scientific names of these species are provided in Tables A.7 through A.9.

COE-3

Construction and maintenance activities could temporarily impact the quality of potable surface water supplies. Also, excavation for project structure foundations could have very localized effects on the production of wells withdrawing water from shallow aquifers. Because of the mitigative measures that would be enforced during construction, such impacts would primarily be confined to increased sediment inputs (rather than chemical inputs), which would be short-term and nondetrimental. However, it is very unlikely that the implementation of the proposed project would result in significant direct and long-term impacts on substantive potable water resources. For example, buffer zones would be required in order to prevent pesticide application into potable surface waters or wells (see Appendix B, Table B.1).

COE-4

Data on specific placement of structures is currently unavailable. The text of Section 4.1.3.2 have been revised to more appropriately address concerns regarding herbicide contamination of groundwater.

COE-5

The values expected from electrical effects associated with the proposed 345-kV AC lines include the contributions from the existing lines. A minor text addition to reflect this has been added to the beginning of Section 4.1.8.

COE-5 (Cont) result from the operation of a 345 kv-AC line. However, the construction of the new AC line in a current right-of-way would parallel other existing AC lines. A cumulative effect of several AC lines in the same corridor should be discussed.

COE-6 6) Discussion of the possible beneficial impacts of the proposed project on deer wintering habitat and other species of open habitat could be added.

COE-7 7) This project will require authorization under Section 404 of the Clean Water Act, for the fills placed for access roads, stream crossings and structure supports. However, the level of detail supplied is insufficient for our evaluation. We need more site specific information, including individual site plans, cubic yards of fill, and area to be filled for each wetland location that would be impacted. This information should be supplied as part of a permit application. Appropriate forms and information are enclosed to assist you. A Corps permit is not required for power lines that will span non-navigable wetlands and streams, provided there will be no filling.

If you have questions or need additional information please contact David H. Killoy at 617-647-8490.

Sincerely,

William F. Lawless, P.E.
Chief, Regulatory Branch
Operations Division

COE-6

The Staff briefly discusses the possible beneficial effects of clearing and right-of-way management on wildlife in Section 4.1.4.1. However, unlike Phase I, which involved new right-of-way construction, Phase II would be located within existing rights-of-way. Thus, only minimal additional benefits to wildlife would be expected. A text addition to reflect this has been added to Section 4.1.4.1.

COE-7

Comment noted. The Staff has forwarded the letter to the Applicant, along with the enclosed forms and information.

ENVIRONMENTAL DEFENSE FUND

ENVIRONMENTAL DEFENSE FUND

444 Park Avenue South
New York, NY 10016
(212) 686-4191

October 15, 1986

The United States Department of Energy
Economic Regulatory Administration
Office of Fuels Programs (RG-22)
1000 Independence Avenue S.W.
Washington, D. C. 20585

Attention: Mr. Anthony J. Como

RE: New England/Hydro-Quebec ± 450 KV
Transmission Line Interconnection --
Phase II Draft Environmental Impact
Statement (EH -23)

Gentlemen:

EDF-1 The watersheds of James Bay and Hudson Bay constitute one of the few great remaining wilderness areas of the world. The construction of additional dams and related hydroelectric facilities within these watersheds on tributary rivers could have far reaching and perhaps devastating impacts on the affected ecosystems. Actions taken by the United States to increase imports of power will have major secondary consequences in terms of increasing the likelihood that additional facilities will be built.

We have read the statement dated September 26, 1986 prepared by Berle, Kass & Case on behalf of the National Audubon Society to you. We concur fully in the comments in that letter about the far-reaching deficiencies of the draft EIS.

We would request that we be included on your service list to receive copies of any additional notices, draft or supplemental EISs or other materials which you circulate for public comment or for public information.

Yours very truly,

James T.B. Tripp
Counsel

1616 P Street, NW
Washington, DC 20036
(202) 387-3500

1405 Arapahoe Avenue
Boulder, CO 80302
(303) 440-4901

2606 Dwight Way
Berkeley, CA 94704
(415) 548-8906

11 South 12th Street
Richmond, VA 23219
(804) 780-1297

RESPONSES TO THE ENVIRONMENTAL DEFENSE FUND

EDF-1
Concerns noted. See the responses to comments by Berle, Kass & Case.

APPENDIX G. DISTRIBUTION LIST

Environmental Law Council of NH
2 White St.
Concord, NH 03301

Environmental Quality Div. MDC
20 Somerset St.
Boston, MA 01824

Essex Conservation District
82 Eastern Avenue
Essex, MA 01929

Garden Club Federation of Mass., Inc.
300 Massachusetts Avenue
Boston, MA 01450

New Hampshire Wildlife Federation, Inc.
East Barrington, NH 03825

The Environmental Coalition
Box 757
Concord, NH 03301

Douglas Zook
Learning Center for the Environment
57 Arborough Road
Boston, MA 02130

Stephan K. Rice
Appalachian Mountain Club
Pinkham Notch Camp
Gorham, NH 03581

Beaver Brook Valley Preserve
The Nature Conservancy
69 Depot Road
Foxborough, MA 01719

Frances Brockely
Society for the Protection of NH Forests
54 Portsmouth Street
Concord, NH 03301

NH Association of Conservation Commissions
54 Portsmouth Street
Concord, NH 03301

New Hampshire Resource Recovery Assoc.
P.O. Box 721
Concord, NH 03301

Inst. of Natural and Environmental Resources
University of New Hampshire
Durham, NH 03824

Dinah Bear
Acting Gen. Counsel
Council on Environmental Quality
722 Jackson Place, NW
Washington, DC 20006

Gordon E. Beckett
Supervisor, NE Area
U.S. Dept. of Interior
P.O. Box 1518
Concord, NH 03301

Bruce Blanchard
Dir., Environmental Project Review
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