Draft Supplement
to the

NUREG-0530

final environmental statement

related to construction of

PILGRIM NUCLEAR POWER STATION UNIT NO. 2

BOSTON EDISON COMPANY

FEBRUARY 1979

Docket No. 50-471

U. S. Nuclear Regulatory Commission • Office of Nuclear Reactor Regulation

NUREG-0530
February 1979

Draft Supplement

to the

FINAL ENVIRONMENTAL STATEMENT

by the

U. S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

FOR

PILGRIM NUCLEAR POWER STATION, UNIT NO. 2

proposed by

BOSTON EDISON COMPANY

Docket No. 50-471

TABLE OF CONTENTS

PREFACE

On December 1, 1977 the Atomic Safety and Licensing Board issued a partial initial decision regarding only the alternative site portion of the Pilgrim Unit 2 Environmental Review. The decision denied the Limited Work Authorization requested by Boston Edison Company citing the inadequacies of the NRC staff's review. This decision necessitated a reevaluation of alternative sites by the staff. This supplement presents the results of this reevaluation.

The Summary and Conclusions presented in this supplement are drawn both from the analyses presented herein and from the Pilgrim Nuclear Power Station Unit 2 Final Environmental Statement issued in September 1974. It summarizes the staff's analysis of the alternative sites in relation to the project and contains the staff's conclusions and conditions relative to the project as now constituted.

Single copies of this statement may be obtained by writing the:

Director, Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Mr. Dino C. Scaletti is the NRC Environmental Project Manager for this project. Should there be questions regarding the content of this statement, he may be contacted at the above address or at 301/492-8443.

PILGRIM ALTERNATIVE SITE REVIEW

Summary and Conclusion

This draft supplement to the final environmental statement was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation.

1. This action is administrative.

2. The proposed action is the issuance of a construction permit to Boston Edison Company for the construction of Pilgrim Nuclear Power Station Unit 2 (Docket No. 50-471) located in the Commonwealth of Massachusetts, near the Town of Plymouth. Pilgrim Nuclear Power Station Unit 1, a 655 MWe net electrical output boiling water reactor, went into commercial operation at this site in June 1972.

   Unit 2 will consist of a pressurized water reactor with a thermal output of 3456 MWe and a net electrical output of 1180 MWe. Cooling water and service water will be withdrawn from Cape Cod Bay through a shoreline intake structure at a design rate of about 52 cms and passed back to the Bay through an open-channel surface jet discharge. The temperature of the cooling water will be raised approximately 12^{o} by passage through the condenser.

In order to meet the power demands and reliability criteria of the applicant's service area, the completion date for Unit 2 has been scheduled for 1985.

3. Principal alternatives considered:

a. Alternative sites

4. Summary of alternative sites review:

On December 1, 1977, the Atomic Safety and Licensing Board (ASLB) denied the Limited Work Authorization requested by Boston Edison Company (BECo) citing the inadequacies of the staff's review of alternative sites for the Pilgrim Unit 2 Application.

On January 26, 1978, BECo submitted for staff review a draft siting study entitled, "Boston Edison Company Siting Study for Long Term Power Generating Capacity Expansion - 1975 to 2000" (1974 siting study). The 1974 siting study was not prepared for the purpose of supporting the construction of Pilgrim Unit 2 at the Rocky Point site but rather for the purpose of identifying current and future generating options and sites to the year 2000. The study assumed that Rocky Point was planned for

only three nuclear plants, and further utilization of the site was not considered. The material in the 1974 siting study was updated by BECo on May 30, 1978.

Our review of the 1974 siting study consisted of an evaluation of the applicant's site selection process and an evaluation of the candidate sites. The evaluation of the site selection process consisted of an examination of the adequacy of the reconnaissance level information used in selecting the candidate sites and the methodology of using that information. The assessment of the candidate sites consisted of an examination of relative merits of these sites in relation to the proposed Rocky Point site.

Based on its review of the 1974 siting study, the staff has concluded that the candidate sites selected by the applicant were all potentially licensable and were among the best that reasonably could have been found within the identified region of interest.

The 1974 siting study was limited to the eastern portions of Massachusetts and did not include the largest fresh water source in the Commonwealth (Connecticut River). The staff believes that applicant should have given consideration to this resource area.

To supplement what was believed to be a major deficiency of the 1974 siting study, the staff selected the Montague site as a representative site from the Connecticut River area to compare with Rocky Point.

With the inclusion of the Montague site, the staff believes that all the major resource areas in the Commonwealth of Massachusetts have been considered in its evaluation with the candidate sites best representing those resource areas. After comparing the environmental attributes of each of the candidate sites with the Rocky Point site, the staff concludes that none of the candidate sites are obviously superior to the Rocky Point site.

In response to ALAB-479, the staff has also included an evaluation of the Seabrook site and the Millstone site and compared them to Rocky Point. The staff concludes that these two sites are not obviously superior to the Rocky Point site.

5. The following Federal, State, and local agencies have been asked to comment on the Draft Environmental Statement:

- Advisory Council on Historic Preservation
- Department of Agriculture

. Department of the Army, Corps of Engineers

. Department of Commerce

. Department of Energy

. Department of Health, Education and Welfare

. Department of Housing and Urban Development

. Department of the Interior

. Department of Transportation

. Environmental Protection Agency

. Massachusetts Department of Natural Resources

. Massachusetts Water Resources Commission

. Board of Selectmen, Town of Plymouth, Massachusetts

6. The Final Environmental Statement was made available to the public, to the Council on Environmental Quality, and to the other specified agencies in September 1974.

7. On the basis of the analysis and evaluation set forth in this and the final statement, after weighing the environmental, technical and other benefits of Pilgrim Nuclear Power Station Unit 2 at the Rocky Point site against the alternative sites, it is concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 is the issuance of a construction permit for Pilgrim Nuclear Power Station Unit 2.

1. INTRODUCTION

On December 1, 1977, the ASLB issued a Partial Initial Decision regarding only the alternative sites portion of the Pilgrim Unit 2 environmental review. The ASLB denied the Limited Work Authorization requested by Boston Edison Company (BECo) citing the inadequacies of the staff's review of alternative sites for the Pilgrim Unit 2 application. This decision was affirmed by the Atomic Safety and Licen ing Appeal Board (ASLAB) ALAB-479 (May 1978).

To enable the staff to remedy the inadequacies, BECo submitted on January 26, 1978, as part of their Pilgrim Unit 2 application, a draft siting study entitled, "Boston Edison Company Siting Study for Long Term Power Generating Capacity Expansion - 1975 to 2000" dated February 1974. The staff conducted a detailed review of this document and an analysis of the alternative sites issue in the areas of aquatic biology and water quality; terrestrial ecology and land use; demography; nearby industrial, transportation, and military facilities; hydrology; socioeconomics; economics; geology, seismology, and geotechnical engineering; and meteorology. The staff supplemented its review, where appropriate, with data gathered independently.

The information used by the staff in its evaluation was developed from the following:

1. "Boston Edison Company Siting Study for Long Term Generating Capacity Expansion - 1975 - 2000," February 1974.
2. Letter, R. M. Butler to Wm. H. Regan, April 13, 1978.
3. Letter, R. M. Butler to Wm. H. Regan, May 28, 1978.
4. Letter, R. M. Butler to Wm. H. Regan, August 2, 1978.
5. Letter, R. M. Butler to Wm. H. Regan, August 18, 1978.
6. Pertinent PSARs, FSARs, SERs, site visits, and published literature.

2. APPLICANT'S METHODOLOGY

The applicant's 1974 siting study used a radial approach to the siting process. Starting at the center of the BECo service area (Boston), they expanded radially along resource areas until the decision was made that a sufficient number of sites could be identified. The regional site search was intended to screen out regions undesirable for siting a major electric power generating plant and, conversely, to focus on regions with good potential for plant siting. Areas within eastern Massachusetts were broadly categorized for their siting suitability based on the following considerations:

1. Present Boston Edison Company System - Final choice of new plant sites must be compatible with BECo system.
2. Land use and demography

a. Present land use

b. Transportation networks and site access

c. Population trends relating to nuclear siting

d. Land area requirements for new sites

3. Water resources

4. Foundation conditions

5. Meteorology

6. Ecological resources

7. Special requirements of offshore plants

8. Land and water use planning

The data used by BECo in the regional site search was obtained from maps, aerial photographs, published sources, and field trips.

The resource areas identified in the site search included: the Massachusetts coastline from the New Hampshire border to the Cape Cod Canal, Buzzards Bay, and rivers (Merrimack River to the New Hampshire Border, the Nashua, Blackstone, Concord, and Taunton Rivers) as well as the lakes and reservoirs in the area. Areas at greater distances from Boston, such as the Connecticut River, were given less consideration. The decision to stop with these resource areas was arbitrary and not based on criteria other than the applicant's decision that a sufficient number of sites could be identified.

3.1 Region of Interest

In the staff's opinion, the applicant did not clearly substantiate (in the 1974 study) why the region of interest was limited to eastern Massachusetts. However, in response to a staff inquiry concerning the extent of the region of interest BECo supplied additional information by letters from R. Butler to W. Regan on April 13, 1978 (Ref. 1), and August 2, 1978 (Ref. 2), respectively. The April 13, 1978, response cited the following considerations that restricted the geographical scope of the 1974 siting study:

1. Geography
    a. Distance from service area/system reliability
    b. Compliance with objectives of regional power planning agency
    c. Cooling water availability
    d. Land requirements
2. Demography
3. Legal, regulatory, and political constraints

Some of the important factors discussed within these areas of consideration were the following: minimizing transmission costs and increasing system reliability by placing the source near the load; coordinating with regional power pool planning; water availability for plant needs;

land availability for plant needs; choosing low population areas for nuclear options; and examining the legal and political constraints associated with siting outside the Commonwealth of Massachusetts (specifically Maine, New Hampshire, Vermont, Rhode Island, and Connecticut).

The difficulties associated with siting in the State of Maine that were identified by the applicant relates to BECo's Indenture of Trust and First Mortgage which would preclude issuance of bonds for construction of a facility in a state that does not adjoin the Commonwealth of Massachusetts (Ref. 1). Also, Maine law requires Maine electric companies to own a majority interest in any generating facilities constructed in that state. The percentage of the Pilgrim facility owned by Maine electric utilities is less than 3 percent (Central Maine Power Company - 2.85%).

In the New England States adjoining Massachusetts, with the exception of Rhode Island, the statutes are less clear as to the siting difficulties that would be encountered by a foreign utility trying to construct an electric generating facility. Rhode Island statutes require part ownership by a domestic utility. Because there are no Rhode Island utilities in the joint ownership of Pilgrim Unit 2, the attempt to locate and construct the facility in Rhode Island would be difficult. In the other three states, the requirements of the applicants to show public need,

tender adequate service to the public in the conduct of its business and a lack of eminent domain by foreign utilities would make it extremely difficult for the Pilgrim applicants (mostly Massachusetts based 88.07% ownership) to site and construct a facility in these states (Refs. 1, 2).

The August 2, 1978 (Ref. 2) submittal dealt solely with the opinions of counsel from resident law firms in the States of Connecticut, Rhode Island, New Hampshire and Vermont. The opinions related to the difficulty of siting in the various states at the time of the preparation of the 1974 siting study (1973) and the difficulty that would be encountered at the present time.

The conclusions of the various counsels is that the statutory framework of the four states, although they do not explicitly preclude it, makes it difficult and, in the case of Rhode Island, legally impossible for a foreign utility to site in their respective states.

The staff has reviewed BECo's reasons for not including the States of Maine, New Hampshire, Vermont, Connecticut and Rhode Island in the geographic scope of the 1974 siting study and concurs with this decision noting that with the existing joint ownership it would have been difficult for the Pilgrim Unit 2 applicants to site the facility outside of Massachusetts in the 1973 time frame as well as for the present. In addition, the staff has reviewed the other factors dictating the applicant's

region of interest and concurs that these key issues were appropriate for consideration by BECo. However, the staff believes the Connecticut River should have been given consideration (see Section 4).

3.2 Selection of Candidate Sites

The applicant's selection of candidate areas within the region of interest involved evaluation of areas against the various factors considered important in the site search. Twenty-six candidate areas were identified within BECo's identified region of interest (see Figure 1).

Field trips to these areas and preliminary assessments based on literature sources led to the pinpointing of some 48 specific sites within these areas including coastal, inland, and offshore locations. Of these, 24 sites were deferred from further consideration for various reasons including population, site size, residential development, water-related problems, and seismicity. Thus, 24 sites (21 new sites and 3 sites with existing generating stations) remained under active consideration. The next step in the study was a more detailed evaluation of each site considering specific plant-site generating concepts (i.e., nuclear, coal, oil, or combined cycle) and resultant cost, engineering, and environmental impact factors. Nuclear plants were evaluated only at those sites that afforded a minimum exclusion radius of 0.8 km and a population distribution considered "licenseable" based on the guidelines established for use in the study.

The sites identified in the study as potential nuclear power plant sites were Sites 1, 1A, 2, and 2A in the Merrimack River Valley about 50 km northwest of Boston; Sites 18A, 18B, 18C, and 18E all within about 3 km of each other on the coast of Cape Cod Bay about 65 km southeast of Boston; Sites 19 and 20 on upper Buzzards Bay about 70 km southeast of Boston; and Site 26, an inland site about 40 km south of Boston. Site 1A was considered to be analogous to Site 1, and Site 26 was considered suitable only for dry cooling systems which has not yet been fully developed for large power plants. Descriptions of the nine candidate sites are presented in the staff's analysis section (Section 4).

3.3 Staff Assessment of Applicant's Reconnaissance-Level Information and of Applicant's Site Comparison Phase

The NRC staff has examined the candidate site evaluation and subsequent candidate site comparison phases of the site analysis used by BECo for the areas of aquatic biology, and water quality; terrestrial ecology and land use; demography; nearby industrial, transportation, and military facilities; hydrology; socioeconomics, economics; geology; seismology, and geotechnical engineering; and meteorology.

In general, the identified impact criteria included aspects associated with site preparation and plant construction (termed "short term impacts" by the applicant), and plant operation. In some areas, impacts associated with offsite areas were not specifically covered by the criteria.

All information used in the site comparisons under these criteria was taken from published data information (reconnaissance-level information) rather than using data developed from onsite investigations (although site visits were made by the site evaluation team). The following assessments were performed by staff specialists in specific disciplines. The conclusions for each section pertain only to that portion of the assessment and to that discipline. The staff's overall conclusion is found on page 151.

3.3.1 Aquatic Biology and Water Quality

The following aquatic environmental impact criteria were considered: (1) impingement; (2) entrainment; (3) thermal discharge effects on the receiving water, the dissolved oxygen concentration and the receiving water biota; and (4) the effects of liquid wastes on the natural chemistry of the receiving waters, on potability, on wildlife and on aquatic biota. The short-term (i.e., construction phase) impact criteria considered chemical, physical and biological aquatic effects and potential effects due to erosion for onsite activities. The staff judges that the selection of the above important aquatic environmental impact criteria is reasonable and that they could be applicable to a wide variety of candidate sites. The staff also judges that the use of these criteria in comparing and constrasting the potential aquatic impacts of the candidate site/cooling system options would be possible based on reconnaissance-level data and information.

The applicant's selection of aquatic impact criteria for comparison of sites is incomplete in that it did not specifically consider the impacts due to offsite construction of makeup and blowdown/discharge pipelines. For the commonly encountered situations, the impacts associated with these activities are controllable, if not avoidable, to acceptable levels with varying degrees of mitigation. Thus, the omission of this criteria in the comparison of sites could contribute to inaccuracies in the prediction of site-specific impacts in the site-to-site comparison. However, it is not likely to result in a fatal flaw.

In applying the aquatic impact criteria to the specific sites, the applicant presupposed that, for all liquid-borne effluents, for all short-term aquatic chemistry effects, and for site erosion potential short-term effects, the application of best-control technology to every situation at each site would result in no impact. The staff believes that this presupposition is conceptually incorrect in that application of best-control technology does not necessarily mean that there will be no impact without appropriate site-specific analyses.

The staff has reviewed the applicant's use of reconnaissance level information for determination of impacts at specific alternate sites. The data base (reconnaissance level information) for the impact assessments under the uniform criteria process described above is presented in the bibliography section of the applicant's report. The staff's review

of the identification of the candidate sites indicates that the sites have been identified with sufficient precision to enable a reasonable determination of the likely important specific aquatic environmental parameters from reconnaissance level information. The placement of plant structures with respect to onsite water bodies, the locations of makeup/blowdown pipelines and the actual in-water structures themselves are not precisely indicated for all of the candidate sites. The site identifications presented are judged to be sufficient to have enabled the applicant to adequately describe the aquatic environmental factors likely to be of importance in siting, constructing and operating a nuclear power plant at the sites in question (e.g., onsite water bodies potentially affected can be identified and described, the potential magnitude of impact can be estimated; the area of the makeup/receiving waters can be identified and described as to existing aquatic resources, water use plans, water quality, water quality standards in effect and pre-existing aquatic environmental stresses can be noted; potential impacts to these resources/conditions can be estimated).

3.3.2 Terrestrial Ecology and Land Use

The applicant utilized the following factors in the selection and evaluation of potential sites: size of the site; topography; railroad, road, and transmission access to site; flora and vegetation; fauna; present land use; and proposed use of the land by various planning agencies.

The information sources utilized in obtaining data on the above factors were: USGS 7.5 minute topographic maps, Massachusetts map down (Ref. 3), aerial photographs, overflight, and actual site visits.

The 1974 siting study was updated to include current terrestrial factors, e.g., Coastal Zone Management Act, prime and unique farmlands, etc. With the inclusion of these factors, the staff concludes that the information used was adequate to identify and compare candidate sites.

3.3.3 Demography

Two types of population guidelines were used by the applicant in the site-selection process. The first guideline consisted of cumulative population values as a function of distance which were obtained from a trade newsletter (Ref. 32) and from an internal working paper of the Regulatory Staff. The guideline values were expressed as cumulative population levels of 30,000 within 8 km, 500,000 within 32 km, and 2,000,000 within 64 km. (These population values correspond to a density of 249 persons per square kilometer (400 per square mile). These values were subsequently modified by the staff. See Appendix A for further discussion of the population guidelines used by the staff.) The second guideline used by the applicant in the 1974 study consisted of an envelope of population distributions of sites previously reviewed by the Regulatory staff (e.g., Indian Point and Newbold Island).

Acceptable sites for nuclear power plants were also required to have an available exclusion area radius on the order of 0.8 km.

In the initial regional site search, general areas were identified that had (1) population densities less than the numerical levels noted above, (2) population densities greater than the numerical levels but comparable to the densities of other high population density sites previously reviewed by the staff, and (3) population densities that clearly exceed both the numerical values and the population densities of other high population density sites reviewed by the staff. The data base for the study was the 1970 Census as displayed on a map of Massachusetts prepared by the Commonwealth of Massachusetts Department of Community Affairs. Population trends and future growth patterns in the study area were discussed but were not quantified. Seasonal transient populations were also not included in the population data base. (The results of the applicant's initial evaluation are shown in Figure IV-11 of the 1974 study and in BECo Exhibit S-4.)

The population information for each of the candidate sites identified in the 1974 study was updated by the applicant in a submittal dated May 30, 1978. The methodology used in developing the new population distributions involved a more detailed examination of the 1970 Census data base. Data from individual Census Enumeration Districts were used to estimate the population in annular rings around each site in one 1.6 km increments

out to 48 km. Population projections, based on reconnaissance-level information, were then made for 1985, the expected date of plant commercial operation, and for 2018, the expected end of plant life (40 years after an assumed issuance of a construction permit in 1978). Seasonal transient population was included in the population projections for sites where it was deemed to be a significant factor (i.e., Sites 18, 19 and 20, the coastal sites southeast of Boston).

The 1974 siting study identified nine candidate sites within the geographical scope of the study as potential sites for nuclear power plants. The population distributions for each of the candidate nuclear power plant sites are shown in Tables 2 through 7 (for population purposes the staff considers Site 18 to be one site). These sites cover a range of population densities, from those that fall below the population density values listed in Regulatory Guide 4.7 to those that exceed these values.

We have made an independent evaluation of the population surrounding each of the candidate nuclear power plant sites (i.e., Sites 1, 2, 2A, 18, 19, and 20) and compared our results to those reported by the applicant in the 1978 update. We obtained an estimate of the cumulative resident population within 48 km of each site from 1970 Bureau of the Census data (Ref. 5) and found that our values were in close agreement with the applicant's population counts. We also compared the applicant's population projections with projections prepared by the Federal Government

(Ref. 6) for Bureau of Economic Analysis Area 4, an area that covers southeastern New Hampshire, eastern Massachusetts, and Rhode Island. The Federal projections indicate that the population in Economic Area 4 will increase at a rate of about 8% per decade between the years 1980 and 2020. The applicant's projections for the population growth between the years 1985 and 2018 range from a low of about 10% per decade for Site 2 to a high of about 17% per decade for Site 18. These values indicate that the projected population growth rate for each of the candidate sites exceeds the projected regional growth rate made by the Federal Government.

We find that the methodology used by the applicant in the 1974 siting study was deficient in that population projections for the area of interest were not made nor were transient populations included in the analysis. The methodology used in the 1978 submittal to update the population distributions for the candidate nuclear sites identified in the 1974 study was in accordance with our current guidance in that population projections over the assumed lifetime of the facility were developed and seasonal transient populations were included. The identification of possible additional alternative sites was not an objective of the 1978 update.

One criticism of the 1978 update is that it does not attempt to account for daily recreational visitors and tourists in the study area. However,

we believe that inclusion of these transients would not alter the population distributions to the extent that the conclusions of this review would be affected considering the amount of time on an annual basis that such daily transients would be present.

3.3.4 Nearby Industrial, Transportation, and Military Facilities

The applicant stated in the 1974 study that each site was examined for the presence of nearby industrial, transportation, and military activities and that the potential impacts of such activities were evaluated to determine whether or not the site should be deferred. However, there is very little discussion of this subject in the siting study and no details are given as to the extent or nature of the evaluations. There is evidence that the applicant was aware of the importance of considering such activities and gave them some weight in the site-selection process. The presence of nearby airports and the potential hazards associated with the close proximity of an interstate highway were among the reasons given for deferring some of the sites. In the 1978 update of the siting study, the applicant submitted additional information on the industrial, transportation, and military facilities in the vicinity of each candidate nuclear power plant site.

It appears that the potential impact on a site of a large, highly visible facility, such as a major airport, was considered at least in a qualitative

manner during the site-selection process. However, much less, if any, attention was given to the evaluation of other less obvious hazards such as pipelines and transportation routes (e.g., shipping on the Cape Cod Canal). We conclude that the siting study was deficient because a thorough, systematic review of all potential external hazards in the vicinity of the candidate sites was not conducted.

3.3.5 Hydrology

In selecting the candidate sites, the following hydrological factors were considered: (1) local damage, (2) erosion control, (3) flood protection, (4) pipelines, (5) intakes and discharges, (6) potential contamination of potable water supplies, and (7) water supply availability and use. For the first six areas, above, the applicant identified resources that would be necessary to avoid obvious environmental and safety impacts associated with construction and operation of a nuclear plant. In these areas, for the sites considered there were no extremely unique, costly, or severe problems resulting from construction and operation.

From a hydrologic engineering standpoint, the most critical factor in determining the viability of sites is the availability of cooling water. Since the applicant chose sites where adequate water was available, we conclude that this factor was adequately considered in establishing the

candidate areas and sites. The rejection or acceptance of a site on the basis of an adequate water supply for a particular type of cooling system was applied correctly and reasonably. However, some water supply problems could be encountered at the Merrimack River sites (see discussion in staff's analysis on page 54).

We conclude, in addition, that there are other areas within the State of Massachusetts where a dependable water supply would be available. The site search, which was confined to the eastern portion of Massachusetts, may not have been extensive enough and probably should have included the Connecticut River. Although acceptable (from a hydrologic engineering standpoint) alternate sites were selected, other acceptable sites probably exist on the Connecticut River and at other coastal locations.

Given the sites that were chosen, we do conclude, however, that the sites selected for consideration as alternatives to the Rocky Point site are realistic alternatives to the proposed site.

3.3.6 Socioeconomics

In the comparison of candidate sites, the following socioeconomic factors were considered: labor, local spending/investment, community services, recreation, preserved areas, aesthetics, adjacent land value, community economy and residential displacement. In performing the candidate site

evaluation, the applicant considered both the constructional and operational impacts and the onsite and offsite impacts. The applicant consulted various reviews, reports, and studies; utilized aerial photographs and topographic maps of candidate sites; contacted agencies and officials; and conducted onsite inspections by technical staff.

The staff concludes that the socioeconomic reconnaissance level of information obtained in the site-selection process by the applicant was acceptable and that the site-selection process contained the necessary ingredients to meet the objective of identifying candidate sites.

3.3.7 Economics

The detailed site evaluation included various cooling options on each of the identified sites. Sites with high cost penalties were generally excluded, such as Site 26 with a design calling for dry cooling towers.

The candidate sites with the plant type and cooling system combination were subjected to continued evaluation to determine an order of preference from an engineering viewpoint and an environmental viewpoint. The engineering order of preference involved an analysis of comparative economic cost penalties for major site-related costs. Only capital costs that varied by more than several million dollars were considered because the level of uncertainty in the estimates does not permit a

refined comparison. Rough approximations were considered appropriate for this level of site comparison.

The study considered the capital costs associated with the following aspects of siting: site development, cooling system, transmission system, liquid waste treatment system, foundation costs, labor differential, and construction access. The staff believes the applicant has given appropriate consideration to economics in the site comparison phase of the 1974 siting study.

3.3. Geology and Seismology

In the review of candidate sites, the applicant considered the effects of topography, surficial geology, bedrock geology, and regional geology and seismicity. The regional geology and seismicity information is principally contained in the Pilgrim Unit 2 PSAR and forms an adequate regional basis for comparison of the alternate sites.

3.3.9 Meteorology

We have reviewed the 1974 Boston Edison Company siting study dealing with meteorology, and find it appropriate for the reconnaissance level review being made for alternate sites selected. The meteorology section provided generally descriptive climatological information for eastern

Massachusetts derived from currently available National Oceanic and Atmospheric Administration (NOAA) and Environmental Protection Agency (EPA) publications. This type of information is acceptable for this evaluation, since detailed onsite meteorological data is not available at this stage of review.

4. STAFF EVALUATION OF SITE SELECTION PROCESS AND CANDIDATE SITES

The staff does not subscribe to any single site-selection process or methodology. Rather, applicants are given considerable latitude in their methodology, as long as their treatment of key issues is reasonable, logical and consistent and results in identification of reasonable siting options. The staff feels that the 1974 siting study and updates treat the necessary issues and identify reasonable siting options for BECo. However, during the staff examination of the 1974 siting study, it was determined that the region of interest considerations were limited in geographical scope to the eastern portion of Massachusetts. BECo excluded western Massachusetts because of transmission distances to their service area. Although, the staff does not believe it is able to supplement the needs of BECo with regard to power plant siting, it does believe that the Connecticut River should have been included as one of the resource areas considered in the 1974 siting study.

The Connecticut River is the largest source of fresh water in the Commonwealth of Massachusetts and probably the only river with sufficient flow capable of supporting a facility the size of Pilgrim Unit 2 without augmentation from another water source.

In order that the staff assure itself that all major resource areas in the Commonwealth of Massachusetts were given consideration, the Montague site was selected as representative of the Connecticut River resource area for comparison with the Rocky Point site. The Montague site is located in the Town of Montague, Massachusetts, and would utilize the Connecticut River for its source of cooling water.

The 1974 siting study considered the major lakes, reservoirs (including the Quabin Reservoir), and rivers (Merrimack, Nashua, Concord, Charles, Taunton and Blackstone) in the eastern portion of Massachusetts. With the exception of the Merrimack, BECo concluded that the consumptive use of water from those sources was not compatible with existing water supply or other usage. The staff concurs with these reasons (see staff evaluation of Sites 1, 2 and 2A for a discussion of the Merrimack River).

The coastal consideration in the 1974 siting study included the north and south shores, Cape Cod, and Buzzards Bay. BECo eliminated Cape Cod as a choice due to heavy recreational use, unfavorable long transmission distances, and land use conflicts. The staff concurs with these reasons.

Consideration of the resource areas in the 1974 siting study by BECo, and with the inclusion of a Connecticut River site by the staff, the staff believes that all of the important resource areas in Massachusetts have been given sufficient consideration. The resource area types (candidate sites) selected for evaluation were sufficiently representative of those areas to determine the reasonable siting options for the Pilgrim project.

The other two sites evaluated by the staff, although they are not considered in the 1974 siting study, are the Millstone and Seabrook sites. Both sites are located outside the area of consideration in the 1974 siting study. Even though the staff does not believe that these sites represent reasonable alternatives to the Pilgrim Unit 2 project as discussed in Section 3 (because of problems involving siting outside the Commonwealth of Massachusetts), the staff has included an evaluation of these two sites in response to ALAB-479 (Ref. 7).

The Montague, Millstone, and Seabrook sites have previously undergone extensive reviews by the staff and have been found acceptable for nuclear power plant locations (Refs. 8, 9, 10). The staff's evaluation of these sites begins on page 99.

The staff's anlaysis of the 1974 siting study was divided into (1) an assessment of the site selection process and (2) an assessment of the

candidate sites. The assessment of the site selection process consisted of examining the adequacy of the information the applicant used in selecting the candidate sites and the methodology employed by the applicant in using that information (see Sections 3 and 4). The staff assessment of the candidate sites consisted of examining the relative environmental merits of the proposed site in relation to alternatives to assess whether any of the alternatives is obviously superior to the proposed site (Rock Point) consistent with the standard established by Commission case law for comparing alternative site.

The staff's assessment of the candidate sites is based on reconnaissance-level information. This information is available from open literature, published or unpublished reports, existing records, authoritative sources or information that can be obtained by brief field surveys performed by recognized experts. It does not include information that must be obtained by detailed onsite monitoring programs or studies. The site description summaries prepared by the applicant from the data base are judged to be inadequate in some technical areas for the determination of the impact due to construction and operating of a nuclear power plant at the candidate sites. Therefore, the staff felt required to supplement the reconnaissance level information to aid in conducting its independent analysis of the identified sites.

4.1 Description of the Rocky Point Site (Pilgrim Station)

The proposed site for Pilgrim Nuclear Station Unit 2 occupies approximately 2'' ha presently owned by the Boston Edison Company. The site is located in the Town of Plymouth, Massachusetts, about 7 km east-southeast of the town center and about 60 km southeast of Boston. It is on the western shore of Cape Cod Bay at a location called Rocky Point.

The site is presently occupied by Pilgrim Unit 1, a 655 MWe nuclear plant owned and operated by Boston Edison Company. The proposed development of Pilgrim Unit 2 at the Rocky Point site would increase the site's generating capacity to approximately 1835 MWe. Both Pilgrim Units 1 and 2 would operate in once-through cooling mode using the existing shoreline intake and discharge systems. Both units have received the necessary approvals and permits from the Environmental Protection Agency to allow Pilgrim Station to operate in the proposed once-through mode, therefore, the staff did not consider a closed-cycle alternative for purposes of comparing Rocky Point with the alternative sites.

The terrestrial resources of the site consist primarily of a mixed oak-pine forest with small- to medium-sized trees and small areas of wetlands (Ref. 3). There are about 4 ha of prime and 22 ha of statewide or locally important farmland (Ref. 11) in site boundary. A portion of

the site has been classified as "best wildlife habitat other than publicly-owned land or wetland" (Ref. 12) by the New England River Basin Commission. The site is located in the coastal zone as described in the Massachusetts Coastal Zone Management Program. There will be no additional land requirements for transmission lines.

The 1975 and projected population distributions within 48 km of the site are shown in Table 1. There is a significant seasonal transient population in the area that includes both seasonal residents and a large number of visitors to the historical sites in Plymouth. The total weighted population was computed by multiplying the seasonal and tourist population by suitable weighting factors to reflect occupancy on an annual basis and then adding the weighted values to the resident population.

The industrial, transportation, and military facilities in the vicinity of the Pilgrim site are described in the Pilgrim Station Unit 2 Preliminary Safety Analysis Report. State Highway 3A, a two-lane paved road, is located approximately 1 km west of the site structures. State Highway 3, a six-lane divided highway, is approximately 5 km west of the site. There is no railroad line within 8 km of the site. The nearest point at which ships traveling north and south between Boston and Cape Cod Canal pass the site is over 5 km due east. Plymouth Municipal Airport, a general aviation facility located about 16 km west of the site, is the closest airport. Otis Air Force Base, which is now operated by the Massachusetts Air National Guard, is located about 30 km southeast of

the site. The nearest Federal low-altitude airway to the site is V141, which passes about 5 km to the northeast. The only facility within 8 km of the site which processes, transports, or stores hazardous material in significant quantities is a petroluem storage facility located approximately 6.5 km west of the site. The staff concluded in the review of the Pilgrim Unit 2 construction permit application that none of these facilities will affect the safe operation of a nuclear plant at the Pilgrim site.

The waters of Cape Cod Bay in the immediate vicinity of the Rocky Point site are designated Class "SA" by the Commonwealth of Massachusetts (Ref. 13). The prescribed best uses and quality criteria for waters in this classification are presented in Appendix A.

There are no surface water bodies immediately adjacent to the Rocky Point site that have special designation or water quality classification above that provided by the Class "SA" designation.

Existing water quality at the Rocky Point site is generally good. The waters of Cape Cod Bay and Plymouth Bay meet the requirements of their assigned Class "SA" classification (Refs. 13, 14). In addition, examination of water column and sediment quality analyses data collected at and around the Rocky Point site (Refs. 15, 16) indicates that the waters meet the "SA" criteria for all parameters for which numerical limits

have been set. A recognized problem in the site area, with a potential to adversely affect water quality near the site, is coastal erosion. The New England River Basins Commission reports (Ref. 17) that areas of "critical erosion" (i.e., erosion at a rate of 1 m or more per year) have been identified along the South Shore region (i.e., the region that contains the site) of the Massachusetts coast. Erosion of the coastline in the immediate vicinity of the Pilgrim plant structures is controlled by the presence of riprap.

Economically important benthic species found in the vicinity of the Pilgrim station include Irish moss and lobster (Ref. 18). Lobsters are generally more abundant on the rocky substrates rather than the sandy substrates, with fishing pressure concentrated on the ledges of Rocky Point, White Horse Beach, and Manomet Point as well as several offshore ledges (Ref. 19). During the summer, lobster fishing in the Cape Cod Bay occurs only to a depth of 18 meters (Ref. 20) and, in the western part of the bay, as many as 6,200 pots per linear kilometer within the 9-m contour are common (Ref. 21). Fishing in deeper water does not occur until late fall (Ref. 19). Larval lobsters also occur in Cape Cod Bay and near the Rocky Point site (Ref. 19). The local lobster population in the vicinity of the Rocky Point site is not self-sustaining and relies on spawning elsewhere. Studies conducted in the vicinity of the station indicated that Brant, Rock High Pine Ledge, Rocky Point (Pilgrim Station), and Scorton Ledge were important hatching areas.

Irish moss requires solid substrate for attachment and is the dominant subtidal macrophyte in the site area (Ref. 19). Moss harvesting is generally conducted from mean low water to a depth of 2 m (Ref. 19). During 1973, moss harvest in the Plymouth area represented 82% of the total Massachusetts landings (Ref. 19). The largest landings in the area have been from the Manomet Point-White Horse Beach area (Ref. 19).

Important mollusks harvested in the vicinity of the Rocky Point site include mussels, soft-shelled clams, surf clams, and hard clams (Ref. 19). Bivalve larvae orginating from Duxbury Bay may drift in a southerly direction down the coast and toward the Rocky Point site; however, the pattern and distribution are not well defined (Ref. 19). Extensive attachment of mussels occur in the rocky areas of the site vicinity (Ref. 22).

The Rocky Point area and Cape Cod Bay support a diverse community of fishes. Forty-one benthic species have been captured in the site vicinity and are dominated by flounders, ocean pout, sculpin, and skates (Ref. 19). Twenty-five pelagic species have been captured and are dominated by pollock, cunner, herring, and alewife (Ref. 19). Although fifty-six species of fish eggs and larvae have been collected from Cape Cod Bay and the Rocky Point area, the bay does not appear to represent a unique spawning habitat and eggs and larvae of several species may enter the bay from outside (Ref. 19). Winter flounder populations exhibit a

seasonal inshore-offshore migration within localized areas of Cape Cod Bay. The adults move inshore to breed. The Plymouth Harbor-Kingston Duxbury Bay region is an area near the Rocky Point site in which intensive breeding takes place for winter flounder (Ref. 23). The adults disperse to deeper water after the breeding season. Winter flounder eggs are demersal and do not tend to be entrained. The larvae however are planktonic and are apt to be suspended in the water column and therefore are subject to entrainment.

Recreational and commercial fishing occurs for several species in the Rocky Point area. Winter flounder, Atlantic menhaden, and bluefin tuna are fished commercially in Cape Cod Bay (Ref. 18). In April 1973, the Rocky Point shorefront was opened to provide public access for recreational fishing at the intake and discharge jetties (Ref. 19). Fishing now occurs in an area where previously there was no public shore fishing. Sixteen species of fish have been caught at the plant site, with cunner, bluefish, and pollock accounting for about 82% of the total (Ref. 19). The rock jetty and breakwater structures serve to attract some species, and the thermal effluent tends to concentrate forage for game species, especially during late summer and early autumn (Ref. 19).

The Rocky Point site lies within a region of general biotic similarity throughout. The aquatic community appears to be diverse and, except for the Irish moss fishery, does not appear to be unique within the region.

There are no known federally designated critical aquatic habitat or threatened or endangered aquatic species inhabitating the offshore marine or marsh-estuary complex in the vicinity of the Rocky Point site that conceivably could be detrimentally impacted by construction of a second nuclear facility at the Rocky Point site.

4.2 Staff Analysis of the Rocky Point Site (Pilgrim Station)

The staff's analysis of the Rocky Point site is set forth in the Final Environmental Statement dated September 1974 and the Safety Evaluation Report (SER) dated June 1975 and its supplements for the Pilgrim Nuclear Station Unit 2 (Refs. 18, 24).

Throughout the course of its review of the alternative sites, the staff has reviewed current information relating to the Rocky Point site and has recently visited the site to confirm that the analyses and the conclusions presented in previous staff documents and testimony were still valid. The staff concurs with the previously stated conclusion that the impacts of construction and operation of Pilgrim Unit 2 will be acceptable (Ref. 18).

4.3 Description of Sites 1, 2, and 2A

Candidate Sites 1, 2, and 2A are all located within 20 km of the Merrimack River and would utilize this source for makeup to their closed-cycle

cooling systems using spray ponds or natural draft cooling tower (NDCT) at Sites 1, and 2A, and a NDCT at Site 2.

Based on assigned water uses, the surface waters associated with these sites have been designated Class "B" by the Commonwealth of Massachusetts. The prescribed uses and quality criteria for these waters are described in the Massachusetts Water Quality Standards. In addition, pollutant discharge to onsite surface waters is prohibited under the protection of low-flow waters provision of the Standards.

Historical data (Ref. 25) indicate that the characteristics most seriously affected in the Merrimack River near the proposed makeup and discharge points are low dissolved oxygen, high biochemical oxygen demand, and high bacteria counts. The results of benthic biological studies have characterized the river as "grossly polluted" (Ref. 26).

The most recent State report (Ref. 27) shows that the present water quality of the Merrimack River is "unsatisfactory" (i.e., not meeting the requirements of the lowest acceptable state classification) from the New Hampshire-Massachusetts State line to the Atlantic Ocean. Segment analysis of the river by the State indicates that high coliform bacterial concentrations, high nutrient levels, and the presence of floating solids are the water quality problems in this stretch of the river.

Data taken by the State of New Hampshire (Ref. 28) predominantly during the latter half of each year from 1974 through 1977 at a point on the Merrimack River approximately 5 km upstream of the State line indicates that Class "B" standards for temperature and dissolved oxygen were satisfied for all samples. Measurement of metals and pH values of the samples were within the limitations of the standards. Total phosphorus concentrations of the majority of samples were above the level suggested by the National Technical Advisory Committee (Ref. 29) for the prevention of nuisance algal growth in flowing waters. The New England River Basin Commssion's latest report (Ref. 25) indicates that ongoing efforts to clean up the river are delayed such that 180 km of river in the basin, including the stretch of the Merrimack River proposed for use in alternative Sites 1, 2, and 2A, are not expected to meet Class "B" Water Quality Standards by 1983.

At present, the quality of the fishery in the Merrimack River is poor; however, Massachusetts plans restoration of an anadromous fishery in the river which would increase the quality of the resource. In addition, there is the possibility that the shortnose sturgeon exists in the Merrimack River, although the occurrence of this species in the Merrimack is presently undetermined (Ref. 30).

4.3.1 Site 1

Site 1 is located in the Town of Dunstable, Massachusetts (see Figure 2). The approximate site boundaries are the New Hampshire State line to the north, the Boston and Maine Railroad on the west, Pleasant Street and the Pepperell town line to the south, and Oak, Brook and Main Streets to the east (see Figure 2).

The site consists of about 1,100 ha. Approximately three quarters of the site is covered by mixed forest of pine and hardwoods with most of the trees in the medium-sized class (Ref. 3). There is the possibility that the site contains prime or state-wide or local importance farmland. Several hundred hectares are currently farmed; logging operations were observed during the site visit. There are three brooks onsite (Unkety, Joint Grass, and Hank), large areas of swamps, and several ponds of various sizes. From the air, the small pond just east of the railroad tracks in the western portion of the site appears to have a floating sphagnum mat. This would be classified as a bog, and bogs have been classified as wetlands with outstanding visual contrast within this geographic region (Ref. 31). The site contains a portion of Unkety Brook which is regularly stocked with trout by the Commonwealth of Massachusetts. The western portion of the site has some areas within the 100-year flood plain.

State Routes 111 and 113, the closest highways, are each located about 2 km from the center of the site. A Boston and Maine Railroad line runs along the western boundary of the site and terminates about 1 km to the north. Sports Center, a small commercial airfield, is located about 1.6 km northwest of the center of the site. Sports Center has a single paved runway 850 meters in length oriented in a northeast-southwest direction. There are three light airplanes based at the field, and the facility is used primarily as a sport parachute center. The possibility of the airfield being expanded is not considered likely with one of the reasons being the presence of Boire Field, New Hampshire, a large general aviation facility which is located 10 km to the north (Ref. 73). Fort Devens Army Airfield is located about 15 km off the site. The nearest low-altitude Federal airway is V106, which is about 10 km northwest. A small fuel storage facility is located at the terminus of the railroad line about 1 km north of the site.

4.3.2 Site 2

Site 2 is located in the Town of Tyngsborough, Massachusetts (see Figure 3). The approximate site boundaries are the New Hampshire State line to the north, Middlesex Road to the west, and the Merrimack River to the east and south.

The site consists of approximately 240 ha of which less than one half is covered by a mixed pine and hardwood forest of mostly medium-sized trees (Ref. 3). There are 48 ha of prime and 105 ha of farmland of State and local importance onsite (Ref. 11). There are two small streams onsite and that portion of the site abutting the Merrimack River is in the 100-year flood plain. The site is bordered on the west by Middlesex Road (State Route 3A) approximately 560 m from the center of the site. The Everett Turnpike (U.S. Route 3), a four-lane divided highway, is about 1 km west of the site. A local road runs through the center of the site and a Boston and Maine Railroad line crosses the eastern part of the site. Some hazardous materials, including chlorine and liquified petroleum gas, are carried on the railroad line. A chemical plant is located about 3 km north of the site. The plant employs about 200 people and stores a quantity of hydrogen cyanide, ammonia, and other chemicals. The closest airfield of significance is Boire Field which is about 15 km northwest. There are no low-altitude Federal airways within 15 km of the site.

4.3.3 Site 2A

Site 2A is located in the Towns of Dunstable and Tyngsborough (see Figure 3). The site is bordered to the north by Pleasant and Lowell Streets, on the west by Massapoag Pond, on the east by Forest Street, and on the south by Chestnut Road.

The above boundaries enclose approximately 730 ha, which are predominantly covered by a mixed forest of pine and hardwoods of mostly medium-sized trees (Ref. 3). There are large swampy areas, small streams, and at least three small ponds on site (Ref. 11). There is a minimum of 5 ha of prime farmland on site. Three orchards occupy about 19 ha, these may be classified as unique farmland.

State Route 113 is located about 1.6 km north of the site center. The Everett Turnpike (U.S. Route 3) is about 4 km to the east. Fort Devens Army Airfield is about 15 km southwest and Boire Field is about 16 km north of the site. There are no low altitude Federal airways within 15 km of the site. A radar tracking/communications station is located about 3 km south of the site.

4.4 Staff Analysis of Sites 1, 2, and 2A

4.4.1 Aquatic Ecology and Water Quality

Construction Impacts: Each site was compared to the preferred site with particular attention directed to the following specific potential construction impacts: (1) onsite stream diversions or alterations; (2) changes in site runoff during site development; (3) right-of-way (ROW) or water pipeline development; and (4) siltation due to dredging for barge facilities, intake/discharge structures, and pipelines.

From examination of the applicant's preliminary proposed plant layouts at the alternate sites, major onsite stream diversion during construction is considered likely at Sites 1 and 2A. Portions of Hauk Swamp, Joint Grass Brook, and an unnamed tributary to Unkety Brook would be destroyed by plant and spray pond construction at Site 1 and a portion of Black Brook would be similarly removed at Site 2A. Less severe stream diversions and alteration of drainage patterns caused by plant construction would likely affect Massapoag Pond and Bridge Meadow Brook (to only a small degree for both water bodies) at Site 2A. Site 1 contains a stretch of Unkety Brook (approximately 2.4-3.2 km in length), which is regularly stocked with trout by the Commonwealth of Massachusetts (Ref. 33). Construction and operation of a power station at Site 1 would remove this portion of the Brook from public access.

Impacts of site development due to increased erosion or suspended solids in runoff from the site or in routine discharges during construction are controllable to a large degree and these impacts can reasonably be expected to be temporary and reversible. Impacts can reasonably be expected to be more widespread and more difficult to control for those sites proposing to use spray ponds than for once-through cooling systems such as the Rocky Point site. This could result in the site construction impacts lasting somewhat longer for the spray pond sites. Stringent runoff and waste control and treatment measures would likely be required at these sites due to the anti-degradation provision applicable to the streams on and adjacent to the sites by the state.

Sites 1 and 2A will require construction of intake and discharge pipelines to the cooling water source that will not be required at the proposed Rocky Point site. This construction will likely involve crossings of streams protected by an anti-degradation provision of the State (Ref. 27). Mitigative measures to control impacts, such as stream bank erosion, siltation and sedimentation in the stream, interruption of flow, and temporary removal of benthic and water column habitat, to acceptable levels at these stream crossings would be required for development of these sites. These potential sources of impact at Sites 1 and 2A do not exist at the Rocky Point site due to the lack of a requirement for such pipelines.

In-river construction activities for placement of intake and discharge structures would likely be the same for any of these sites. They would be of limited duration and can reasonably be expected to produce only localized increases in turbidity. In-water construction activities at the Rocky Point site for structure placement for Unit 2 are limited to intake structure placement and modifications of the existing discharge canal and construction of the barge facility. Effects of these activities with regard to turbidity and siltation have also been previously assessed and determined to be localized and temporary (Ref. 18).

Dredging activities associated with the creation and maintenance of a channel to provide sufficient pump head at the intake during low river

flows may cause violations of the water quality standard for turbidity in the vicinity of the site. The violations may recur due to a need for periodic maintenance dredging of the intake channel. The temporal and areal extent of the Merrimack River waters near the site that would be adversely affected will be limited.

The potential for impact to onsite water bodies during construction and the need to place cooling water pipelines likely involving stream crossings are disadvantages for Sites 1 and 2A as compared to the Rocky Point site. Dredging in the river channel for structure placement, an activity associated with all of these sites, is also a disadvantage as compared to the Rocky Point site. Construction of a closed-cycle plant at Sites 1, 2, or 2A is judged to have a greater potential for adversely affecting aquatic resources than construction at the Rocky Point site.

Intake Effects: Intake effects to aquatic biota are primarily those impacts associated with impingement or entrainment. A closed-cycle cooling station design is proposed for Sites 1, 2, and 2A. All sites would withdraw water from the Merrimack River in the vicinity of Site 2 near the present BECo transmission line crossing. The proposed intake structure and any wier or low water dam required to maintain cooling water flow during periods of low water would be located in a stretch of the Merrimack River that possesses a gravel bar (Ref. 34). Withdrawal of water and any river diversions or obstructions would impact those

species of fish which use the gravel bar for spawning. No other gravel bar exists upstream or downstream for some distance. At present, the fishery resources of the Merrimack River are considered to be of low quality and offer little to the Massachusetts angler (Ref. 34).

Plans to reestablish an anadromous fishery may result in an increased importance of the gravel bed. The anticipated impact to the fish population presently inhabiting the Merrimack River due to impingement and entrainment is judged to be insignificant, primarily because of the present poor quality of the fishery.

The decision to choose Sites 1, 2, and 2A (with a single-unit plant using, closed-cycle cooling), or the Rocky Point site (with a once-through system) depends on the anticipated impingement and entrainment impacts to the fishery at the Rocky Point site. Since the anticipated impact to the fishery due to impingement and entrainment at the Rocky Point site is negligible, and because the fishery resources of the Merrimack River are considered poor, no significant environmental impacts due to the intake are anticipated, neither the Rocky Point site nor Sites 1, 2, and 2A can be judged to be superior.

Depending upon the success of the efforts to improve the Merrimack River fishery and the extent of in-river structures required to maintain an adequate supply of intake water, this conclusion may change such that if

water quality is significantly improved, the presence of the shortnose sturgeon is established, and the reestablishment of anadromous species is accomplished, the Rocky Point site may be considered environmentally preferable.

Discharge Effects: Operational phase discharge-related impacts to aquatic biota in receiving waters are primarily those impacts associated with thermal loading, cold shock, physical effects (including scouring of the bottom and shoreline) discharge of biocides and other compounds, discharge of waters differing in quality from the receiving waters, and gas bubble disease (GBD) induced mortality.

Scour at Sites 1, 2 and 2A could be minimized by proper design of the discharge structure. Mortality to aquatic biota due to GBD would probably not occur because of the reduced discharge flow and the long retention time in the spray ponds associated with closed-cycle cooling.

Interaction of the discharge plume and the biota either presently or potentially associated with the gravel bed in the Merrimack River would have to be examined. The discharge structure could also be moved to the southernmost portion of Site 2, thereby avoiding the potential gravel bed issue entirely.

As indicated in the description of the various sites, the Merrimack River in the vicinity of the sites is not expected to meet its assigned water quality classification by 1983 (Ref. 25). Examination of available data on existing conditions, as well as consideration of the anticipated effects of upstream waste treatment reveals that a concentration factor of five for dissolved solids in the plant discharge would not likely create receiving water quality criteria violations beyond the immediate vicinity of the discharge. Under the requirements of the EPA Effluent Guidelines for Steam Electric Power Plants, cold side blowdown would be employed for such a plant, thereby minimizing the temperature differential between the blowdown and receiving waters. The dissolved oxygen concentration in the cooling tower blowdown would be at or slightly above the saturation point for the temperature of the discharge. Dissolved oxygen stress in the river resulting from plant operation is not expected since current data show dissolved oxygen levels consistently above the 5 mg/l minimim of the standards.

High water temperatures, high available nutrient levels, and low turbidity could combine to make chlorination of the cooling tower and service water portions of the cooling system necessary even if mechanical means were used to clean the plant main condensers. Chlorine has been demonstrated (Refs. 35, 36) to be toxic to a wide range of both warm water and cold water aquatic organisms, and recommended exposure limits have been set at very low concentrations (e.g., less than 0.1 mg/l). Adverse

effects on water quality due to toxic chlorine concentrations are a possibility in the discharge vicinity if conventional chlorination practices are employed at the site. This could adversely affect the anadromous fishery restoration program planned by Massachusetts for the Merrimack River. Mitigative measures, such as modifications to plant operations (blowdown holdup allowing for residual chlorine degradation) or dechlorination, are available and may be necessary for protection of river water uses at this site.

Periodic maintenance dredging of the intake channel in the river during the life of the plant could temporarily adversely affect water quality near the site. The combination of the existing stressed water quality and the potential for high thermal loading during low river flows is a disadvantage for the Merrimack River sites as compared to the Rocky Point site. Therefore, siting a closed-cycle plant at Sites 1, 2, or 2A is judged to have greater potential for adversely affecting aquatic resources than siting at Rocky Point.

Cold shock induced mortality to fishes would probably not be a problem at present due to the low quality of the Merrimack River fishery. Should the fishery improve, cold shock may become a potential problem. If two units are constructed on a site, the potential for cold shock is decreased since simultaneous outages would occur less frequently than single unit outages.

Whether or not Sites 1, 2, or 2A utilizing closed-cycle cooling are judged to be superior to the Rocky Point once-through site is dependent on the anticipated impact of the discharge to the fishery in the vicinity of the Rocky Point site. Because the anticipated impact due to the discharge to the fishery at the Rocky Point site is negligible, and the fishery resources of the Merrimack River are considered poor, neither site can be judged superior. Depending upon the success of the efforts to improve the Merrimack River fishery, this conclusion may change such that, if water quality is significantly improved, the presence of the shortnose sturgeon is established, and the reestablishment of anadromous species is accomplished, the Rocky Point site may be considered environmentally preferable and possibly superior.

4.4.2 Terrestrial Ecology and Land Use

The staff has reviewed a variety of factors (dedicated areas, forests, wildlife habitat, farmlands, coastal zone, wetlands and flood plains) relating to the analysis of the site's terrestrial resources. With regard to Sites 1, 2, and 2A there are no Federal lands, natural landmarks, State and local forests, or critical habitats located on these sites.

4.4.2.1 Site 1

Siting a nuclear power plant anywhere on Site 1 would preempt considerably more forest than the 11 ha proposed to be removed on the Rocky Point site. Removing this large area of forest would also mean preempting this area as wildlife habitat. Therefore, from the point of view of forest and wildlife habitat, Site 1 is deemed less desirable than the Rocky Point site.

It would be difficult to avoid preempting all of the wetlands on the site (Ref. 11). The wetlands on the Rocky Point site will be preserved. Therefore, Site 1 is considered less desirable than the Rocky Point site for this factor.

The areas's soils have not been surveyed since 1924, this precludes using this factor in the site comparison. Nevertheless Site 1 has 81 ha in active farmland, whereas no farmland occurs on the Rocky Point site. This renders Site 1 less desirable than the Pilgrim site.

The two sites are considered equivalent for all other factors.

4.4.2.2 Site 2

Some forest would undoubtedly have to be cut (Ref. 3), therefore, some of this cover type and its associated wildlife habitat would be preempted.

However, because of the uncertainty in the extent of the area potentially affected, no conclusion can be reached in comparison to the Rocky Point site for these two factors.

Because Site 2 has large areas of prime and statewide or local importance farmland, (Ref. 11) it is considered less desirable than the Rocky Point site by this factor.

Although there are two small streams onsite there are no appreciable wetlands to be preempted. Therefore, this site is neither better nor worse than the Rocky Point site for this factor. A portion of the site is in the 100-year flood plain of the Merrimack River and a railroad goes through the long axis of the site which would require moving according to preliminary siting plans. These constraints render Site 2 less desirable than the Rocky Point site.

The two sites are considered equivalent for all other factors.

4.4.2.3 Site 2A

Siting a nuclear power plant anywhere on Site 2A would preempt considerably more forest than the 11 ha proposed to be removed Pilgrim 2 at the Rocky Point site. Also, it would be impossible to avoid all wetlands on the site. Removing this area of forest and wetlands would also mean

4.4.4 Nearby Industrial, Transportation, and Military Facilities

The potential impact on the safe operation of a nuclear plant of the industrial, transportation, and military facilities in the vicinity of Sites 1, 2, and 2A have been evaluated and compared to the Rocky Point site. Of the facilities described in this section, the railroad line through Site 2 is considered to be the most significant. Development of Site 2 would necessitate the relocation of the railroad line. This would be an additional cost factor for Site 2, but then the railroad should not be a safety hazard assuming the railroad is moved far enough from the site so that the effects of postulated accidents on the railroad upon the plant would be acceptable. We conclude that Sites 1 and 2A are equivalent to the Rocky Point site in that no significant external hazards have been identified either at the candidate sites or at the Rocky Point site which would require additional plant design considerations to withstand the effects of postulated accidents. Site 2 is considered to be less preferable than the Rocky Point site in that a railroad at Site 2 would need to be relocated. However, once the railroad is relocated, Site 2 and the Rocky Point site would be equivalent with regard to the risk from external hazards.

4.4.5 Hydrology

Sites 1, 2, and 2A would draw makeup water from the Merrimack River. Based on our analysis we do not consider the Merrimack River to be a

dependable year-round water supply. We conclude that competing water use in the Merrimack River Basin does not justify withdrawal of cooling water without providing for replacement of water used (Refs. 37, 38, 39, 40, 41, 42, 43). A serious problem for the Merrimack River is the demand being placed on it to provide the urban areas of both eastern Massachusetts and southeastern New Hampshire with municipal water supplies. Potential competition for water supplies could occur among users, especially if plans are implemented to direct water to the Boston Metropolitan District Commission (MDC) and/or coastal areas in New Hampshire. The river is also being considered as a potential water supply source for many cities located upstream. The overall situation is further aggravated by poor water quality, by increasing industrial demands, and by potential refinery development. The Merrimack River is being polluted by raw municipal sewage, combined sewer overflows, and from industrial discharges. Use of river for drinking requires expensive treatment. Recreational uses are limited by high BOD and low oxygen levels. There are many uncertainties involved with predicting the impact of water use in Merrimack River Basin. The staff has reviewed studies (Refs. 37, 38, 41, 42, 43) conducted by State and Federal agencies; however, it is still not clear how much water is needed to satisfy the water supply, recreational, and pollution abatement needs of the Merrimack Basin.

Although the Merrimack River has an adequate average annual flow of water for closed-cycle cooling, this water is not always available when

and where it is needed. Flow data for the Merrimack River at a nearby gauging station at Lowell, Massachusetts, which is indicative for a site on the lower Merrimack, indicates the following flows over the period extending from 1923 to 1971 (Refs. 42, 44, 45):

7-day 10-year low flow	27.8 cms
Minimum daily flow	5.6 cms
Average flow	200 cms

The above data indicate that, with an average flow of 200 cms at Lowell, the Merrimack River is more than capable of supplying a makeup water flow to cooling towers at a rate of about 1 cms. However, the river flow has dropped to very low levels - as little as 5.6 cms averaged over a day.

Because the river flow drops to low levels, an augmentation reservoir (or some other means of water supply) would likely be required to replace consumptive water loss during periods of low flow. It cannot now be determined what flow augmentation would be required, since it is unclear what flow is acceptable to maintain the various water needs in the basin. A detailed cost-benefit analysis is usually required for a utility to determine the design basis for an augmentation reservoir. While we conclude that a detailed analysis was not necessary for this alternate site analysis, a study would have to be performed to determine

the frequency of low flows, the drought to be designed for (a 50-year drought, for example) and the actual quantity of water to be stored to replace consumptive losses.

Also, care will have to be taken to select a discharge location and type of discharge where thermal inputs are minimized during periods of low river flow. During low flow periods, the river may be somewhat shallow, thereby increasing the potential for thermal plumes covering a significant portion of the river width. In addition, construction of an intake structure may require dredging (both initial and periodic maintenance) and/or construction of a small low-head dam to secure adequate head on the pumps.

On the basis of the potential difficulties of an adequate water supply we conclude that Sites 1, 2, and 2A are inferior to Rocky Point from a hydrologic engineering point of view.

4.4.6 Socioeconomics

4.4.6.1 Site 1

Depending on the exact boundary lines, the displacement that is expected to occur at this site includes 20 to 30 residences, a town dump, one industrial establishment and four commercial establishments (Ref. 46).

There are no onsite historic or natural features listed in the national or state registers (Refs. 47, 48, 49). Onsite items of local historic interest include two homesteads, one house and the Stage Tavern. There are no onsite recreation or scenic areas listed in the state outdoor recreation plan, and no archaeological sites are reported (Ref. 49).

The construction work force is expected to originate primarily from the local hiring halls in Lowell, Lawrence, and to a lesser extent, from Boston (Ref. 50). The commuting workers would use U.S. Route 3 and exit at Exit 35 and/or Exit 34. The drivers using Exit 35 would contribute to congestion at this point and west along Main Street for over 5-6 km leading to the site. In this situation, the applicant would anticipate the traffic to impact Union School and some plan requiring detouring would have to be considered. The drivers using Exit 34 would contribute to congestion at this point, west along Dunstable Road and Lowell Street for 4 km, and west on Main Street for 2-7 km. Some planning with regard to detouring in the Union School vicinity would be needed.

A plant with a natural draft cooling tower and associated plume would be partially visible from surrounding points such as Blanchard Hill, Hollis Depot, and along Route 113 between East Pepperell and Dunstable, and would be a visual intrusion to the area.

With respect to the socioeconomic factors considered, Site 1 is less preferable to the Rocky Point site in terms of onsite displacement, traffic impacts, and visual intrusions.

4.4.6.2 Site 2

Depending on the exact boundary lines, the displacement expected to occur at this site includes 50 to 60 residences and 10 commercial establishments (Ref. 46).

There are no onsite historic or natural features listed in the national or state registers, and no archaeological sites are reported (Refs. 47, 48, 49). Onsite items of local historic inclued three houses, a homestead, and a cemetery. There are two onsite areas (Wanalanset and Black Brook) listed in the state outdoor recreation plan. Wanalanset is a 12-ha acre area located on Pond Street with campground and picnic areas. Black Brook is a 5-ha area of conservation land.

The construction work force is expected to originate primarily from the local hiring halls in Lowell, Lawrence, and to a lesser extent, from Boston (Ref. 50). The workers would use U.S. Route 3 and exit at Exit 36. Traffic congestion could be expected at this point and leading to Middlesex Road which borders the site.

A plant with a natural draft cooling tower and associated plume would be partially visible from surrounding points such as the village of Tyngsborough and along Route 3 and Route 3A as well as Frost Road across the Merrimack River and would be a visual intrusion to the area.

With respect to the socioeconomic factors considered, Site 2 is less preferable to the Rocky Point site in terms of onsite residential and economic displacement and visual intrusions.

4.4.6.3 Site 2A

The displacement expected to occur at this site includes 30 to 40 residences and 5 commercial establishments. Between 90 and 120 residents could be expected to be displaced (Ref. 46).

The construction work force is expected to originate primarily from the local hiring halls in Lowell, Lawrence, and to a lesser extent, Boston (Ref. 50). The workers using Exit 35 would contribute to congestion at this point and west along Main Street for about 3 km leading to the site. Workers using Exit 34 would contribute to congestion at this point, west along Dunstable Road and Lowell Street for 4 km and south on Westford Road for 1.5 km.

A plant with a natural draft cooling tower and associated plume would be visible from Dunstable and partially visible from surrounding points such as along Forest Road, Chestnut Road, Route 113, Route 3 and would be a visual intrusion to the area.

With respect to the socioeconomic factors considered, Site 2A is less preferable to the Rocky Point site in terms of onsite displacement, visual intrusions, traffic impacts and potential impact on two onsite areas listed in the State outdoor recreation plan.

4.4.7 Geology, Seismology, and Geotechnical Engineering

Following the tectonic province approach described in Appendix A to 10 CFR Part 100, we can make a preliminary determination the safe shutdown earthquake (SSE) at each site based on a knowledge of regional geology and seismicity. Utilizing the Trifunac-Brady (1975) empirical relation between intensity and ground acceleration, we can assign an acceleration value to the expected maximum intensity. The acceleration value corresponding to intensity VII is 0.13 g, and the value for intensity VIII is 0.25 g.

We find that the alternate sites in northeastern Massachusetts (Sites 1, 2, and 2A) lie within the Boston-Cape Ann seismic zone. An intensity VIII (MM) earthquake, equivalent to the largest historical earthquake in

the Boston-Cape Ann seismic zone, could occur at these sites. We conclude that the SSE could result in intensity VIII at these sites. Soil columns may amplify the acceleration values at Sites 1, 2, and 2A.

These three sites are regarded as being somewhat less desirable than the Rocky Point site because they are located in an area of higher seismic risk and near a major zone of tectonic deformation. These sites would require a higher SSE design value than the Rocky Point site and extensive geologic investigations similar to those previously conducted for Pilgrim Nuclear Station Unit 2.

4.5 Description of Site 18 Complex

The four sites that make up the Site 18 complex total approximately 1400 ha and are located in the town of Plymouth, Massachusetts (see Figure 4). The approximate site boundaries are 18A, Route 3A and Center Hill Road; 18B, in Bay Shallows between Center Point and Harlows Landing; 18C, Ship Pond Road, Center Hill Road and Sandwich Road; and 18E, Sandwich Road, Route 3 and 3A. Sites 18A and 18B are located entirely within the coastal zone.

Slightly over one half of Site 18A is covered by a mixed forest of pine and hardwoods with most trees in the small-sized class (Ref. 3). There are approximately 4 ha of prime, 12.8 ha of unique (cranberry bogs), and

nonaquatic portion of Site 18B is covered by a mixed forest of pine and hardwoods with most trees in the small- or medium-sized class (Ref. 3). There is about 1.5 ha of statewide or local importance farmland onsite (Ref. 11). There are three ponds and a connecting brook onsite. Most of Site 18C is covered by a mixed forest of pine and hardwood, with most of the trees in the small-sized class (Ref. 3). There are about 3 ha of unique farmland onsite, most of which are active commercial cranberry bogs. A portion of the site is considered best upland habitat. There is one small wetland area other than cranberry bogs. Most of Site 18E is covered by a mixed forest of pine and hardwoods with most trees classified in the small- or medium-sized class (Ref. 3). A portion of the site is considered best upland wildlife habitat (Ref. 59). There are about 24 ha of unique (cranberry bogs) and 1.5 ha of statewide or local importance farmland onsite (Ref. 11). There are five ponds and three wetlands areas other than cranberry bogs (Ref. 11).

State Route 3, a divided highway and the main access road to Cape Cod from the Boston area, runs along the western border of Site 18E. The Cape Cod Canal is located about 10 km south of the site. Ship traffic between the Canal and Boston Harbor may approach as close as about 2.5 km from Sites 18A and 18B, based on information obtained from the U.S. Coast Guard (Ref. 51) and inspection of the nautical charts for the area. However, it is likely that most of the ship traffic stays further offshore to provide a margin of safety. The nearest boundary of the

Otis Air Force Base/Camp Edwards military reservation is located about 10 km south of the site. The runways and support facilities, which are now operated by the Massachusetts Air National Guard, are located about 20 km south of the site. The Camp Edwards artillery ranges are located in the area between the reservation boundary and the air base facilities, a distance of at least 10 km from the site.

The four sites would use Cape Cod Bay water for their cooling systems, once through at all four sites or spray pond on Sites 18C and 18E. Based on available reconnaissance-level information, a nursery area for aquatic organisms may exist near where the Site 18 complex would withdraw water for cooling. There are tidal flats, a salt pond and associated salt marsh located near the proposed boundaries of Sites 18A through 18E. These features might be important for the development of eggs and larvae of some recreationally and commercially important species inhabiting Cape Cod Bay. The role that the above-identified features in the vicinity of the Site 18 complex plays in the spawning and rearing of important species in Cape Cod Bay cannot be precisely determined from reconnaissance-level data; however, its value to the fishing in Cape Cod Bay is probably at least equal to if not greater than the Rocky Point site.

One onsite body of water, Savery Pond on Site 18E, could be affected by development on Sites 18C and 18E. This pond drains to Salt Pond in

Ellisville Harbor. Development of Site 18B would result in the destruction of the habitat afforded by Center Hill Pond and Black Pond.

Based on assigned water uses, the surface waters associated with these sites that are subject to the rise and fall of the tide are designated Class "SA" by the State of Massachusetts. Similarly, those surface waters associated with these sites that are not subject to the rise and fall of the tide are designated Class "B". The prescribed uses and quality criteria of these waters are described in the Massachusetts Water Quality Standards.

Problems in Cape Cod Bay continue in general and exist in the form of inadequately treated wastes from nearby development and urban centers, wastes from vessels, and industrial wastes that threaten existing aquatic biological resources and aquatic habitat (Ref. 52). However, the existing water quality at these sites is generally good. The waters of Cape Cod Bay meet the requirements of their designated classification, Class "SA" (Refs. 27, 52). Examination of water quality and sediment quality analyses data collected at and around the nearby Rocky Point site (Refs. 53, 54) indicates that the waters meet the "SA" criteria for all parameters for which numerical limits have been set.

4.6 Staff Analysis of Site 18 Complex

4.6.1 Aquatic Ecology and Water Quality

Construction Impacts: Each site was compared to the preferred site with particular attention directed to the following specific potential construction impacts: (1) onsite stream diversions or alterations; (2) changes in site runoff during site development; (3) right-of-way (ROW) or water pipeline development; and (4) siltation due to dredging for barge facilities, intake/discharge structures, and pipelines.

Construction activities at Sites 18A, 18C, and 18E would not result in the loss of any significant onsite bodies of water. Onsite ponds at Site 18E could potentially be affected by site clearing and grading activities, construction of access to the site, or creation of material storage areas during plant construction. Pond bank erosion, pond sedimentation, increased turbidity, and habitat alteration or loss are potential adverse effects during construction that could require mitigation. Construction at Site 18B would result in the destruction of three small ponds along the shoreline (Ref. 55).

Makeup and discharge pipelines for Sites 18C and 18E would not be expected to impact surface water bodies prior to the point where they enter Cape Cod Bay. The construction of intake and discharge structures and the

associated piping and the barge unloading facility is judged to require approximately the same activities with respect to extent and location for all of the Site 18 complex. These activities are judged to be about equal in terms of potential aquatic impacts and need for mitigation as those associated with the construction of the additional intake structure for Pilgrim Nuclear Station Unit 2 and the modification required to the discharge structure at the Rocky Point site. The staff, in FES Sections 4.2 and 4.5.2 for the proposed Pilgrim Unit 2 at Rocky Point (Ref. 18), found the predicted construction impacts at the proposed site to be acceptable with respect to water quality and aquatic ecological impacts in Cape Cod Bay. In the southern coastal region areas of the Cape Cod Bay shoreline have been characterized as "critical erosion rates" areas (Ref. 52). Erosion is presently being controlled at the Rocky Point site by the use of riprap shoreline stabilization as a result of construction of Pilgrim Unit 1. In the FES for Pilgrim Unit 2 (Ref. 18), impacts on Cape Cod Bay waters due to erosion of the shoreline or runoff from the site during construction were not found to require additional mitigative action. The staff estimates that the impacts in Cape Cod Bay due to construction at Sites 18C and 18E could be similarly controlled. Sites 18A and 18B are considered likely to have somewhat potentially greater construction impacts due to the more extensive shoreline alterations required at these sites as opposed to the Rocky Point site, where the bulk of the shoreline alteration has already occurred due to construction of Pilgrim Unit 1. In addition, extensive filling in of

the near shore area will be required for development of Site 18B. Mitigative action to control water column turbidity and siltation of the bottom, minimizing temporary loss of benthic habitat in nearby areas (e.g., Salt Pond in Ellisville Harbor) would likely be required.

The proposed Rocky Point site has an advantage over Sites 18A and 18B because of the lesser amount of shoreline modification needed to construct the plant. The Rocky Point site has an advantage over Sites 18C and 18E because of the absence of a need to place cooling water pipelines to the water source. With the exception of the potential impacts and need for mitigative actions associated with the filling in of the near-shore area at Site 18B, the in-water construction activities for placement of intake and discharge structures at the Rocky Point site and the Site 18 complex would likely result in about the same levels of potential impact, which could be controlled to acceptable levels. With respect to construction impacts, the staff believes that none of the alternate sites in the Site 18 complex are environmentally preferable to the proposed site.

Intake Effects: Intake effects to aquatic biota are primarily those impacts associated with impingement or entrainment. Sites 18A, 18B, 18C, and 18E have been proposed for once-through cooling. Based on the anticipated design of the intake, its placement, and an evaluation of the operational data from the Pilgrim Unit 1 (Ref. 19), impingement at

the Site 18 complex with once-through cooling is not considered to be a significant potential impact. Losses associated with impingement at the Site 18 complex should be comparable to those anticipated at the Rocky Point site and should have a negligible effect on the Cape Cod Bay fishery.

Sites 18C and 18E have also been proposed for closed-cycle cooling utilizing spray ponds. Impingement losses associated with the operation of either of these proposed sites, due to the much-diminished flow rates, would be substantially less than would be experienced at the proposed Rocky Point site. Whether or not Sites 18C and 18E, with closed-cycle cooling, are judged to be superior to the Rocky Point once-through site is dependent, however, on the anticipated impingement-related impacts to the fishery at the Rocky Point site. Since the anticipated impact to the fishery at the Rocky Point site is negligible, it is concluded that Sites 18C and 18E with closed-cycle cooling are environmentally preferable but not environmentally superior to the Rocky Point site with respect to the impact of plant operation on the bay fishery.

Studies (Ref. 54) conducted in Cape Cod Bay in 1974, 1975, and 1976 indicated that there was a higher density of lobster larvae (all stages) just south of the Site 18 complex than at the Rocky Point site. It can be concluded that losses of lobster larvae would likely be greater at the Site 18 complex with once-through cooling than at the Rocky Point

site because of the higher density of lobster larvae possibly moving northward from the Cape Cod Canal. The existence of the nearby Ellisville Harbor and its associated salt marsh may also act as a nursery ground for other species of aquatic organisms. Densities of eggs and larvae of recreationally or commercially important species are likely to be greater near the Site 18 complex than near the Rocky Point site.

Based on the type of intake proposed and reported higher densities of lobster larvae, and the possibility of higher densities of other important species offshore of the Site 18 complex, the staff judges the Rocky Point site with once-through cooling as environmentally comparable or possibly preferable to the Site 18 complex with respect to the operation of the station utilizing once-through cooling on the bay fishery.

Discharge Effects: Operational phase discharge-related impacts to aquatic biota in receiving waters are primarily those impacts associated with thermal loading, cold shock, discharge of biocides and other compounds, discharge of waters differing in quality from the receiving waters, physical changes in the receiving waters near the discharge, including scouring of the bottom and shoreline, and gas bubble disease (GBD) induced mortality. Once-through cooling has been proposed at Sites 18A, 18B, 18C and 18E. All four sites utilize Cape Cod Bay as receiving waters. Discharge effects would be similar at all sites since

the location of the discharge structure would be similar for all site/plant configurations.

The effects of scour would be greater at Sites 18A, 18B, 18C and 18E than at the Rocky Point site because Pilgrim Unit 2 would use the existng Unit 1 discharge structure. However, if a fully riprapped discharge apron is constructed, scour would be minimal.

The effects of GBD would be about the same for both the Site 18 complex and the Rocky Point site since they both use once-through cooling. Mitigative measures employed in the Pilgrim Unit 1 discharge could be applied to a discharge structure at the Site 18 complex and would reduce any potential for GBD induced mortality to insignificant levels.

The impact to the Cape Cod Bay fishery associated with thermal loading and chemical and biocidal discharges might be greater at the Site 18 complex than at the Rocky Point site should the nearby Ellisville Harbor marsh complex prove to be a nursery ground for various fishes species. This potential could only be determined after extensive biological sampling in the area, thermal plume predictive studies, and studies of the exact placement and design of the discharge structure.

Mitigative measures similar to those employed at Pilgrim Unit 1 could be employed at the Site 18 complex to minimize mortality to fishes due to

cold shock. A second unit at the Rocky Point site is preferable to a single unit at the Site 18 complex since simultaneous outages would be less frequent than a single unit outage.

Based on the reconnaissance level information available (Refs. 27, 52) on the existing water quality for the Site 18 complex and the Rocky Point site and on the lack of definable differences in existing water quality problems between these site areas (Refs. 27, 52), the physical and chemical impacts on the receiving waters of the two areas from chemical discharges (including biocides) during plant operation are judged to be comparable. Based primarily on the results of studies conducted at Pilgrim Unit 1 (Ref. 56), the staff's evaluation of the Pilgrim Unit 2 station (Ref. 18), and available reconnaissance level data for the once-through sites proposed for the Site 18 complex, the Rocky Point site is judged to be environmentally comparable and possibly preferable to the Site 18 complex with respect to discharge effects.

Sites 18C and 18E were also identified as possible locations for closed cycle cooling using spray ponds. Impacts to biota of Cape Cod Bay associated with the much-diminished discharges from these sites would be negligible and probably imperceptible. Whether or not Sites 18C and 18E with closed-cycle cooling are judged superior to the Rocky Point site with once-through cooling depends on whether or not a significant impact is anticipated at the Rocky Point site. Since the anticipated impacts

to the fishery from the Rocky Point site are negligible, it is concluded that a closed-cycle station located at Site 18 may be environmentally preferable but not environmentally superior to the Rocky Point site with respect to the impact of operation on the receiving waters fishery.

4.6.2 Terrestrial Ecology and Land Use

The staff has reviewed a variety of factors relating to the analysis of terrestrial resources associated with Site 18. There are no Federal lands, natural landmarks, State and local forests or critical habitats associated with the Site 18 complex.

4.6.2.1 Site 18A

Because of its small size, most, if not all, of the forest and accompanying wildlife habitat would be preempted. This represents a considerably larger area than would be required at the Rocky Point site. Therefore, the Rocky Point site is considered better by these two criteria.

Because the Rocky Point site does not contain any unique farmland, it is slightly better for this factor.

The proposed site for Pilgrim Unit 2 is adjacent to Pilgrim Unit 1 and the Massachusetts CZM program (Ref. 57) states that general development

is encouraged to locate in already developed areas or in areas contiguous to them. This indicates that the Rocky Point site is more desirable.

The two sites are equivalent for all other factors considered.

4.6.2.2 Site 18B

Because of its small size, about 30 ha, most or all of the forest and its accompanying wildlife habitat would be preempted. Or, as the applicant suggests (Ref. 11), little terrestrial habitat would be involved in plant operation then construction disturbance would have to occur on site 18A. Because the amount of land to be cleared would be much greater than at the Rocky Point site, the Rocky Point site is considered a better choice.

There is considerably less statewide or local importance farmland on this site than on the Rocky Point site. Therefore, on the basis of this factor, Site 18B is a better choice.

The wetlands would have to be filled in at Site 18B. Therefore, the Rocky Point site is a better choice by this factor.

The entire site is within the coastal zone area that is recommend for designation as an area for preservation or restoration (Ref. 57). Therefore, by this criterion the Rocky Point site is preferable.

The two sites are considered equivalent for all other factors considered.

4.6.2.3 Site 18C

Siting a nuclear power plant on this site would preempt the use of the forest and wildlife habitat of a much larger area than at the Rocky Point site. Therefore, the Rocky Point site is preferable by these two factors.

Commercial cranberry bogs could probably be avoided if a once-through cooling system is used. However, if a cooling pond is used, the preemption of the cranberry bogs would not be avoided according to preliminary siting plans provided by the applicant.

The small wetland area could probably be avoided, thereby making the two sites equivalent for this factor.

For all other factors, the two sites are considered equivalent.

4.6.2.4 Site 18E

Use of this site would preempt a larger area of forest and wildlife habitat than at the Rocky Point site. Therefore, the Rocky Point site is preferable by these two factors.

The cranberry bogs and wetlands could probably be avoided if a once-through cooling system is used. However, if a cooling pond is utilized, the cranberry bogs and wetlands would not be avoided according to the preliminary siting plans provided by the applicant (Ref. 11)

The two sites are considered equivalent for all other factors.

4.6.3 Demography

An examination of the population data in Table 5 shows that the population density of Site 18 is generally lower than the population density around the Rocky Point site. However, based on the population considerations discussed in Appendix A, we find that the population density of Site 18 is not significantly lower than the population density of the Rocky Point site and, hence, Site 18 is not preferred in comparison to the Rocky Point site.

4.6.4 Nearby Industrial, Transportation, and Military Facilities

The potential impact on the safe operation of a nuclear plant of the industrial, transportation, and military facilities in the vicinity of Site 18 have been evaluated and compared to the Rocky Plant site. The proximity of the highways to Sites 18A, 18C and 18E is such that transportation accidents involving truck-size shipments of hazardous materials

would need to be considered if a nuclear plant were to be located at these sites. However, we believe that postulated highway accidents should not adversely affect the suitability of the sites for a nuclear power plant.

Ship traffic offshore of Sites 18A and 8B may be of some concern and a detailed evaluation of the hazard posed by shipping would be required if either of these sites were to move beyond the alternative site selection phase. However, our assessment at this time, based on the separation distance of the shipping route from the sites and the general type of hazardous materials carried (Refs. 51, 58), is that the risk of shipping accidents adversely affecting the safe operation of a nuclear plant at Sites 18A and 18B is sufficiently low that such accidents would not need to be considered design basis events for the plant.

The separation distances of Otis Air Force Base and the Camp Edwards artillery ranges from the sites are adequate to provide reasonable assurance that these facilities will not adversely affect the sites.

Comparing Sites 18A, 18B, 18C, and 18E to the Rocky Point site, we conclude that these sites are equivalent to the Rocky Point site in that no significant external hazards have been identified either at the candidate sites or at the Rocky Point site that would require additional safety features or strengthening of plant structures to withstand the effects of postulated accidents.

4.6.5 Hydrology

Because cooling water will be withdrawn from the ocean, no water supply problems are expected. No unique or significant hydrologic impacts were identified. Therefore, the staff considers the Site 18 complex equivalent to the Rocky Point site.

4.6.6 Socioeconomics

4.6.6.1 Site 18A

Depending on the exact boundary lines, the staff estimates that construction of an electric generating facility at this site could cause 30 to 35 residences to be displaced (Ref. 11).

There are no onsite historic or natural features listed on the national or state registers (Refs. 47, 48, 49). There are no onsite recreation or scenic areas listed in the state outdoor recreation plan, and no archaeological sites are reported (Ref. 49).

The construction work force is expected to originate primarily from the local hiring halls of Brockton, and to a lesser extent, Boston (Ref. 50). The commuting workers would use State Route 3 and exit at Exit 42. Traffic congestion could be expected at this point and north of the site on State Route 3A.

An electric generating station would be visible from points offshore and along the coast such as Bayside Beach (0.8 km to the north), Surfside Beach (1.6 km to the north), Harlows Landing (1.2 km to the south), and Ellisville Harbor (2.5 km to the south) as well as points along State Route 3A. A plant with a once-through cooling mode would be a visual intrusion to the area. This would constitute a new industrial complex as opposed to locating next to Pilgrim Unit 1, which is an already existing industrial complex.

With respect to the socioeconomic factors considered, Site 18A is less preferable to the Pilgrim site in terms of onsite displacement and visual impacts.

4.6.6.2 Site 18B

Depending on the exact boundary lines, the staff estimates that 10 to 15 residences could be expected to be displaced (Ref. 46).

There are no onsite historic or natural features listed on the national or state registers (Refs. 47, 48, 49). There are no onsite recreation or scenic areas listed in the state outdoor recreation plan, and no archaeological sites are reported (Ref. 49).

The construction work force is expected to originate primarily from the local hiring halls of Brockton, and to a lesser extent, Boston (Ref. 50). The workers would use State Route 3 and exit at Exit 42. Traffic congestion could be expected at this point and north of the site on State Route 3A to the site.

An electric generating station would be visible from points off the coast and points along the coast such as Surfside Beach (1.6 km distant), Bayside Beach (less than 1.6 km distant to the north), and Ellisville Harbor (1.6 km to the south). A plant with a once-through cooling mode would be a visual intrusion to the area. This would constitute a new industrial complex as opposed to locating next to Pilgrim Unit 1, which is an existing industrial complex.

With respect to the socioeconomic factors considered, Site 18B is less preferable to the Rocky Point site in terms of onsite displacement and visual impacts.

4.6.6.3 Site 18C

Depending on the exact boundary lines, the displacement that is expected to occur at this site includes 35 to 40 residences and a scout camp several hundred hectares in size (Ref. 46).

There are no onsite historic or natural features listed on the national or state registers, and no archaeological sites are reported (Refs. 47, 48, 49). There is one onsite area (Camp Child) listed in the state outdoor recreation plan.

The construction work force is expected to originate primarily from the local hiring halls of Brockton, and to a lesser extent, Boston (Ref. 50). The commuting workers would use State Route 3 and exit on Exit 42 Traffic congestion could be expected at this point and north of to the site on State Route 3A.

An electric generating station would be visible from points along State Route 3A, from points off the coast, and from points along the coast such as Bayside Beach (less than 1.6 km away), Surfside Beach (about 2.5 km distant), and Ellisville Harbor (about 2 km distant). The station would be partially visible from points in the Savery Pond area. A plant with a once-through cooling mode would be a visual intrusion to the area. This would constitute a new industrial complex as opposed to locating next to Pilgrim Unit 1, which is an existing industrial complex.

With respect to the socioeconomic factors considered, site 18C is less preferable to the Pilgrim site in terms of onsite displacement, visual impacts and potential impact on the onsite Camp Child scout camp listed in the state outdoor recreation plan.

4.6.6.4 Site 18E

Depending on the exact boundary lines, the displacement expected to occur at this site includes 5 to 10 residences, one landfill, and 3 commercial establishments (Ref. 46).

There are no onsite historic or natural features listed on the national or state registers (Refs. 47, 48, 49). There is one onsite archaeological site reported that is adjacent to Svery Pond. There are no onsite recreation or scenic areas listed in the state outdoor recreation plan (Ref. 49).

The construction work force is expected to originate primarily from the local hiring halls of Brockton, and to a lesser extent, Boston (Ref. 50). The commuting workers would use State Route 3 and exit at Exit 42. Traffic congestion could be expected at this point and north of the site on State Route 3A.

The station would be partially visible along State Route 3, which is less than 1.6 km away, and from some vistas around the Savery Pond area (1.6 km distant) and points along the coast (3.2 km distant). A plant with a once-through cooling mode would be a visual intrusion to the area. This would constitute a new industrial complex as opposed to locating next to Pilgrim Unit 1, which is an existing industrial complex.

With respect to the socioeconomic factors considered, Site 18E is less preferable to the Rocky Point site in terms of onsite displacement, visual impacts, and potential impact on one reported onsite archeological site.

4.6.7 Geology, Seismology, and Geotechnical Engineering

The sites in southeastern Massachusetts (Sites 18A, 18B, 18C, 18E), and Rocky Point all lie within the Piedmont-New England tectonic province. The safe shutdown earthquake (SSE) could result in at least an intensity VII at these sites, depending on the distance from each site to the Boston-Cape Ann seismic zone. Soil columns at the sites may also amplify the acceleration values.

From seismic, geologic, and geotechnical engineering points of view, Sites 18A, 18C, and 18E are considered to be equivalent to the Rocky Point site. Site 18B is less desirable because considerable earthwork will be required during site preparation, and dewatering is likely to present problems.

4.7 Description of Sites 19 and 20

Sites 19 and 20 are located on Buzzards Bay and would use the Bay for makeup water to the respective cooling systems. Site 19 is proposed for

either a spray pond or a NDCT and Site 20 is proposed only for a NDCT. Both sites would withdraw water from and discharge to the bay area near the western terminus of Cape Cod Canal.

Based on assigned water uses, the surface waters associated with these sites are designated Class "SA" by the State of Massachusetts. The prescribed uses and quality criteria of these waters are described in the Massachusetts Water Quality Standards.

The water of Buzzards Bay in the vicinity of these sites is considered good. Water quality surveys conducted by the State (Ref. 27) in the near shore areas show that the waters are meeting the requirements of the assigned classification. Localized problems have been noted in the form of high biochemical oxygen demand, high coliform bacteria counts, and low dissolved oxygen concentration for areas such as Sippican Harbor, the mouths of the Weweantic and Wareham Rivers, and Onset Bay (progressing from just south of Site 20 to just north of Site 19, respectively). These problems are associated with recreational boating activities and suspected failing or leaching septic systems from the heavy residential development along the shoreline. Stressed parameters have not been noted for Buzzards Bay proper, however, infrequent occurrences of oil pollution in the bay from ships using the Cape Cod Canal waterway through the bay have been experienced.

Studies conducted in northern Buzzards Bay (Ref. 60) yielded the largest concentrations of lobster larvae reported on the east coast of the United States. The seasonal mean larval densities in both southwestern Cape Cod Bay and northern Buzzards Bay were greater than those obtained in the vicinity of the Rocky Point site. The possibility exists that a significant number of larvae move from Buzzards Bay through the Cape Cod Canal to populate the Cape Cod Bay.

Studies conducted from 1976 to 1978 (Ref. 60) have reported 46 species of icthyoplankton from Buzzards Bay, Cape Cod Canal, and the mouth of the Cape Cod Canal in Cape Cod Bay. One station was located near Stony Point dike adjacent to Site 19. Cunner, tautog, and yellowtail comprised 79.0% of all eggs collected; cunner and tautog comprised 28.5% and 14.2% of all larvae collected.

There are no significant onsite aquatic water bodies at either S te 19 or 20.

4.7.1 Site 19

Site 19 is located in the Town of Wareham, Massachusetts, in the southeast corner of Ascot Neck (see Figure 5). The approximate site boundaries are Widows Cove to the north, a residential area to the west, Stony Point to the east, and Buzzards Bay to the south. The site is approximately 182 ha and is covered mostly by a mixed pine and hardwood forest

with about two-thirds of the trees falling in the small-sized class and the remainder in the medium-sized range (Ref. 3). About 65 ha of the site contains soils of statewide or local importance farmland. The Stony Point dike is Federal property and the Massachusetts Audubon Society own 14.4 ha on the site's northern boundary (Ref. 11). About 25% of the site is occupied by coastal flood plains, i.e., salt marshes, plus several small freshwater ponds and a red maple swamp. The entire site is located in the coastal zone (Ref. 57).

The site is immediately adjacent to the Cape Cod Canal on the east. The Canal has a controlling depth of 9.75 m and in 1974 approximately 7,870 commercial vessels carried a total of about 12,000,000 tonnes of cargo through the Canal (Ref. 58). Included among the cargo were petroleum products, liquified gases, and various chemicals.

Otis Air Force Base is located about 11 km southeast of the site. An extension of a routine departure path passes over the site area. Low-altitude Federal airway V167 is about 11 km to the south. The artillery ranges at Camp Edwards are located between 6 and 13 km east of the site.

4.7.2 Site 20

Site 20 is located in the town of Marion with the approximate site boundaries being Cross Neck Road, Point Road, Wings Cove and Buzzards Bay (see Figure 6).

Of the 304 ha associated with Site 20, about half is covered by forest of pine or hardwood or a combination of the two with most trees in the small-sized class (Ref. 3). About 174 ha of the site are judged to contain soil of statewide importance for farming (Ref. 11). The site contains two large swamps north of Delano Road, and the entire coastal portion of the site has been designated a wetlands protective district by the Marion Conservation Commission.

U.S. Route 6, the closest highway to the site, is about 3 km to the northwest. The nearest railroad is about 5.5 km to the northeast. The Cape Cod Canal shipping channel is about 4 km to the southeast of the site. There are no civilian airfields within 16 km of the site. Otis Air Force Base is about 16 km east-southeast and low-altitude Federal airway V167 is about 8 km south of the site. The Camp Edwards artillery ranges are over 13 km east of the site.

4.8 Staff Analysis of Sites 19 and 20

4.8.1 Aquatic Ecology and Water Quality

Construction Impacts: Each site was compared to the preferred site with particular attention directed to the following specific potential construction impacts: (1) onsite stream diversions or alterations; (2) changes in site runoff during site development; (3) right-of-way (ROW) or water pipeline

development; and (4) siltation due to dredging for barge facilities, intake/discharge structures, and pipelines.

Based on examination of the applicant's preliminary site development layout diagrams, construction of the plant at Sites 19 and 20 would not result in the loss of onsite water bodies. Impacts on aquatic resources to Widows Cove, Buzzards Bay, and Wings Cove from site clearing and construction activities can reasonably be expected to be controlled to acceptable levels through normal construction practices.

In-water construction activities for placement of the intake and discharge structures and their associated piping, the construction of the cooling pond breakwater (for Site 19), dredging of the cooling pond area to a uniform depth (for Site 19), and the construction of a barge-unloading facility and dredged channel to the Cape Cod Canal waterway are likely to be greater in magnitude (i.e., material to be disturbed), areal extent, and duration than at the Rocky Point site. The greater potential for necessary mitigative actions to protect the aesthetic recreational and productive (i.e., for shellfish) aspects of the surrounding shallow waters exists at Sites 19 and 20 than at the Rocky Point site.

The deeper water immediately adjacent to the site, the lack of intensely utilized aquatic resources whose value is dependent upon water quality parameters likely to be affected by the proposed construction activities,

and the lesser amount of in-water construction activities associated with the Rocky Point site are judged to reduce the potential for impacts as compared to Sites 19 and 20. The staff believes that neither of these sites is environmentally preferable to the proposed site with respect to construction impacts.

Intake Effects: Intake effects to aquatic biota are primarily those impacts associated with impingement and entrainment. Sites 19 and 20 have been proposed for closed-cycle cooling and would withdraw and discharge water into the northern region of Buzzards Bay.

Buzzards Bay is considered to be biologically highly productive and may contribute substantially to the Cape Cod Bay fishery. Nearby Weweantic and Wareham Rivers, although heavily urbanized, may also be important. Movement of eggs, larvae, juveniles and adults of lobster and recreationally and commercially important fish species from Buzzards Bay through the Cape Cod Canal would move past the intake structures for both Sites 19 and 20.

Although the proposed use of closed-cycle cooling at both Sites 19 and 20 would substantially reduce mortality related to the entrainment and impingement that would be associated with once-through cooling, the high apparent by high biological importance of the northern portion of Buzzards Bay may result in the determination that even closed-cycle cooling in

this region would still result in significant adverse impacts to the fishery.

Based on the potential for adverse impacts to the fishery and the negligible impacts anticipated at the Rocky Point site, it is concluded that an electric generating unit station at either Site 19 or 20 would not be environmentally preferable to the Rocky Point site with respect to adverse impacts to the fishery due to impingement and entrainment.

Discharge Effects: Operational phase discharge impacts related to aquatic biota in receiving waters are primarily those impacts associated with thermal loading, cold shock, discharge of biocides and other compounds, discharge of waters differing in quality from the receiving waters, physical changes in the receiving waters near the discharge, including scouring of the bottom and shoreline, and gas bubble disease (GBD) induced mortality.

The effects of scour at these two sites can be mitigated through proper design of the discharge structure. Scour would probably be less at these two sites than at the Rocky Point site since the use of closed-cycle cooling would result in a significant decrease in the discharge flow.

Mortality to aquatic biota due to GBD probably would not occur because of the reduced discharge flow and the long retention time in the spray pond/cooling tower basin associated with closed-cycle cooling.

Cold shock is not anticipated to be a problem should Sites 19 or 20 be developed because of small volume of water discharged.

Based on the applicant's preliminary plant layouts for these sites, the discharge locations would be in areas of Buzzards Bay where water quality standards are being met. Adverse interactions between plant chemical discharges (e.g., biocides, demineralizer wastes, and concentrated naturally occurring chemical species from the effects of the closed-cycle cooling system) and the localized low dissolved oxygen stress in the near shore and river mouth areas are not expected.

The low volume of the discharge and the use of a submerged diffuser would act to reduce adverse effects of biocide discharges from a closed-cycle cooling system at these sites. However, the shallow water, poor circulation and the high density of aquatic organisms in northern Buzzards Bay indicate that a potential does exist for adverse effects to occur during plant operation.

Although no significant impacts are anticipated to the aquatic biota of Buzzards Bay due to the blowdown from either proposed site, the facts that (1) Buzzards Bay is biologically highly productive and contributes to the maintenance of surrounding fisheries, (2) poorer mixing of the discharge is anticipated at these sites when compared to all other sites, and (3) no significant impacts are anticipated at the Rocky Point

once-through site, cause the staff to conclude that neither Site 19 nor 20 is environmentally preferable to the Rocky Point site.

4.8.2 Terrestrial Ecology and Land Use

The staff has reviewed a variety of factors relating to the analysis of Sites 19 and 20 terrestrial resources.

4.8.2.1 Site 19

There are two dedicated areas on this site whereas the Rocky Point site has none. Therefore, the Rocky Point site is considered better for this factor.

Utilization of this site would preempt the use of forest and wildlife habitat for an area larger than that at the Rocky Point site. Therefore, the Rocky Point site is preferable considering these two factors.

Both sites contain a similar amount of important farmlands; therefore, they are considered equivalent in this regard.

Terrestrial and coastal wetlands would be preempted. The entire site is located in the coastal zone. Therefore, the Rocky Point site is preferred for these two factors. The two sites are considered equivalent for all other factors.

4.8.2.2 Site 20

A considerably larger amount of forest and its accompanying wildlife habitat would be preempted than at Rocky Point. Therefore, the Rocky Point site is preferable for these two factors.

Because of the much greater amount of soils of statewide importance for farmland on Site 20, the Rocky Point site is considered preferable for this factor.

Some of the swamps would be preempted and the entire site is in the coastal zone. Therefore, the Rocky Point site is preferable for these factors.

Because Site 20 contains coastal floodplains and the Rocky Point site does not, the Rocky Point site is preferable for this factor.

The two sites are considered equivalent for all other factors.

4.8.3 Demography

An examination of the population data in Tables 6 and 7 shows that the population densities surrounding Sites 19 and 20 in general exceed the population density of the Rocky Point Site. Based on the population

considerations discussed in Appendix A, we therefore conclude that with respect to population, Sites 19 and 20 are not preferred in comparison to the Rocky Point site.

4.8.4 Nearby Industrial, Transportation, and Military Facilities

The potential impact on the safe operation of a nuclear plant of the industrial, transportation, and military facilities in the vicinity of Sites 19 and 20 have been evaluated and compared to the Rocky Point site.

4.8.4.1 Site 19

The presence of Cape Cod Canal adjacent to Site 19 is a significant feature with the potential to affect the suitability of the site for a nuclear power plant. It is likely that the effects (e.g., explosive overpressure, fire, toxic gas cloud) of postulated shipping accidents involving hazardous materials would have to be accommodated in the design of a nuclear plant located at Site 19. Another facility that may affect the suitability of the site is Otis Air Force Base. Although located 11 km southwest of the site, an extension of a routine departure path passes over the site area. An evaluation of aircraft operations in the site vicinity would be required to determine whether the risk of an aircraft accident is sufficiently high to be considered as a design

basis event for a nuclear plant located at Site 19. We conclude that Site 19 is less preferable than the Rocky Point site due primarily to the risk posed by shipping activities in the Cape Cod Canal and, to a lesser extent, military aircraft operations over the site area.

4.8.4.2 Site 20

The Cape Cod Canal shipping channel is about 4 km southeast of the site. Otis Air Force Base in about 16 km east-southeast, and an extension of a routine departure path passes approximately 5 km northeast of the site. An evaluation of these facilities would be required to determine whether the risk posed by possible shipping and aircraft accidents is sufficiently high to require that such accidents be considered as design basis events for a nuclear plant located at Site 20. Our preliminary judgment is that the separation distances of these facilities from the site are adequate to provide reasonable assurance that postulated shipping and aircraft accidents would not adversely affect the site. Therefore, we conclude that with respect to external hazards, Site 20 and the Rocky Point site are equivalent.

4.8.5 Hydrology

Buzzards Bay has been identified as having shallow water and poor circulation patterns (Ref. 55), which may require the use of cooling methods

other than once-through cooling. A detailed analysis is needed to confirm the dispersions capability of Buzzards Bay.

Since the cooling water will be withdrawn from Buzzards Bay, no water availability problems are anticipated. No other unique or significant hydrological impacts were identified. From a hydrologic engineering point of view, Site 20 is equivalent to the Rocky Point site.

4.8.6 Socioeconomics

4.8.6.1 Site 19

Depending on the exact boundary lines, the displacement expected to occur at this site includes 10 to 15 residences and a seminary (Ref. 46).

There are no onsite historic or natural features listed in the national or state registers (Refs. 47, 48, 49). There are no onsite recreation or scenic areas listed in the state outdoor recreation plan, and no archaeological sites are reported (Ref. 49).

The construction work force is expected to originate primarily from the local hiring halls of New Bedford, and to a lesser extent, from Boston (Ref. 50). The workers would use State Route 25 (southern end) and contribute to traffic along this stretch of road, along U.S. Route 6

east for 0.5 km passing through developed areas in East Wareham and south along Great Neck Road for about 4 km. In this situation, the applicant anticipates that some traffic control modification would be needed at the turn onto Great Neck Road as well as some road upgrading and widening to facilitate the traffic flow.

A plant with a natural draft cooling tower and associated plume would be visible from points offshore, the Cape Cod Canal, and the surrounding communities and would represent a visual intrusion to the surrounding area.

With respect to the socioeconomic factors considered, Site 19 is less preferable to the Rocky Point site in terms of onsite displacement, traffic impacts and visual impacts.

4.8.6.2 Site 20

Depending on the exact boundary lines, the displacement which is expected to occur at this site includes 20 to 30 residences and one commercial establishment (Ref. 46).

There are no onsite historic or natural features listed on the national or state registers (Refs. 47, 48, 49). The archeological site (Great Hill) reported would require an evaluation and possible mitigating

attention if the plant were to intrude on this resource. There are no onsite recreation or scenic areas listed in the state outdoor recreation plan (Ref. 49).

The construction work force is expected to originate primarily from the local hiring halls of New Bedford, and to a lesser extent, from Boston (Ref. 50). The workers would use I-95 and exit at Exit 20. Traffic congestion could be expected at this point, north on U.S. Route 6 for 1.6 km passing through developed areas in Marion, and south on Point Road for 1.6 km. In this situation, the applicant anticipates that some traffic control modification would be needed at the turn onto Point Road as well as some road widening and upgrading to facilitate the traffic flow.

A plant with a natural draft cooling tower and associated plume would be visible from points offshore, the Cape Cod Canal and the surrounding communities along the Bay and would be a visual intrusion to the area.

With respect to the socioeconomic factors considered, Site 20 is less preferable to the Rocky Point site in terms of onsite displacement, traffic impacts, visual impacts and potential impact to one reported onsite archeological site.

4.8.7 Geology, Seismology, and Geotechnical Engineering

Sites 19 and 20 are within the Piedmont-New England tectonic province. The safe shutdown earthquake (SSE) could result in at least an intensity VII at these sites, depending on the distance to the Boston-Cape Ann seismic zone. Soil columns at the sites may also amplify the acceleration values. These sites are considered to be equal to the Rocky Point site.

4.9 Description of the Millstone Site

The 200-ha Millstone site is in the Town of Waterford, Connecticut, on Long Island Sound (see Figure 7). The site is owned by Northeast Utilities and contains two operating nuclear power plants; Millstone Unit 1 (652 MWe) and Millstone Unit 2 (830 MWe). A third unit, Millstone Unit 3 (1,150 MWe PWR), is under construction; it has a projected operation date of 1986. All three units use a once-through cooling system.

Development of Pilgrim Unit 2 (1,150 MWe) at the Millstone site is considered with a once-through cooling system, and with a cooling tower. If it were to be developed, it would increase the total site generating capacity from 2,632 MWe to 3,782 MWe. Essentially, it would be a fourth Millstone unit, although it is assumed herein that it would be completed in 1985, approximately one year prior to Millstone Unit 3.

The terrestrial resources of the site are limited due to two operating nuclear plants and one other under construction. There are extensive laydown areas and associated construction facilities. Some forests and grassland areas occur on eastern and central regions of the site which provide habitat for wildlife. An osprey nest, associated fresh water wetlands, and salt marsh are preserved and protected by Northeast Utilities and the State (Ref. 9). The osprey is a state-listed endangered species.

Part of the site is an abandoned horticultural nursery; some hayfields are located east of the main access road. These areas could contain a few hectare of prime farmlands (Ref. 9).

Economically important aquatic benthic species are found in the Millstone area. Lobsters are found in rocky outcrops with scattered hard sand patches existing to the south and east of Millstone Point (Ref. 61). Shellfish occur around the periphery of Niantic Bay and in Jordan Cove (Ref. 62). Hard-shelled clams, and oysters occur in the area (Ref. 9), but the fishery is not large. Bay scallops are found in the vicinity of the site, however, the harvest is not significant (Ref. 63).

Total bivalve mollusk larvae are more abundant in the upper Niantic River with decreasing numbers at areas proceeding into the lower Niantic River and out into the Bay (Ref. 61). The Niantic River apparently is

an effective concentrating system with a water circulation pattern that retains planktonic organisms within the river estuary (Ref. 64). This may account for the fact that not much of the estuary water flushes past the station intake structures (Ref. 9).

Studies (Ref. 65) have shown that lobster larvae are concentrated in the western sector of Long Island Sound with relatively low larval abundance in the eastern sector near Fisher's Island (which is southwest of Millstone), despite the large number of adult lobsters caught near the station. Lobster larvae entrained at Millstone may not reflect the larvae produced by the local adult population (Ref. 66), but the predominance of young larvae suggests that they may have hatched in the vicinity of Millstone.

The Millstone area supports a diverse community of shore zone, pelagic, and benthic fish species (Ref. 61). Recreational and commercial fishing occurs for several species in the Long Island Sound waters of Connecticut. Recreational angling for bluefish and striped bass occurs nearby throughout the year in the station's discharge effluent. The rocky areas around Twotree Island apparently are also good fishing grounds. Commercial fishing occurs for several species of fishes, mollusks, and crustaceans in Long Island Sound, however, the area in the vicinity of the Millstone site contributes a small percentage to the total state harvest (Ref. 67). Commercial lobster fishing is conducted in the vicinity of the site.

The Millstone site area of eastern Connecticut lies within a region of general biotic similarity throughout. The aquatic community appears to be numerous and diverse with little apparent uniqueness within the region.

The waters of Long Island Sound adjacent to the site area are designated Class "SA" by the State of Connecticut (Ref. 68).

Jordan Cove and Niantic Bay have been recognized by the New England River Basins Commission (Ref. 69) as high-quality shellfish areas in need of protection from both point and non-point pollution sources.

The existing water quality in Long Island Sound in its eastern end is considered good (Ref. 70). Specific water quality problems in the vicinity of the site have not been identified to the extent that individual parameters are listed as stressed (Refs. 9, 69, 70). Urban development of the coastline and drainage basins of the Niantic River, Niantic Bay and Jordan Cove, and intense recreational use of the area by watercraft have raised concern over the future ability of the waters near the site to meet their classification requirements. This concern has been extended to the entire eastern coastal waters of Connecticut (i.e., from the Connecticut River eastward to the Connecticut-Rhode Island State line) (Ref. 69).

Station effluent and general area water quality studies have been conducted in relation to the operation of the Millstone Nuclear Power Station. Review of recent data (Refs. 71, 72) shows that the existing units are operating without evidence of water quality related impacts near the site. Effluent monitoring during 1976 and 1977 shows that water entering Twotree Island Channel from the discharge quarry were within the limits of the Environmental Technical Specifications for pH and residual chlorine. Studies in the surrounding area have not shown deleterious effects on water quality due to changes in pH, depressed dissolved oxygen concentration, or the presence of heavy metals (Refs. 71, 72).

The 1970 and projected population distributions within 48 km of the site, based on data obtained from the Millstone Unit 3 PSAR, are given in Table 8. The coastal area of Long Island Sound near the site attracts a large number of seasonal residents and daily visitors. The Millstone Unit 3 applicants estimated that in 1970 approximately 35,000 seasonal transients could be found on an average summer day within 16 km of the site. We computed the population figures given in Table 8 by multiplying the seasonal and daily transient populations by suitable weighting factors to reflect occupancy on an annual basis and then added the weighted values to the permanent resident population. We also assumed that the transient population increased over the years at the same rates as that projected for the resident population.

The Millstone site is traversed by a double-track mainline railroad which passes about 725 m north of the Unit 3 containment structure at its closest point of approach. Some hazardous material is carried on this line. A fuel storage terminal with capacity for 166 cubic meters of fuel oil, 166 cubic meters of gasoline, and 477 cubic meters of propane is located about 2.5 km miles northeast of the site.
The closest airport to the site is New London Airport which is located about 6.5 km to the north. New London Airport is a general aviation facility with a maximum runway length of 580 m. The nearest airport with commercial air service is Trumbull Airport in Groton about 10 km east of the site. Trumbull Airport has three runways, the longest of which is 1,525 m. The Federal low-altitude air route nearest the site is V58, which passes about 8 km northeast of the site. The nearest shipping lane in Long Island Sound is about 4 km to the south, and a reef southeast of the site prevents ships from coming closer to shore. The major port facilities in the area are on the Thames River in New London about 6.5 km east-northeast of the site. There is no significant amount of commercial shipping in Niantic Bay west of the site.

4.10 Staff Analysis of the Millstone Site

4.10.1 Aquatic Biology and Water Quality

Construction Impacts: Each site was compared to the preferred site with particular attention directed to the following specific potential

Construction impacts: (1) onsite stream diversions or alterations; (2) changes in site runoff during site development; (3) right-of-way (ROW) or water pipeline development; and (4) siltation due to dredging for barge facilities, intake/discharge structures, and pipelines.

The staff has previously examined the potential for impact and the need for mitigation associated with plant construction at the Millstone site (Ref. 9). No water quality or aquatic biota impacts requiring special mitigation were anticipated. (Precautionary measures for turbidity reduction during intake cofferdam construction were recommended.) The staff believes that additional construction at the Millstone site, using practices and controls similar to those used on Millstone Units 1 and 2 could reasonably be expected to result in minor and temporary effects on water quality localized near the site.

Intake Effects: Intake effects to aquatic biota are primarily those impacts associated with impingement or entrainment. The magnitude of the intake effects associated with the operation of a fourth unit at Millstone is dependent on the cooling mode selected and its interaction with the two existing units and the additional unit already under construction at the site. The incremental operational effects of adding Unit 3 as an open-cycle system to those of Units 1 and 2 were evaluated in the 1974 FES (Ref. 9), which predicted acceptable impacts for once-through cooling, but it was recommended that further study be made with emphasis on the entrainment of winter flounder ichthyoplankton.

Since monitoring began in 1972, continuous daily monitoring has shown that between 1972 and 1977 a total of 103,692 fish and 66,915 macroinvertebrates have been impinged at the Millstone Units 1 and 2 intakes (Ref. 74). At least 30 species of fish and 16 species of invertebrates have been collected. Winter flounder has been the most abundant, constituting about 46% of the total for all years studied (Ref. 74).

Approximately 9% of all invertebrates collected for all years studied were lobster and 8% were blue crab.

With Unit 3 approved for once-through cooling total station, impingement losses might to double or possibly increase to higher losses than those of Units 1 and 2 combined, since the operation of Unit 3 will result in almost a doubling of the station's water withdrawal. An additional closed-cycle unit with a water withdrawal rate of only 1.8% of the combined flow rates for Units 1 through 3 would not result in any significant incremental impingement loss. The addition of a fourth once-through unit would increase the total flow rate through the station by almost 50% and may result in a localized reduction of the population of certain species.

Entrainment of planktonic organisms has been studied at the Millstone station since 1970. Units 1 and 2 entrain approximately 4% of the tidal

volume of Niantic Bay (Ref. 74). Millstone Units 1 through 3 will entrain approximately 6% of the flow through Twotree Island Channel (Ref. 9). An additional unit would increase the entrainment percent of by a factor equivalent to the amount of water withdrawn. A fourth unit utilizing once-through cooling would increase the entrainment percentage of to approximate 9% of the flow.

A fourth unit at Millstone, utilizing closed-cycle cooling, would probably have an insignificant incremental impact on the entrainable stages of the lobster since the flow through the station would be increased by only 1.8% over the combined flows of Units 1 through 3.

Once-through cooling of a fourth unit at Millstone is judged to be less environmentally preferable than a second unit at the Rocky Point site due primarily because of the possibility of significant impacts of impingement and entrainment to the winter flounder and lobster fishery at the Millstone site.

Whether or not the Millstone site with a fourth unit utilizing closed-cycle cooling is judged to be superior to the Rocky Point once-through site is dependent, however, on the anticipated impingement and entrainment related impacts to the fishery at the Rocky Point site. Because the anticipated impacts to the fishery from the Rocky Point site is negligible, it is concluded that a fourth unit at Millstone utilizing

closed-cycle cooling is environmentally preferable (a reduced number of aquatic organisms is effected) but not environmentally superior to the Rocky Point site with respect to the impacts of operation on the source water's fishery.

Discharge Effects: Operational phase discharge related impacts to water quality and aquatic biota of the receiving waters are primarily those impacts associated with the discharge of biocides and other compounds, discharge of waters differing in quality from the receiving waters, thermal loading on the fisheries of the receiving waters, and mortality to the fishery due to gas bubble disease (GBD) and cold shock. The magnitude of the effects of the discharge on the water quality and aquatic biota of the receiving waters is dependent on the cooling mode selected. Discharges from a once-through cooling system would have a greater impact on the fisheries than the closed-cycle system.

Estimates of discharge concentrations of chemicals in the combined discharge of the Millstone station from the addition of Unit 3 (of similar size and type as the unit proposed for Pilgrim Unit 2) have been made for this site (Ref. 9). The predicted increases over background levels in the discharge using once-through cooling from such sources as demineralizer regeneration and steam generator blowdown are small, and no adverse effects on the quality of the receiving waters is anticipated. Using the predicted discharge characteristics, water quality degradation

or criteria violations would not be expected from these sources during operation of the additional Pilgrim open-cycle units at the Millstone site.

The anticipated low concentration factor for dissolved ambient constituents, reduced discharge volume, and good available mixing in the discharge area combine to indicate that operation of the Pilgrim unit with closed-cycle cooling at the Millstone site would not reasonably be expected to cause water quality criteria violations.

The applicant has previously indicated that total residual chlorine would be held to a maximum of 0.1 mg/l in the discharge from the Pilgrim station. A similar limitation has been in effect at the Millstone site under both the NPDES permit and the NRC Environmental Technical Specifications. However, in addition, when intake water temperature is between 7°C and 13°C, continuous, simultaneous chlorination is permitted at the plant to control fouling due to mussels. The staff believes that it is reasonable to assume that these practices would be employed if the additional unit was located at this site. The increase in the discharge flow rate from the site if the open-cycle Pilgrim unit was located there would increase the volume of water affected by residual chlorine. This could cause areas of the receiving water to not meet the water quality criterion on harmful chemical constituents. Review of data collected during a one- and two-unit chlorination practice study at the Millstone

site (Refs. 71, 75, 76) indicates that the plant discharge has consistently had a residual chlorine concentration below the 0.1 mg/l limit. The staff concludes that site-specific studies of the combined discharge would be necessary to quantify the area, volumetric extent, and location of areas that may be in violation of water quality standards if a fourth open-cycle unit were sited at Millstone.

The addition of the Pilgrim unit with closed-cycle cooling to the Millstone site is not anticipated to cause water quality impacts due to chlorination because of its small contribution of discharge compared to the already-present Millstone units discharges (120 cms).

The existence of nearby valuable aquatic resources and citation of these areas as being in need of water quality protection could require mitigation of chlorine discharges in open-cycle cooling systems. The existing good water quality and good available mixing characteristics of the receiving water near the discharge make the Millstone site suitable for placement of the Pilgrim unit with closed-cycle cooling. Siting of the Pilgrim unit with closed-cycle cooling at the Millstone site would have small and approximately equivalent effects on water quality when compared to siting at Rocky Point.

Thermal effects from discharge into Twotree Island Channel were evaluated in the 1974 FES (Ref. 9). Three units with once-through cooling could

create a surface plume of 33.4 hectares with temperatures 2.2°C or more above ambient and a plume of 344.8 hectares with temperatures 0.8°C or more above ambient (Ref. 9). The only effects predicted from thermal discharges were in the immediate vicinity of the discharge, where some species shifts could occur. Species shifts in the discharge vicinity have been observed (Refs. 9, 61) but effects appear to be localized. An additional once-through unit would increase the discharge flow rate by about 50% and has the potential for incremental thermal effects. The staff concludes that because of the already high thermal loading in the vicinity of Millstone station and the significant aquatic resources located nearby an additional once-through unit would not be environmentally preferable to the Rocky Point site.

Whether or not the Millstone site with a fourth unit utilizing closed-cycle cooling is judged to be superior to the Rocky Point once-through site is dependent, however, on the anticipated thermal loading related impacts to the fishery at the Rocky Point site. Since the anticipated impacts to the fishery at the Rocky Point site is negligible, it is concluded that a fourth unit at Millstone utilizing closed-cycle cooling is environmentally preferable but not environmentally superior to the Rocky Point site with respect to the impact of unit operation on the fishery of the receiving waters.

The staff has evaluated the potential for mortality to fishes due to GBD and cold shock in the vicinity of the discharge at the Millstone site.

Mitigative measures employed during operation of Units 1 and 2 have reduced the incidence of GBD and cold shock mortality to insignificant levels. Utilization of the same measures would probably insure the absence of significant GBD or cold shock-induced mortality after Unit 3 is operational and probably would be effective even if a fourth unit, either with once-through or closed-cycle cooling is employed. Furthermore, an additional once-through unit at the Millstone site would result in a lessening of any potential for cold shock since simultaneous outage of all four units would be less frequent than a three-unit outage.

Since mortality associated with GBD can be effectively controlled by the use of mitigative devices at both the Millstone and Rocky Point sites, the Millstone site with respect to GBD cannot be judged superior to the Rocky Point site.

4.10.2 Terrestrial Ecology and Land Use

The Rocky Point and Millstone sites are considered equivalent for all terrestrial factors considered.

4.10.3 Demography

An examination of the population density data in Tables 1 and 8 shows that the population densities surrounding the Millstone site are greater

at almost all distances than the population densities surrounding the Rocky Point site at both the assumed date of initial plant operation (1985) and end of plant life (2020). Therefore, based on the population considerations discussed in Appendix A, we conclude that the Millstone site is not preferred in comparison to the Rocky Point site.

4.10.4 Nearby Industrial, Transportation, and Military Facilities

The review of the industrial and transportation facilities in the vicinity of the Millstone site indicates that the most significant factor is the railroad line through the site. Since the most likely location of the additional reactor units would place them closer to the railroad line than the reactor units now onsite, postulated railroad accidents would have more severe consequences for the new units. Depending on the actual location of the plant structures in relation to the railroad, a detailed study of the traffic, and the possible effects of the postulated accidents (e.g., explosive overpressure, fire effects) on the plant's safety, it may be necessary to require additional plant protective features to mitigate the consequences of postulated railroad accidents. The fuel storage terminal located 2.5 km from the Millstone site is judged to be far enough away, based on previous staff analyses of similar facilities, so that postulated accidents at the terminal will not affect plant design. We conclude that, with regard to external accidents, the possibility of a railroad accident becoming a design basis event weighs

against the Millstone site when compared with the Rocky Point site and for this reason we find the Millstone site less desirable.

4.10.5 Hydrology

The cooling tower makeup water flow of about 2 cms could possibly be incorporated into the present intake and discharge structures with very little modification. The existing discharge channel is capable of handling this increase in flow, and a new discharge system would probably not be required, other than those additions required to route discharge flows to the channel.

Because cooling water is withdrawn from the ocean, an adequate water supply can be made available for open- or closed-cycle cooling. No significant hydrologic impacts are associated with the construction and operation of a nuclear plant at this site.

The staff concludes that the Millstone site and the Rocky Point site are equivalent from a hydrologic engineering standpoint.

4.10.6 Socioeconomics

No onsite displacement activity is anticipated (Ref. 77).

There are no onsite historic or natural features listed in the national registers (Refs. 47, 48, 49). An archaeological survey taken of the site indicates that there are no significant archaeological remains in the site area (Ref. 78). There are some ball fields (baseball and football) located onsite, which are presently leased to the Town of Waterford, and certain construction activities could possibly disrupt activities in these fields.

The construction work force is expected to originate and commute mainly from the various communities of southeastern Connecticut, which includes such counties as New London, New Haven, and Middlesex (Ref. 9). Workers driving from the west and using I-95 would exit at Exit 72 and use State Route 156, to the site. Workers driving from the east would use U.S. Route 1A and State Route 156. The major congestion points would be at the Millstone Road and State Route 156 area of the site and along Niantic River Road leading to and from I-95.

The Millstone site is situated on a peninsula which constitutes the eastern side of Niantic Bay. The existing station is clearly visible from various beach vantage points. Some station structures are partially visible, depending on the extent of tree cover and other structures, along Route 156, at Harkness Memorial State Park, and along parts of Route 213 in New London. Locating Pilgrim Unit 2, with a once-through cooling mode, on the existing Millstone site would not appreciably

decrease the existing visual ambience. A plant with a thermal draft tower and associated plume would be visible from off shore and the surrounding communities and would be a visual intrusion to the area.

With respect to the socioeconomic factors considered, the Millstone site is less preferable to the Pilgrim site in terms of traffic impacts and visual impacts related to the cooling mode (NDCT).

4.10.7 Geology, Seismology, and Geotechnical Engineering

The Millstone site is in an area of seismic risk similar to that at Rocky Point. However, being a bedrock site, it is regarded as being more favorable for plant siting than the Rocky Point site.

4.11 Description of the Montague Site

The Montague Site, approximately 770 ha in size, is located in the town of Montague, Massachusetts (see Figure 8). The site is owned by Northeast Utilities which proposes to develop it for two nuclear power plants, each with a generating capacity of 1,150 MWe. These would be boiling water reactor powered units with natural draft cooling towers. Projected completion dates are estimated to be in the early 1990's, although the schedule is not definite.

Development of Pilgrim Unit 2 (1,150 MWe PWR) at the Montague site is considered with a natural draft cooling tower. Essentially, it would be the first of three Montague units and would contribute to a total site generating capacity of 3,450 MWe. The source of cooling water would be the Connecticut River.

This site is predominantly (greater than 90%) mixed cutover/burned forest of relatively young stands (less than 50 years old). The sandy soils of the glacial outwash support pure stands of both scrub oak and pitch pine uncommon for this region. A bald eagle, and endangered species, was observed as a transient. The osprey is a summer resident (Ref. 77).

The site contains about 10 ha of prime farmland; 0.8% of the site. Some 75 to 80% of the site is covered by Henkley sandy loam, with 0 to 15% slope. This soil has been classified as farmland of statewide or local importance by the Soil Conservation Service (SCS). However, the SCS Soil Survey of Franklin County (1967) states that because of drought, this soil is poorly suited to general crops, hay, or pasture unless it is irrigated. Without irrigation, it is best suited for use as woodland or wildlife habitat.

There is a small wetland area of about 12 ha on site.

Thirty-six species of fish are known from the Holyoke Pool of the Connecticut River. The Holyoke Pool fish community is comprised of resident, catadromous, and anadromous species. Within the Holyoke Pool, the important anadromous species are the American shad, blueback herring and the Atlantic salmon. Atlantic salmon, an important recreational fishing species, has been recently reintroduced into the river as part of the anadromous fish restoration program (Refs. 8, 79). The most important species in Holyoke Pool is the shad, which does not require stocking to maintain an annual migration (Ref. 80).

At present the upstream area of the river most accessible to migrating shad and other anadromous species is the Holyoke Pool because fish passage facilities are not yet complete at Turners Falls Dam. Upon successful completion of the fish passage facilities, shad and other anadromous fishes can be expected to utilize the Montague vicinity of the Holyoke Pool for both upstream and downstream migrations and spawning. Future fish passage facilities could increase the number of migrating shad at the river mouth from the 1970 figure of 419,000 to more than one million by 2020 (Ref. 81).

American shad utilize Holyoke Pool for spawning. In addition, eggs and larvae of at least 14 fish species have been collected within Holyoke Pool (Ref. 79) including carp, minnow and shiner, white sucker, catfish, killifish, white perch, sunfish, rock bass, yellow perch, and walleye (Refs. 8, 79).

Fishing on the Connecticut River within the Holyoke Pool segment is entirely recreational (Ref. 79). An angler census conducted in the Holyoke Pool during 1965-66 showed that the major species taken were channel catfish, black crappie, yellow perch, and white perch (Ref. 79). Walleye and yellow perch are taken near Turners Falls, channel catfish are taken from Deerfield to Holyoke, and shad are taken near Holyoke (Ref. 80).

A commercial shad fishery exists in the Connecticut River but is restricted to the State of Connecticut.

The shortnose sturgeon, (Acipenser brevirostrum), a Federally designated endangered species, is known to come from the Connecticut River. Since 1964 a reproducing population has been identified inhabiting the Holyoke Pool (Ref. 82). Tagging studies indicate that a population of less than 500 sturgeon inhabit the Holyoke Pool with all life stages having been captured (Refs. 8, 79, 80). The shortnose sturgeon is not known to come from Turners Pool at present but may inhabit the pool following installation of the fish passage facilities at the Turners Falls Project.

The shortnose sturgeon is defined as a benthic feeding carnivore (Ref. 83). Spawning reproduction and early maturation for this species is poorly known. A study (Ref. 83) conducted in the St. John River in New Brunswick, Canada, indicates that spawning took place between May 15 and June 15 in

the main river during peak flood in extremely turbid water. The water temperature at the time of spawning was approximately 10°C. Adults appear to choose spawning sites in the upper estuary adjacent to deep turbulent sections of the river. The eggs have been found to be demersal and adhesive (Ref. 84). Studies indicate (Ref. 83) that young shortnose sturgeon are difficult to catch because they live in the deep channels where strong currents make sampling impossible.

Based on assigned water uses, the waters of the Connecticut River in the vicinity of the site are designated Class "B" by the State of Massachusetts. The prescribed best uses and quality criteria for waters of this classification are presented in the Massachusetts Water Quality Standards.

There are two surface water bodies adjacent to the Montague site that have water uses requiring special designation and water quality classification. Green Pond and Lake Pleasant are part of the municipal water supply for the Turners Falls Fire District, which supplies the villages of Montague City and Turners Falls and sells water to the Millers Falls Water District and the Lake Pleasant Water District (Ref. 79). These waters are Class "A" under the State regulations and are designated as sources of public water supply. The quality criteria for these waters are presented in the Massachusetts Water Quality Standards. There are no municipal water supplies withdrawing water from the Connecticut River (Ref. 79).

The existing water quality in the Connecticut River near the site meets the requirements of the Class "B" classification for all parameters except for coliform bacteria (Refs. 85, 86). Sewer overflows and storm drain discharges into the upstream Turners Falls power canal is cited as the reason for non-compliance. Upgrading to secondary treatment for wastes entering the Connecticut River near the site has been planned (Ref. 87) Upon completion of these facilities, the Connecticut River waters near the site are expected to meet all Class "B" criteria.

Site-specific studies submitted by Northeast Nuclear Energy Company in the Montague ER have been cited by the State (Ref. 86) as cause for concern over heavy metal concentrations in the river. Over a one-year period from May 1973 to April 1974, maximum observed concentrations for cadmium and mercury exceeded the EPA-recommended water quality criteria, although the average of the recorded values did not exceed these limits.

The 1970 and projected resident population distributions, based on data obtained from the Montague PSAR, are shown in Table 9. Transient population in the vicinity of the site does not significantly alter the resident population distribution.

There a number of relatively small industrial facilities in the area, but none are engaged in operations involving large quantities of hazardous materials. There are no fuel storage terminals within 4 km of the site,

and the closest pipeline is a 10-cm diameter low-pressure gas pipeline 2.5 km from the site. There are several railroad lines that lie to the east, south, and west of the site, the closest of which is approximately 2 km from the center of the site. A Boston and Maine Railroad switchyard is located about 3 km to the west. The nearest highways to the site are State Highway 63, which is 2 km southeast, and State Highway 2, which is about 3 km northeast. Interstate Highway 91 is located about 6.5 km west of the site. The Turners Falls Airport is located approximately 1.6 km north of the site and has a single paved runway 915 m in length. There are no scheduled air carrier services at the field which is used primarily by general aviation aircraft having normal loaded weights of less than 3630 kg. Approximately 35,000 operations were recorded at the airport in 1974. The closest airport to the site with scheduled air service is located in Keene, New Hampshire, 45 km north-northeast of the site. Federal low-altitude airway V93 passes approximately 4 km west of the site.

4.12 Staff Analysis of the Montague Site

4.12.1 Aquatic Biology and Water Quality

Construction Impacts: Each site was compared to the preferred site with particular attention directed to the following specific potential construction impacts: (1) onsite stream diversions or alterations; (2)

changes in site runoff during site development; (3) right-of-way (ROW) or water pipeline development; and (4) siltation due to dredging for barge facilities, intake/discharge structures, and pipelines.

The staff has previously examined the potential impacts of construction and operation for a two-unit nuclear plant using closed-cycle cooling at the Montague site (Ref. 8).

The combination of the applicant's construction practices and proposed measures to protect the aquatic environment were judged by the staff as likely to result in only minor impacts to the Connecticut River during in-river construction and operation of the Montague units.

Likewise, runoff from the site, due to flat topography, sandy soil at the site, and planned runoff control procedures, was judged to produce negligible offsite aquatic impacts. No adverse effects on Green Pond or Lake Pleasant were anticipated. Staff-recommended mitigative actions to control aquatic impacts during construction were limited to control and treatment of preoperational cleaning waste solutions prior to release. It is the staff's judgment that these commitments and the additional staff-recommended limitations could be applied to the construction of the Pilgrim unit at this site. Construction of the Pilgrim unit at the Montague site could reasonably be expected to produce similar minor and temporary effects on water quality localized at the site.

Intake Effects: Intake effects to aquatic biota due to the operation of the Pilgrim station would be those impacts associated with impingement and entrainment. In evaluating the intake structure the design of the structure is assumed to be similar to the intake structure proposed for the deferred Montague station.

The shoreline intake structure would be located along a region of the river where the river channel sweeps along the east bank, which consists of an exposed, steep, rock ledge. The bottom substrate in this area is rock, cobble, and sand. Location of the intake in this region allows water to be withdrawn from a relatively deep portion of the river that would be less heavily used for fish spawning (Ref. 82). The intake structure is flush with the shoreline at minimum river water elevation, has lateral fish passageways that will aid in reducing impingement, and has the maximum velocity component toward the screens of 7.5 cm per second.

Based on the anticipated design of the intake, its placement, the use of closed cycle cooling, and the density and distribution of organisms in the river near the proposed location, impingement is not considered to be a significant potential impact. Losses associated with impingement should have no effect on resident or anadromous species.

The impact of a single closed-cycle station on the aquatic resources of Holyoke Pool due to entrainment has been determined to be insignifi ant.

Except for the American shad and the shortnose sturgeon the low density and widely scattered distribution of eggs and larvae of fish species spawning in Holyoke Pool preclude the possibility of detectable impacts from entrainment to these populations.

A worst-case analysis of the impact to American shad from entrainment do to operation of the two-unit deferred Montague station indicated a loss of less than 0.2% of the total Connecticut River shad run (Ref. 8). A one-unit station would reduce this estimate to less than 0.1% of the total run. Losses of this magnitude would not measurably reduce the shad population of the river.

Pursuant to Section 7 of the Endangered Species Act of 1973, the USNRC sought consultation with US Department of Commerce, National Marine Fisheries Service (NMFS), for a threshold determination of effects of construction and operation of the deferred Montague NPS upon the shortnose sturgeon. On November 28, 1977, NMFS replied stating that the threshold examination "revealed a probable impact" on the species but the data available were "insufficient to form a complete biological opinion."

The USEPA has reviewed the potential effects of the deferred Montague NPS on the shortnose sturgeon of Holyoke Pool. In an April 1978 response, EPA stated "concerning the possibility of shortnosed sturgeon mortalities,

it is still the power plant review group's position that no intake structure can be allowed in the Holyoke Pool because of predictable egg and larvae entrainment" (Ref. 88). EPA also cited the lack of adequate biological information. The data on the distribution and abundance of shortnose sturgeon eggs and larvae in Holyoke Pool, information on the life history of the species, and the proposed design and placement of the intake structures for the one-unit Pilgrim alternate has been evaluated. It is the staff's opinion that although some eggs and larvae may be entrained during the life of the station no detectable impact to the Holyoke Pool population of shortnose sturgeon will occur.

Due to the lack of information the effects of entrainment on Atlantic salmon, should this species become fully reestablished in the Holyoke Pool section of the Connecticut River, has not been evaluated.

Whether or not the Montague site, with a single unit, utilizing closed-cycle cooling, is judged to be superior to the Rocky Point once-through site is dependent, however, on the anticipated impingement and entrainment related impacts to the fishery at the Rocky Point site. Since the anticipated impact to the fishery at the Rocky Point site is negligible, and the possibility of an adverse impact to the Atlantic salmon population exists, it is concluded that the Montague site with closed-cycle cooling may be environmentally preferable but not environmentally superior to the Rocky Point site.

Discharge Effects: Operational phase discharge related impacts to water quality and aquatic biota of the receiving waters are primarily those impacts associated with the discharge of biocides and other compounds, discharge of waters differing in quality from the receiving waters, thermal loading on the fisheries of the receiving waters, and mortality to the fishery due to gas bubble disease (GBD) and cold shock. The magnitude of the effects of the discharge on the water quality and aquatic biota of the receiving waters is dependent on the cooling mode selected. Discharges from a once-through cooling system would have a greater impact on the fisheries than the closed-cycle system. Effects of operation on water quality from a two-unit nuclear power plant using closed-cycle cooling at Montague have been assessed by the staff (Ref. 8).

An estimate of the chemical discharges from the Montague plant design is presented in the Montague FES (Ref. 8) using a concentration factor of 5. The operation of the Pilgrim unit at the Montague site utilizing similar waste treatment schemes would be expected to produce similar effluents. The amount of wastes over a given period of time would be expected to be smaller for the Pilgrim unit, due to the reduction of plant size at the site to one unit. Because of the concentrating effect of the closed-cycle cooling system on constitutents in the incoming cooling water, metals such as iron, aluminum, cadmium, zinc, and copper could be present in the plant discharge at concentrations that have been found toxic to aquatic organisms (Refs. 8, 86). Adverse water quality

conditions in the vicinity of the discharge could occur. The affected area is not anticipated to be either large or conducive to prolonged habitation by aquatic bota. Adverse impacts, if any, are likely to be small. The projected minium river flow at the site when a plant could become operational is 40 cms (at Turners Falls Dam) plus the flow of the Deerfield River. Plant blowdown flow is expected to be on the order of 0.3 cms or less. The staff has found that resultant mixed concentrations of the above metals would only be slightly above ambient conditions (approximately 3 to 5% concentration increase at the above flow under maximum concentration conditions). These increases have been judged as not having "adverse toxic effects on the biota of the river" (Ref. 8). In its review of the water quality impacts from operation of a nulcear plant at the Montague site, the State concluded that adverse effects would not be expected (Ref. 87). Based on the small concentration increase and the anticipated effects of upstream waste treatment in reducing ambient levels of metals in the Connecticut River, water quality criteria violations are not expected as a result of plant operation.

Discharge of residual chlorine from plant biocide treatment at the site was predicted to not have adverse impact on receiving water quality due to mixing in river afforded by the discharge design and the large available Connecticut River water flow at the site (Ref. 8). The proposed Montague Plant design differs from the Pilgrim design in that a mechanical cleaning system would be used for condenser defouling in the Montague

design versus heat treatment and biocide used in the current Pilgrim design (Refs. 8, 89). The EPA recommended water quality standard for residual chlorine in a freshwater warmwater fishery is 0.010 mg/l (Ref. 90). Under the minimum anticipated controlled flow at the site, with complete mixing and making no allowance for degradation to chloride ion, discharge concentrations of residual chlorine up to three times the planned Montague design level of 0.25 mg/l total residual chlorine could be tolerated without exceeding the water quality standard. This is greater than the discharge concentration considered likely to be necessary even if chlorination was used for cleaning the condensers as well as the remainder of the cooling water systems. Biocide usage at the site would not then be expected upon complete mixing to cause water quality criteria violations in the Connecticut River.

The discharge concentration used in this analysis, 0.25 mg/l is above levels considered to be toxic to some freshwater biota (Ref. 91) and, therefore, adverse water quality conditions in the immediate vicinity of the discharge could occur. This area is not anticipated to be either large or conducive to prolonged habitation by aquatic biota, so that adverse impacts, if any, are likely to be small. Site-specific studies of the performance of the discharge, the chlorine demand that exists in the Pilgrim plant design system under operating conditions, the chlorine demand of the Connecticut River water, and residual chlorine effluent levels may have to be performed to determine the size of the mixing zone

in which this constituent is above toxic levels. Mitigative measures are available to reduce concentrations and impacts in the receiving waters from this source so that this would not preclude siting the Pilgrim unit at Montague.

The combination of ambient metals concentrations in the intake and receiving waters and the concentrating effect of the closed-cycle cooling system is a potential disadvantage for the Montague site as compared to the Rocky Point site. Siting a closed-cycle plant at the Montague site has no apparent disadvantage over siting at Rocky Point with regard to water quality.

The effects of the thermal discharge from the cooling tower blowdown for the Montague Nuclear Power Station Units 1 and 2 were evaluated in the FES (Ref. 8). No adverse impacts due to thermal discharges were predicted due to rapid mixing and a high discharge velocity 4.3 mps (Ref. 8). The Commonwealth of Massachusetts similarly predicted no thermal impacts upon fisheries.

Due to the high velocity of the discharge and its small volume in relation to even minimum river flow, fish, if attracted to the plume, would not maintain themselves in the plume for sustained periods. For these reasons, neither cold shock nor gas bubble disease (GBD) related mortality would be significant, and furthermore, thermal blockage of the river would not occur (Ref. 8).

Whether or not the Montague site with the Pilgrim alternate unit utilizing closed-cycle cooling is judged to be environmentally superior to the Rocky Point once-through site is dependent, however, on the anticipated discharge-related impacts to the fishery at the Rocky Point site. Since the anticipated impacts to the fishery at the Rocky Point site is negligible, it is concluded that a single unit at the Montague site utilizing closed-cycle cooling is environmentally preferable but not environmentally superior to the Rocky Point site with respect to the impact of unit operation on the fishery of the receiving waters.

4.12.2 Terrestrial Ecology and Land Use

There are no Federal lands, national landmarks, State and local forests or critical habitat on the Montague site. However, siting a plant on the Montague site would preempt the use of a larger area of forest and wildlife habitat than it would at the Rocky Point site. Therefore, Montague is not preferable to Rocky Point.

Because there is more important farmland onsite than at Rocky Point, the Rocky Point site is preferable for this factor.

The two sites are equivalent for all other factors.

4.12.3 Demography

An examination of the population density data in Tables 1 and 9 shows that the Montague population densities are, with some exceptions, lower than the Rocky Point population densities. However, based on the population considerations discussed in Appendix A, we find that the population density of the Montague site is not significantly lower than the population density of the Rocky Point site, and therefore, we conclude that the Montague site is not preferred in comparison to the Rocky Point with respect to population.

4.12.4 Nearby Industrial, Transportation, and Military Facilities

A review of the industrial and transportation facilities in the vicinity of the Montague site indicates that the only facility of significance is the Turners Falls Municipal Airport 2 km north of the site. The staff found acceptable the Montague applicants' proposal to design the plant safety-related structures to withstand the impact of an aircraft weighing up to 6800 kg provided that there were no more than about 100 operations per year of aircraft weighing greater than 6800 kg. It would be necessary to verify that the safety-related structures of a plant could withstand the impact of a 6800-kg aircraft if a plant were to be located at the Montague site. We believe that an analysis would show that the plant's safety-related structures could withstand the impact of a 6800-kg

aircraft and, further, assuming that the applicants could obtain similar agreements with the airport operators concerning aircraft weight limitations and flight patterns, we believe there is reasonable assurance that the Pilgrim design would be acceptable for the Montague site. We conclude that with regard to external hazards, the Montague and Rocky Point sites are equivalent in that no significant external hazards have been identified at either site which would require additional safety features or strengthening of plant structures.

4.12.5 Hydrology

Since 1930, the United States Geological Survey (USGS) has maintained a gauging station at Montague City, about 2.5 km upstream from the proposed plant intake structures. Flow records through 1971 for the Connecticut River at this location are as follows (Refs. 44, 45, 92, 93).

Average annual flow	380 cms
Minimum daily flow	6 cms
Minimum 7-day flow of record	37 cms
7-day 10-yr low flow	49 cms

The Connecticut River Basin Coordinating Committee, in conjunction with the U.S. Army Corps of Engineers recommended that the Turners Falls Project (a hydroelectric dam and reservoir located just upstream) be

required to discharge at all times a minimum flow equivalent to 2.2×10^{-3} per square kilometer of drainage area.

Because the drainage area of the river is 18,552 square km at the dam, the minimum flow requirement would be 40.6 cms (Ref. 94). In a letter to the Federal Power Commission (FPC), the Western Massachusetts Electric Co., owner of the Turners Falls Project, indicated its intent to comply with this recommendation. A minimum flow of 40.6 cms would therefore be provided by continuously discharging through the generating units at the hydro station to supplement normal leakage. The Turners Falls Project, in effect, is an augmentation reservoir for the Montague project.

Because there will be a minimum of 40.6 cms flowing past the site and the plant would consumptively use only about 1.7 cms, it is expected that this flow reduction would not adversely affect downstream water users. The river is not used downstream for municipal supply.

We conclude that the Connecticut River will provide an adequate water supply and water use impacts will be minimal. No flood protection is required, since the site is located well above the river. No unusual intake or discharge problems are expected.

Based on the above, we conclude that there is no basis for favoring either the Rocky Point or Montague site over each other with regard to hydrologic engineering factors.

4.12.6 Socioeconomics

No displacement activity and no onsite historic resource intrusion is anticipated (Refs. 47, 77). An archaeological survey was conducted and the potential archaeological resources and artifacts within the site boundaries are to be recovered under an established program (Ref. 79).

The Montague site is situated on the Montague Plain which has been nominated for designation to the National Registry of Natural Landmarks. Such designation, however, does not restrict change. (Ref. 8).

The construction work force is expected to originate and commute mainly from the various communities in central and western Massachusetts as well as communities in southern Vermont and southern New Hampshire (Ref. 79). The potential traffic situation has been analyzed by a number of studies. (Ref. 8). A study performed for the Montague applicant analyzed anticipated traffic flows from all directions (Ref. 95). Seven major areas of potential flow restrictions were identified and involved substandard road designs and intersections related to the nearby communities of Greenfield, Millers Falls, Sunderland, North Amherst, and Turners Falls.

Pilgrim Unit 2, with a natural draft cooling tower and associated plume, located alongside the area set aside for the proposed Montague Units 1

and 2, also with natural draft cooling towers, would produce a visual intrusion into the area. The staff earlier concluded in its analysis of the proposed Montague Units 1 and 2 with natural draft cooling towers that the towers would produce "significant, long-term intrusive visual...impacts to the Montague area" (Ref. 8). Visual contacts could be expected from the historic Mohawk Trail, state parks, transportation corridors, and from residential, commercial, and institutional areas.

With respect to the socioeconomic factors considered, the Montague site is less preferable to the Rocky Point site in terms of visual impacts and traffic impacts.

4.12.7 Geology, Seismology, and Geotechnical Engineering

The Montague site is in an area of seismic risk similar to that at Rocky Point. However, because Montague is a bedrock site, it is regarded as more favorable for plant siting than the Rocky Point site.

4.13 Description of the Seabrook Site

The 283-ha Seabrook site is in the Town of Seabrook, New Hampshire, near the Atlantic Ocean (see Figure 9). The site is owned by Public Service Company of New Hampshire and the other joint owners of the Seabrook project, which propose to develop the site for two pressurized water

reactor (PWR) powered electric generating units, each with a capacity of 1150 MWe. The units will use a once-through cooling system. Projected operation dates for the units are 1982 and 1984.

Development of the Pilgrim Unit 2 (1,150 MWe) at the Seabrook site is considered both with a once-through cooling system and with a natural draft cooling tower. If developed, it would increase the total site generating capacity from 2,300 MWe to 3,450 MWe in 1985.

There are Federal lands, natural landmarks, State and local forest or critical habitat onsite. Uncleared portions of the site are predominantly upland mixed forest. Salt marsh occur on the north, east, and south of the site. Vegetation interface between salt marsh and upland forests is comprised of flora normally subjected to a high salt environment.

Upland site habitat is not unique for this coastal region except for a small area supporting a hemlock riverine community. Hampton Marsh is a highly valuable habitat for migratory birds. The site contains a small area (4 ha or less) supporting a hemlock-ravine plant community to be preserved.

The Hampton Marsh-estuary complex supports a wide variety of aquatic organisms. Within the State of New Hampshire, the only other estuarine area of significance to aquatic resources is the Piscataqua River-Great

Bay complex to the north. This complex, however, has only a few fringing marshes. (Ref. 96). Harvesting of lobster, green crab, soft-shelled clams, and marine annelids occurs in Hampton marsh. (Refs. 10, 97). In the State of New Hampshire, soft-shelled clams are taken primarily from the Hampton marsh, with the Piscataqua River-Great Bay estuary of relatively minor importance.

Species of fish of economic importance that use the marsh for spawning include winter flounder (Refs. 10, 98) and rainbow smelt (Ref. 98). Alewife and blueback herring are anadromous species known to utilize the upstream area of Taylor River for spawning (Refs. 98, 99, 100). Recreational fishing occurs within the marsh complex (Ref. 99) from the Route 1A bridge, and from the north jetty at the harbor entrance (Ref. 101).

Pre-existing aquatic stresses upon some fishery resources exist due to high commercial exploitation rates. The inshore lobster population in the Gulf of Maine is commercially exploited beyond its maximum sustainable yield and the soft-shelled clam populations of Hampton Marsh is being overharvested (Ref. 102).

Based on assigned water uses, the surface waters associated with the Seabrook site have been designated Class "B" by the State of New Hampshire (Ref. 103). The prescribed best uses and quality criteria of these waters are described by the Use Classification and Water Quality Standards for the State of New Hampshire.

Existing water quality along the New Hampshire coast and coastal tidal water basin in the vicinity of the Seabrook site is generally good. Current and previous studies of the area show that the water quality parameter of concern has been bacteria count and, to a lesser extent, dissolved oxygen concentration (Refs. 103, 104, 105). Point source discharges of untreated municipal and domestic wastes to coastal waters are cited from the towns of Newcastle, Rye, and North Hampton (Ref. 104). In a 1975 report (Ref. 105) raw domestic sewage discharges totalling 566 cubic meters per day were cited for the towns of Rye, North Hampton, and Hampton.

Comparison of data contained in the 1975 and 1978 reports of the NHWSPCC (Refs. 103, 105, 106) shows improvement in the bacterial water quality of Hampton Harbor and Hampton River to the extent that these waters now meet the Class "B" standards for this parameter. Available recent information indicates that the seawater coliform bacteria levels along the entire coastline of the State are within the limits established for Class "A" waters (Ref. 104). In recent studies conducted for the applicant (Ref. 10), offshore dissolved oxygen concentrations at the discharge site were shown to be high (ranging from 7.0 mg/l in November to 11.6 mg/l in March 1975). Saturation percentage values were consistently high (only one sample indicated a value below 80 %). Variations were related to planktonic photosynthesis, temperature and salinity, with homogeneous distribution within the water column noted

for any given time of the year. It is estimated that all of the waters of the State in the coastal basin will meet Class "B" standards by 1983 after application of planned abatement measures (Ref. 104).

The population distribution and population density within a 48-km radius of the Seabrook site are given in Table 11. The population figures shown in the table include the permanent resident population plus the seasonal population within 8 km of the site weighted with appropriate occupancy factors to reflect an equivalent permanent population.

The nearest industrial facility to the site is the Bailey Division of the USM Corporation, located about 1.6 km west-southwest of the site. Liquid propane is stored at the Bailey plant in two storage tanks, each containing 57 cubic meters. The other facility in the vicinity of the site whose operations involve hazardous material is the Rockingham Fireworks Manufacturing and Display Company, which employs 3 persons and is located about 2 km southwest of the site. The amount of hazardous material stored at the fireworks company is limited by State law. The nearest pipeline to the site is a 10-cm-diameter gas line about 1 km to the west.

The Boston and Maine Railroad line that passes through the exclusion area approximately 550 m from the plant structures is the closest transportation route. The railroad terminates 10 km south of the site and is

used infrequently. The nearest major highway is U.S. Route 1, which is located 1.6 km west of the site. Interstate 95 passes 2.5 km to the west, and U.S. Route 1A runs along the coast about 2.5 km east of the site. Hampton Harbor is not a deepwater port and the nearest shipping lane to the site is over 8 km offshore.

The nearest airport to the site is Hampton Airport, a privately owned general aviation facility located about 7 km north-northeast of the site. The airport has a 610-m turf runway and is used primarily by light, single-engine aircraft. The owner estimates that there are currently about 10,000 operations per year at the airport and has also confirmed that there are no plans to physically expand the airport (Ref. 107). The most significant aviation facility in the area around the site is Pease Air Force Base, which is located about 18 km to the north. Certain flying patterns at Pease, primarily radar-controlled approaches to runway 34, result in military aircraft passing over the site area. The staff has performed a detailed study of the aircraft operations at Pease during the Seabrook construction permit proceedings.

4.14 Staff Analysis of the Seabrook Site

4.14.1 Aquatic Biology and Water Quality

Construction Impacts: Each site was compared to the preferred site with particular attention directed to the following specific potential

construction impacts: (1) onsite stream diversions or alterations; (2) changes in site runoff during site development; (3) right-of-way (ROW) or water pipeline development; and (4) siltation due to dredging for barge facilities, intake/discharge structures, and pipelines.

The construction of the Pilgrim Unit at the Seabrook site is expected to be accomplished within the confines of the existing site boundaries for either an open-cycle or closed-cycle cooled plant (Ref. 77). In addition, construction of the Pilgrim units closed-cycle cooling system and its attendant structures at the Seabrook site would involve the same kinds of activities as for the once-through cooling system plant design. Because of this similarity in the construction activities and the affected area, the staff concludes that the potential water quality impacts associated with construction of the Pilgrim unit with either an open-cycle or a closed-cycle cooling system at Seabrook would be of the same types and comparable in magnitude to those previously considered by the staff in the Seabrook FES. Requirements for measures to mitigate these impacts would likely be the same as those described in the FES. Therefore, application of these mitigative control measures at the closed-cycle cooling system construction sites could reasonably be expected to preclude adverse impacts to offsite water quality.

Intake Effects: Intake effects to aquatic biota are primarily those impacts associated with impingement or entrainment. The magnitude of

intake effects associated with the operation of a third unit at Seabrook is dependent on the cooling mode selected. The selection of the once-through cooling option would require the construction of a new intake structure similar to the structure proposed for Units 1 and 2. The location of this structure would be near the location of the intake for Units 1 and 2. The velocity cap designed for the new intake, and the offshore location of the intake (2130 m), would minimize impacts associated with impingement and entrainment.

Due to the utilization of a velocity cap and the probable placement of the new intake structure, the incremental impingement rate associated with either once-through or closed-cycle cooling for the third unit is not considered to be significant. No detectable change in local populations due to impingement-related mortality is anticipated.

Once-through cooling at a third Seabrook unit is judged to be less environmentally preferable than a second unit at the Rocky Point site because of the proximity of the Seabrook site to the significant aquatic resources of the Hampton Marsh Estuary complex. Although the staff is of the opinion that a third once-through unit utilizing new intake and discharge structures would not result in a significant impact to the soft-shelled clam or any other planktonic population in the area, the Rocky Point site is still considered environmentally preferable due to lack of any nearby significant aquatic resources subject to impact by entrainment.

The closed-cycle cooling option at the Seabrook site, due to the much-diminished flow rates, would result in substantially less of an impact to aquatic biota from impingement and entrainment than would be experienced at the proposed Rocky Point site. Whether or not the Seabrook site, with a third unit utilizing closed-cycle cooling, is judged to be superior to the Rocky Point once-through site is dependent, however, on the anticipated impingement and entrainment related impacts to the fishery at the Rocky Point site. Since the anticipated impact to the fishery at the Rocky Point site is negligible, it is concluded that the Seabrook site with closed-cycle cooling is environmentally preferable (due to the reduced number of organisms impacted) but not necessarily environmentally superior to the Rocky Point site.

Discharge Effects: The evaluation of discharge effects at the Seabrook site for Unit 3 is limited to the a discussion of biocides and other compounds, discharge of waters differing in quality from the receiving waters, thermal loading, and mortality to aquatic organisms from gas bubble disease (GBD) and cold shock.

Discharge-related impacts on offsite water quality at Seabrook resulting from a closed-cycle cooling system have been evaluated by the staff in the FES (Ref. 10). The impacts categories considered were oxygen availability, chemical effluent effects on water quality, and effects on aquatic biota. They were found to be qualitatively the same as or less

than those for the once-through cooling system alternative at Seabrook. Neither cooling system type would likely interfere with State water quality management objectives at the site and vicinity.

Operation of the Pilgrim unit with open-cycle cooling at the Seabrook site could reasonably be expected to produce effluents similar to those considered by the staff for the Seabrook plant in the Seabrook FES. Low-volume chemical wastes (e.g., demineralizer regeneration wastes, primary and secondary coolant system wastes, and their makeup water treatment system wastes) would be discharged in the cooling water at very low concentrations as compared to ionic species concentrations in the receiving waters. No adverse effects on site water quality are expected from these sources.

Biocide treatment of the Pilgrim unit under the open-cycle cooling system option with a separate discharge at the Seabrook site could reasonably be expected to be found to require the same limitation on discharge concentration as was found by the staff in the Seabrook analysis (i.e., 0.1 ppm total residual chlorine or less at the diffuser outfall) (Ref.10). Adverse effects on water quality would not be expected from this source using a submerged diffuser.

Operation of an additional unit with a closed-cycle cooling system at Seabrook would result in higher discharge concentrations of naturally

occurring chemical species due to the concentrating effect of the evaporative cooling system. This would affect only a small area in the vicinity of the discharge due to the small discharge volumetric flow rate of the Pilgrim unit as compared to the two Seabrook units, the low concentration factor (e.g., 1.5), and the discharge design which provides for rapid mixing. Detectable adverse effects would not be expected. Biocide discharges from a closed-cycle cooling system would likely result in biocide presence for a longer time for each application as compared to an open-cycle cooling system because the discharge rate is small relative to the cooling system volume. For a combined discharge, the small anticipated increase in the size of the receiving water area affected by the additional Pilgrim unit with the closed-cycle option, along with the dispersion provided by the discharge, provides mitigation against toxic effects.

Whether or not the Seabrook site with a third unit utilizing closed-cycle cooling is judged to be superior to the Rocky Point once-through site is dependent, however, on the anticipated thermal loading related impacts to the fishery at the Rocky Point site. Since the anticipated impact to the fishery at the Rocky Point site is negligible, it is concluded that at third unit at Seabrook utilizing closed-cycle cooling is environmentally preferable but not environmentally superior to the Rocky Point site.

Since mortality to aquatic biota associated with GBD and cold shock can be effectively controlled by the use of mitigative devices at the Rocky

Point site and it is postulated that no significant losses to aquatic biota due to GBD or cold shock would occur at the Seabrook site with a third unit utilizing either closed-cycle or once-through cooling, the Seabrook site therefore cannot be judged environmentally preferable or superior to the Rocky Point site.

4.14.2 Terrestrial Ecology and Land Use

There are no Federal lands, natural landmarks, State and local forests or critical habitat on site. The staff considers Rocky Point and Seabrook to be equivalent for all terrestrial factors.

4.14.3 Demography

An examination of the population density data in Tables 1 and 10 shows that the population densities surrounding the Seabrook site are greater at almost all distances out to 48 km than the population densities surrounding the Pilgrim site both at the assumed date of initial plant operation (1985) and at the end of plant life (2020). Therefore, based on the population considerations discussed in Appendix A, we conclude that the Seabrook site is not preferred in comparison to the Pilgrim site.

4.14.4 Nearby Industrial, Transportation, and Military Facilities

The most significant facility in the area around the site is Pease Air Force Base, which is located about 18 km to the north. The staff performed a detailed study of the aircraft operations at Pease during the Seabrook review and concluded, based on a structural analysis which demonstrated the capability of the containment structure to withstand the impact of an FB-111 type of aircraft weighing 37,140 kg and flying at 515 km per hour, that the probability of an aircraft accident having consequences greater than the design basis accidents at the Seabrook Station is sufficiently low so as to present no significant hazard to the population in the area surrounding the site. We conclude that, with regard to external hazards, the Seabrook and Rocky Point sites are equivalent in that no significant external hazards have been identified at either site which would require additional safety features or strengthening of plant structures.

4.14.5 Hydrology

Since cooling water is to be withdrawn from the ocean, no supply problems are expected. Adequate flood protection can be provided. No unusual hydrologic problems have been identified related to construction and operation of a plant at this location. Overall, no basis exists for favoring the Seabrook site and the Rocky Point site are equivalent from a hydrologic engineering standpoint.

4.14.6 Socioeconomics

Pilgrim Unit 2 could be located next to Seabrook Units 1 and 2 with no anticipated displacement activity. There are no onsite historic or natural features listed on the national registers (Refs. 47, 48, 77). An archaeological survey of portions of the Seabrook site revealed material remains at five sites. Excavations were later conducted at three of the archaeological sites by the Department of Sociology and Anthropology of the University of New Hampshire for further analyses (Ref. 108).

The construction labor force is expected to originate and commute mainly from nearby areas such as Hillsborough, Rockingham, and Merrimack Counties of New Hampshire, and Essex, Middlesex, Norfolk, and Suffolk Counties of Massachusetts.

Workers driving from the north or south on I-95 would use Exit 1 and continue on State Route 107 to U.S. Route 1. Workers coming from the west would use a variety of roads intersecting with U.S. Route 1. The major congestion points would be at the intersections of U.S. Route 1 and the two access roads located to the north and south of Rocks Road.

The Seabrook site is situated on a peninsula of land known as the Rocks, which is located on the western side of the tidal marsh called Hampton

Flats. The station is clearly visible from various vantage points such as Locke Point, The Willows, Great Boars Head and points along Route 101E. The station is partially visible at points along Route 1A south to Salisbury Beach, Massachusetts.

Locating Pilgrim Unit 2 with a natural draft cooling alongside Seabrook Units 1 and 2, which are using once-through cooling modes, would increase the visual impact. The cooling tower over 150 meters high is more than twice the height of the tallest station buildings. The tower would be partially visible from the Governor Meshch Warehouse, which is about 2 km from the site and listed on the National Register of Historic Places and the recently nominated Edgerly Archaeological Site, which is less than 2 km from the site. The tower would also be partially visible at points along U.S. Route 1 depending on the tree cover and other structures obstructing the view. Locating Pilgrim Unit 2 with a once-through cooling mode alongside Seabrook Units 1 and 2, also using once-through cooling modes, would not appreciably decrease the existing visual ambience.

With respect to the socioeconomic factors considered the Seabrook site is less preferable to the Pilgrim site in terms of visual impacts relating to the cooling tower mode.

4.14.7 Geology, Seismology, and Geotechnical Engineering

The Seabrook site lies within the Boston-Cape Ann seismic zone. The staff has previously assigned the Seabrook site an intensity VIII and an acceleration value of 0.25 g (1975). However, the Rocky Point site has a acceleration value of 0.20 g. Based on seismic risk, the Seabrook site is not considered more suitable than the Rocky Point site.

4.15 Conclusion

Table 11 is a summary of the staff's perception of the environmental impacts at twelve sites based on reconnaissance-level information and the preceding discussions. Qualitative descriptors are used in this summary to briefly inform the reader of the staff's judgment of the degree of impact for those site and regional factors that entered into the staff's assessment. The comparative environmental evaluation uses the following rating:

(-) - a greater degree of impact than would be encountered at the Rocky Point site

(0) - about the same degree of impact as would be encountered at the Rocky Point site

(+) - a lesser degree of impact than would be encountered at the Rocky Point site

Table 11 shows that only in two technical areas have sites been rated with a (+) indicating a lesser degree of impact than would be encountered at the Rocky Point site. These areas are: terrestrial ecology and land use (farmlands); and aquatic ecology (impingement, entrainment, and discharge effects).

The staffs review of farmlands at the various sites indicate that Rocky Point has more land with the designated soil type than at Sites 18B, 18C, and 18E.

The (+) rating for the aquatic categories relates directly to the number of organisms being impacted. The (+)s are assigned to some of the sites with closed-cycle cooling systems. The reduced flow rate for the closed-cycle systems would impinge and entrain fewer organisms. The discharge would also impact a smaller area than would the discharge for the open-cycle system proposed for Pilgrim Unit 2 at Rocky Point. The (+)s assigned to the open-cycle mode at the Seabrook sites relate to the location of the intake structure. The staff assumed that the Pilgrim station located at the Seabrook site would use an intake of similar design and location to that proposed for Seabrook Units 1 and 2. The offshore intake would impact fewer organisms than the shoreline intake proposed for Pilgrim Unit 2 at Rocky Point. The (+)s do not bear on the significance of the impacts at the Rocky Point site, but relate only to the numbers of organisms that could be impacted. Pilgrim station has

previously been found to have a negligible impact on the fishery at the Rocky Point site.

With regard to the comparison factors considered in the staff's evaluation, none of the twelve sites reviewed exhibit characteristics that make them superior to the Rocky Point site, in fact may of the site appear to have combine deficiencies that would make them inferior to the Rocky Point site. The staff, therefore, concludes that none of the site reviewed are obviously superior to the Rocky Point site.

Figure 1: Potential Site Areas for Detailed Study

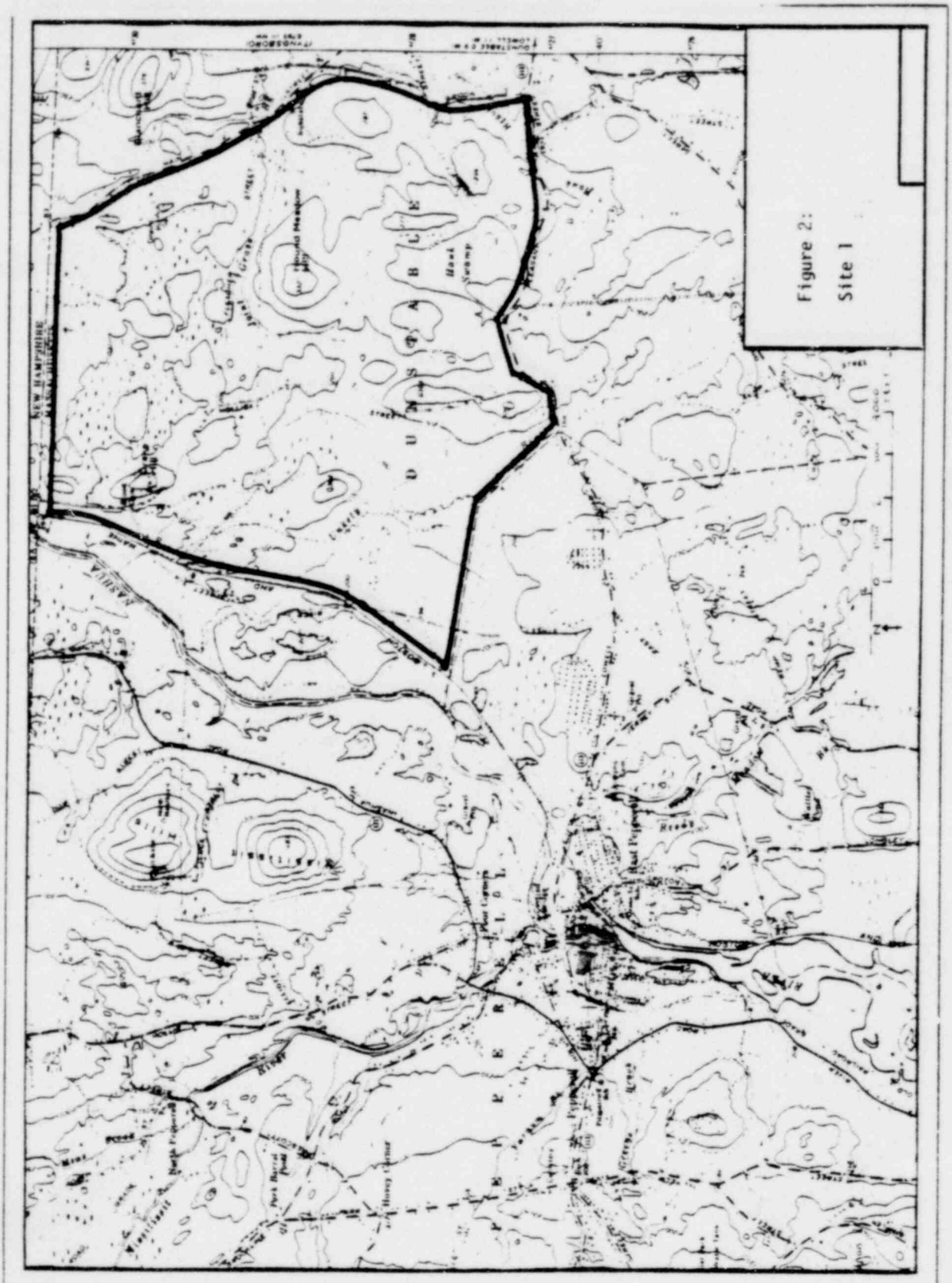
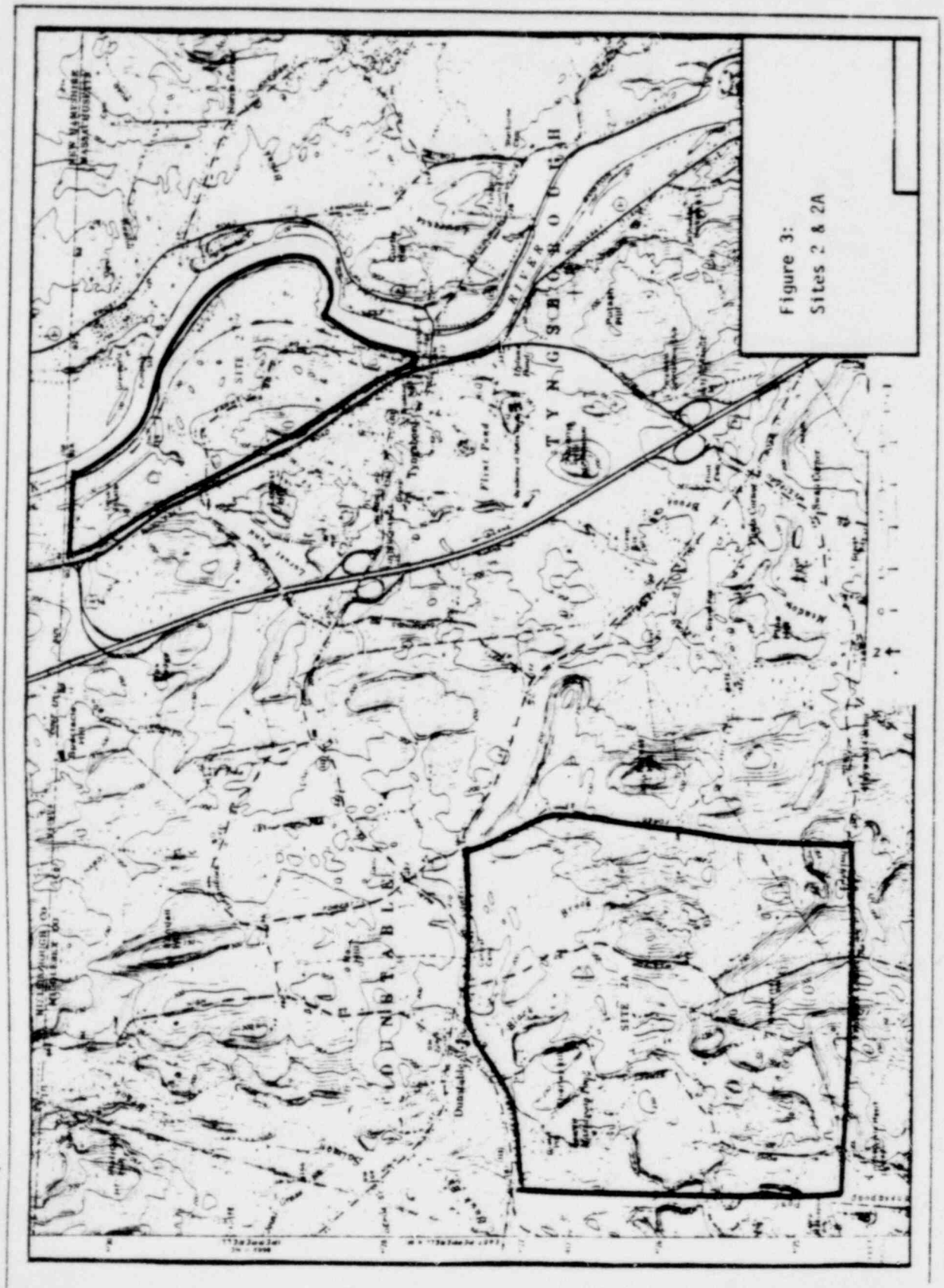


Figure 2:
Site 1


TYNGSBOROUGH
DUNSTABLE
SITE 2
SITE 2A
Figure 3:
Sites 2 & 2A

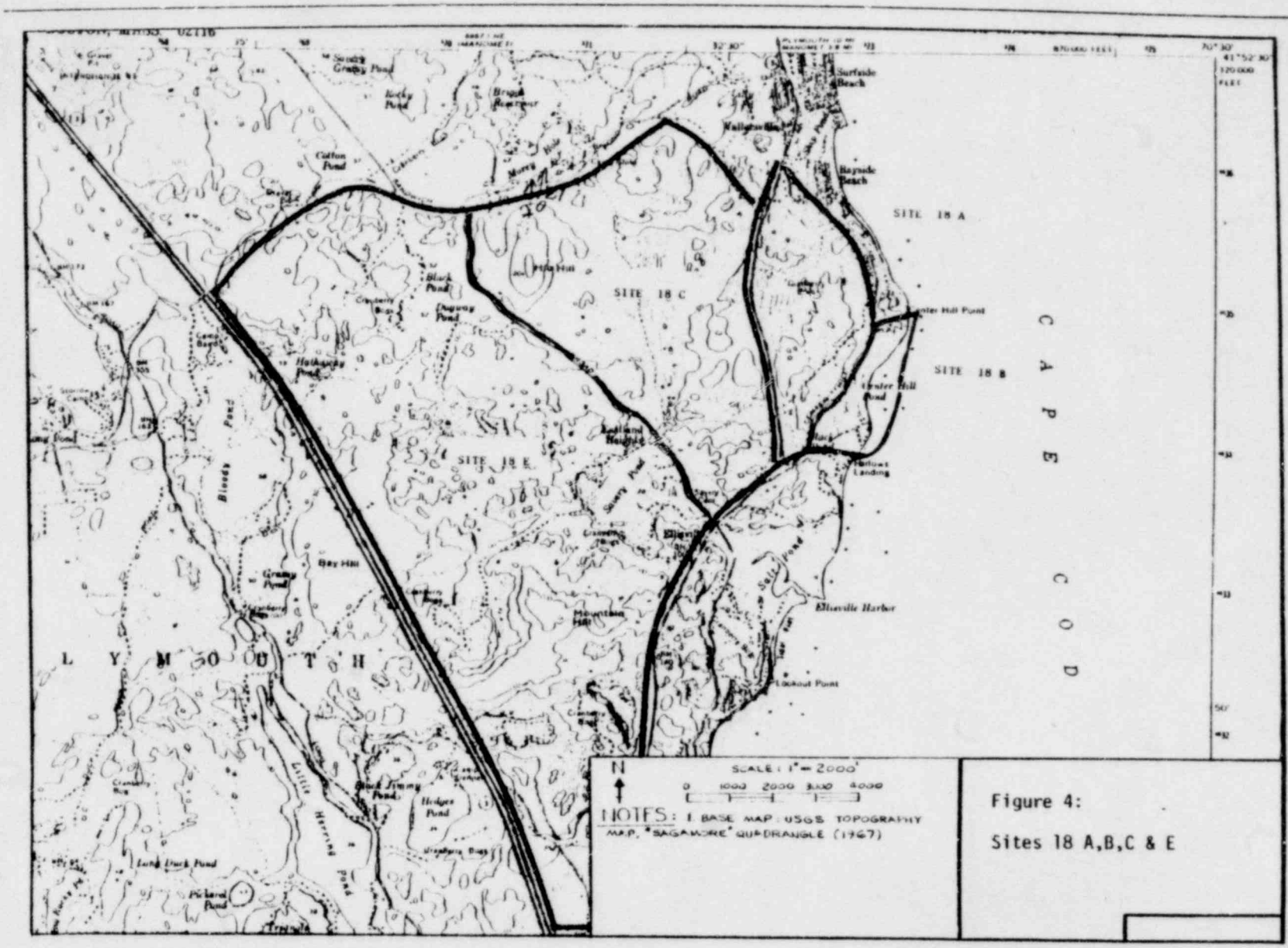


Figure 4:

Sites 18 A,B,C & E

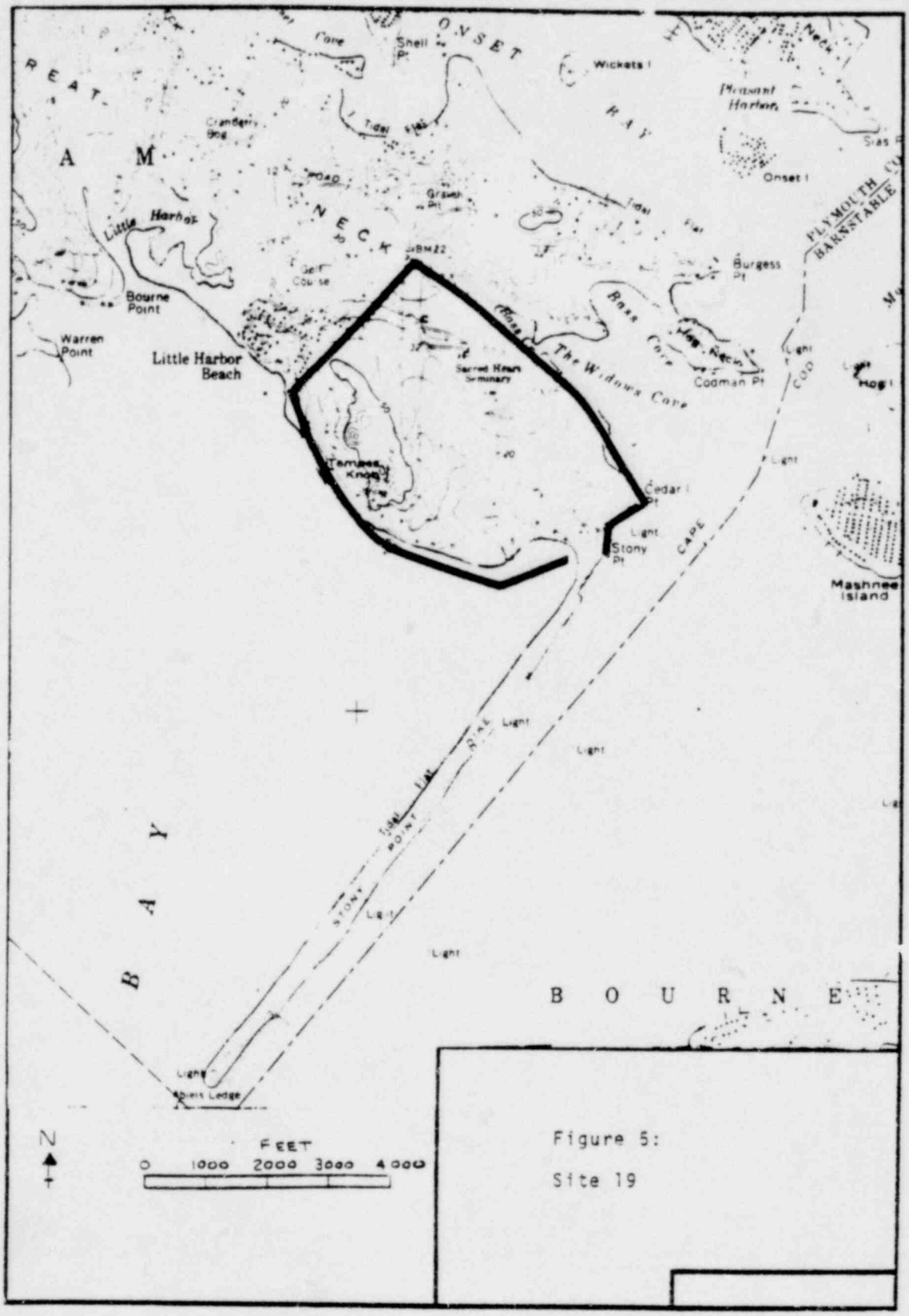


Figure 5:

Site 19

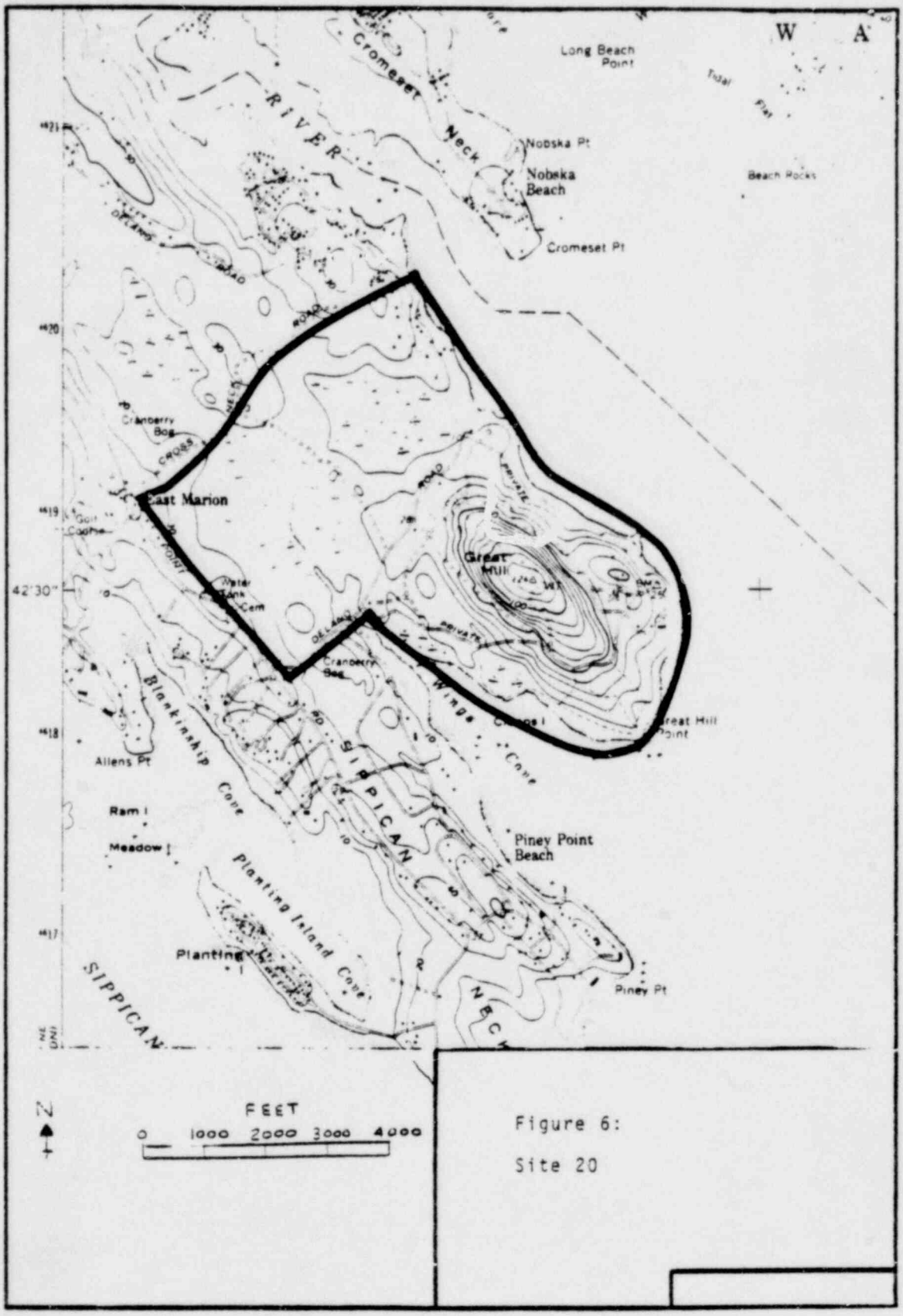


Figure 6:

Site 20

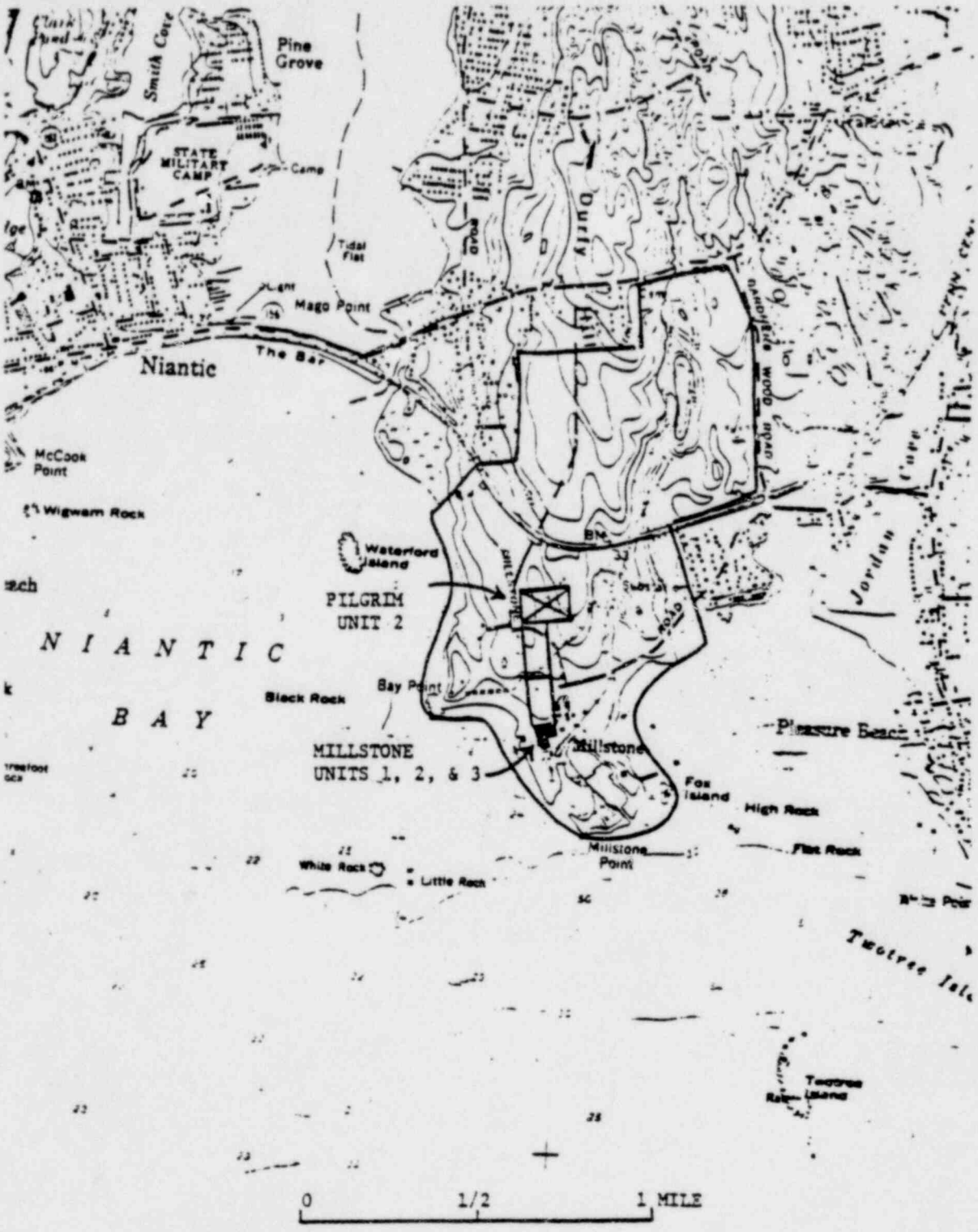


Figure 7: Millstone Site with Pilgrim Unit 2

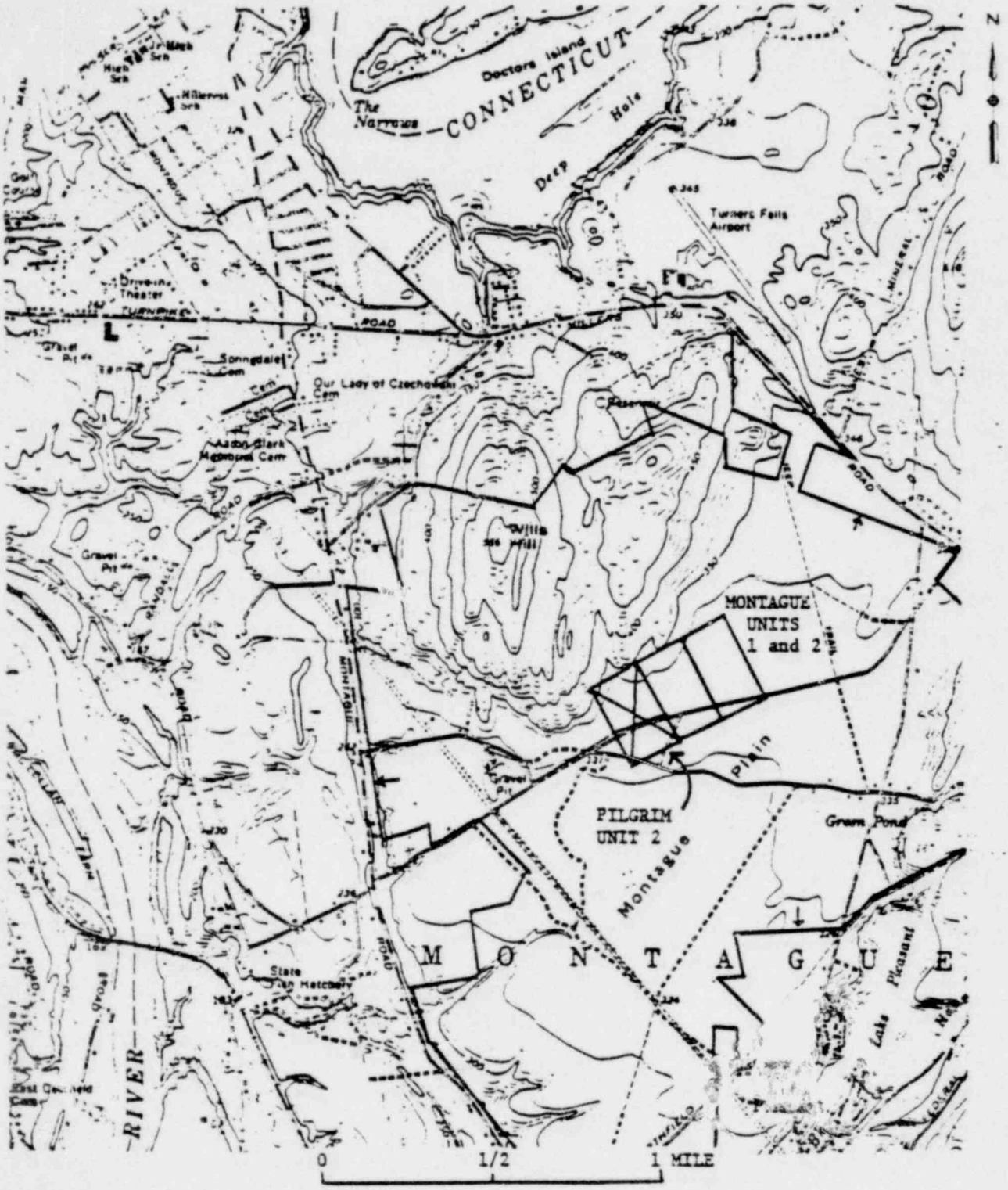


Figure 8: Montague Site with Pilgrim Unit 2.

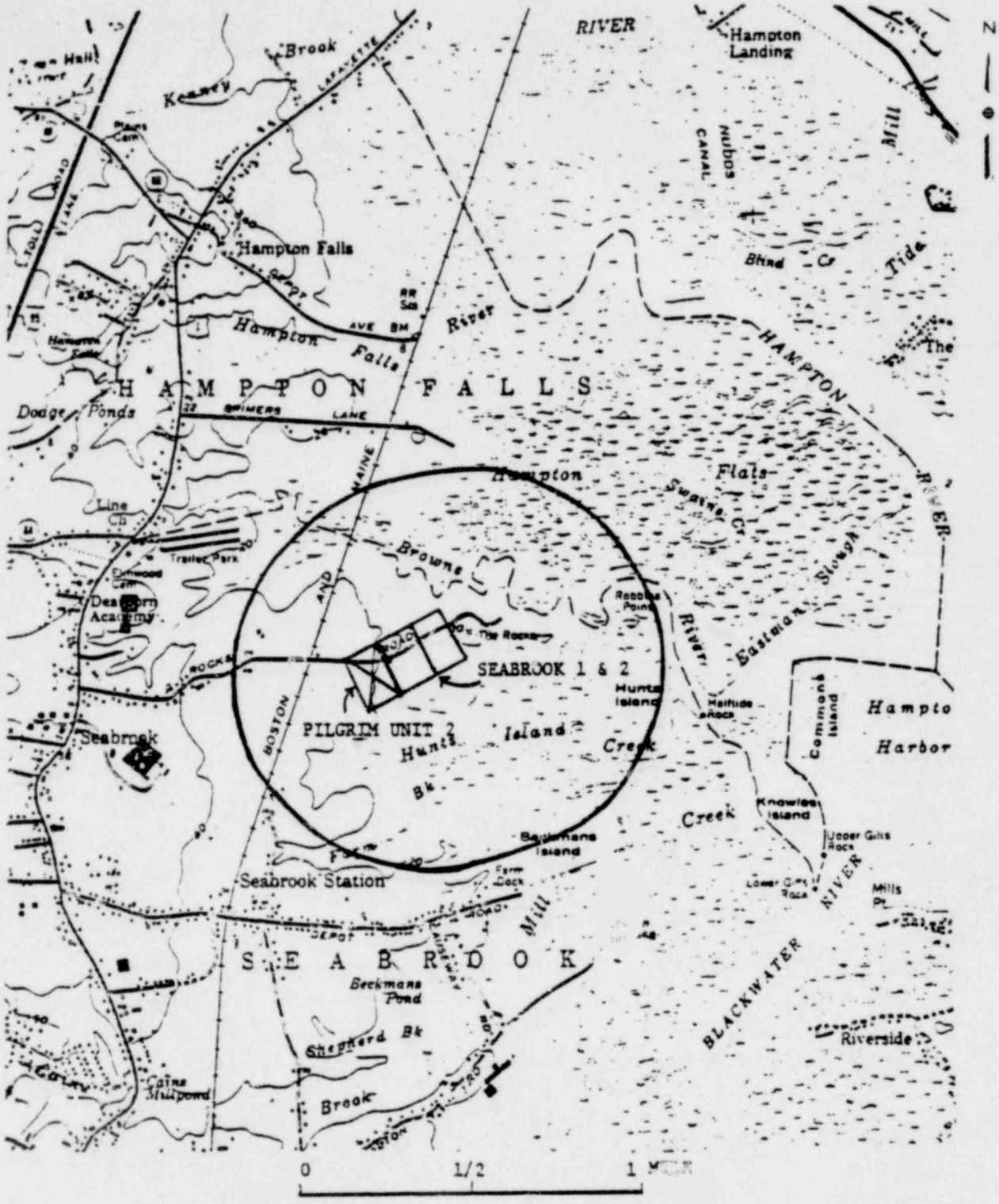


Figure 9: Seabrook Site with Pilgrim Unit 2.

TABLE 1

POPULATION DISTRIBUTION - PILGRIM SITE[1]

Distance km (miles)	Cumulative Population[2]			Population Density (people/mi^2)		
	1975	1985	2020	1975	1985	2020
0-2 (0-1)	433	559	1005	138	178	320
0-3 (0-2)	2238	3214	6397	178	225	508
0-5 (0-3)	5721	7931	13,879	202	280	490
0-7 (0-4)	9030	12,021	20,688	180	239	412
0-8 (0-5)	16,028	21,104	36,312	204	269	463
0-16 (0-10)	53,000	89,042	217,735	169	284	693
0-32 (0-20)	216,124	359,209	934,105	172	286	751
0-48 (0-30)	918,502	1,234,933	2,551,895	325	437	903

(1) Source: Pilgrim Station Preliminary Safety Analysis Report.

(2) Includes seasonal population weighted to reflect an equivalent permanent population.

TABLE 2

POPULATION DISTRIBUTION - SITE 1

Distance km (miles)	Cumulative Population			Population Density (people/mi²)		
	1970*	1985	2018	1970	1985	2018
0-8 (0-5)	21,429	29,500	38,188	273	376	486
0-16 (0-10)	130,595	193,320	300,959	416	616	958
0-32 (0-20)	711,086	979,176	1,497,799	566	780	1,193
0-48 (0-30)	1,984,102	2,463,497	3,415,875	702	872	1,209

*Bureau of the Census Data

TABLE 3

POPULATION DISTRIBUTION - SITE 2

Distance km (miles)	Cumulative Population			Population Density (people/mi²)		
	1970*	1985	2018	1970	1985	2018
0-8 (0-5)	50,336	65,444	85,069	641	834	1,084
0-16 (0-10)	248,843	331,022	462,181	792	1,054	1,472
0-32 (0-20)	841,122	1,149,621	1,754,886	670	915	1,397
0-48 (0-30)	2,774,519	3,328,898	4,400,811	982	1,178	1,557

*Bureau of the Census Data

TABLE 4

POPULATION DISTRIBUTION - SITE 2A

Distance km (miles)	Cumulative Population			Population Density (people/mi^2)		
	1970*	1985	2018	1970	1985	2018
0-8 (0-5)	28,160	38,491	52,226	359	490	665
0-16 (0-10)	239,665	317,269	449,477	763	1,010	1,431
0-32 (0-20)	815,354	1,117,506	1,724,887	649	890	1,373
0-48 (0-30)	2,673,312	3,238,389	4,316,832	946	1,146	1,528

*Bureau of the Census Data

TABLE 5

POPULATION DISTRIBUTION - SITE 18

Distance km (miles)	Cumulative Population			Population Density (people/mi²)		
	1970*	1985	2018	1970	1985	2018
0-8 (0-5)	3,430	7,258	15,710	44	92	200
0-16 (0-10)	30,631	61,440	124,891	98	196	398
0-32 (0-20)	138,823	262,347	523,300	111	209	417
0-48 (0-30)	587,978	857,753	1,370,555	208	304	485

*Bureau of the Census Data

TABLE 6

POPULATION DISTRIBUTION - SITE 19

Distance km (miles)	Cumulative Population			Population Density (people/mi^2)		
	1970*	1985	2018	1970	1985	2018
0-8 (0-5)	18,620	34,256	66,851	237	436	852
0-16 (0-16)	36,918	71,851	136,317	118	229	434
0-32 (0-20)	281,315	406,019	644,897	224	323	513
0-48 (0-30	604,153	835,004	1,303,733	214	295	461

*Bureau of the Census Data

TABLE 7

POPULATION DISTRIBUTION - SITE 20

Distance km (miles)	Cumulative Population			Population Density (people/mi²)		
	1970*	1985	2018	1970	1985	2018
0-8 (0-5)	12,223	23,771	55,582	156	303	708
0-16 (0-10)	53,145	86,126	156,985	169	274	500
0-32 (0-20)	275,374	373,470	568,744	219	297	453
0-48 (0-30)	722,207	975,659	1,492,257	256	345	528

*Bureau of the Census Data

TABLE 8

POPULATION DISTRIBUTION - MILLSTONE SITE[1]

Distance km (miles)	Cumulative Population[2]			Population Density (people/mi^2)		
	1970	1985	2010	1970	1985	2010
0-2 (0-1)	148	218	394	47	69	125
0-3 (0-2)	4,991	7,446	12,983	396	591	1,030
0-5 (0-3)	13,052	19,123	32,136	461	676	1,136
0-7 (0-4)	30,241	41,138	64,464	602	819	1,284
0-8 (0-5)	50,648	65,585	97,342	645	835	1,240
0-16 (0-10)	106,279	155,377	211,249	338	495	673
0-32 (0-20)	275,355	393,892	604,876	219	314	482
0-48 (0-30)	456,552	659,602	1,024,676	162	233	363

(1) Based on data from the Millstone Unit 3 Preliminary Safety Analysis Report.
(2) Includes seasonal population weighted to reflect an equivalent permanent population.

TABLE 9

POPULATION DISTRIBUTION - MONTAGUE SITE*

Distance km (miles)	Cumulative Population			Population Density (people/mi²)		
	1970	1985	2020	1970	1985	2020
0-2 (0-1)	147	163	191	47	52	61
0-3 (0-2)	2,892	3,181	3,744	230	252	297
0-5 (0-3)	8,734	9,598	11,296	309	339	399
0-7 (0-4)	16,708	18,351	21,601	333	366	430
0-8 (0-5)	26,436	29,028	34,167	337	370	435
0-16 (0-10)	40,563	45,350	53,091	129	144	169
0-32 (0-20)	146,364	175,339	229,256	117	140	183
0-48 (0-30)	454,923	505,896	660,246	161	179	234

*Based on data from the Montague Preliminary Safety Analysis Report.

TABLE 11. COMPARISON OF ALTERNATIVE SITES

Site Comparison Factors	Site 1, Closed Cycle	Site 2, Closed Cycle	Site 2A, Closed Cycle	Site 18A, Open Cycle	Site 18B, Open Cycle	Site 18C		Site 18E		Site 19, Closed Cycle	Site 20, Closed Cycle	Millstone		Montague	Seabrook	
						Closed Cycle	Open Cycle	Closed Cycle	Open Cycle			Closed Cycle	Open Cycle	Closed Cycle	Closed Cycle	Open Cycle
Water availability for plant operation	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0
Terrestrial ecology & land use:																
1. Dedicated areas	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0
2. Forests	-	0	-	-	-	-	-	-	-	-	-	0	0	-	0	0
3. Wildlife habitat	-	0	-	-	-	-	-	-	-	-	-	0	0	-	0	0
4. Farmlands	-	-	0	-	+	-	+	-	+	0	-	0	0	-	0	0
5. Wetlands	-	0	-	-	-	0	0	-	0	-	-	0	0	0	0	0
6. Floodplains	0	-	0	0	-	0	0	0	0	-	-	0	0	0	0	0
7. Transmission lines	-	-	0	-	-	-	-	-	-	-	-	0	0	0	-	-
Socioeconomics:																
1. Labor shed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Historic places	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Displacements	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0
4. Visual	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	0
5. Traffic	-	0	-	0	0	0	0	0	0	-	-	-	-	-	0	0
Demography	-	-	-	0	0	0	0	0	0	0	0	-	-	0	0	0
Hazards	0	0	0	0	0	0	0	0	0	-	0	-	-	0	0	0
Aquatic Ecology and Water Quality																
1. Presence of threatened or endangered species	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0
2. Standards compliance/ W. Q. stress presence at time of construction & operations	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Construction impacts on Water Quality and Aquatic Biota	-	-	-	0	0	0	0	0	0	-	0	0	-	0	0	0
4. Intake effects	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0
a. Impingement	0	0	0	0	0	+	0	+	0	-	-	+	-	+	+	+
b. Entrainment	0	0	0	0	0	+	0	+	0	-	-	+	-	+	+	+
5. Discharge effects on Water Quality and Aquatic Biota	0	0	0	0	0	+	0	+	0	0	0	+	-	+	+	0
Geology and Seismology	-	-	-	0	-	0	0	0	0	0	0	0	0	0	-	-
Meteorology	-	-	-	0	0	0	0	0	0	0	0	0	0	-	0	0

Legend: Superior +
Equal 0
Inferior -

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APPENDIX A

POPULATION CONSIDERATIONS

The Commission's criteria for determining the suitability of proposed sites for nuclear power plants are contained in 10 CFR Part 100. Proposed sites are required to meet certain tests related to the surrounding population. The objective is to assure that the potential consequences of postulated accidents do not pose an undue risk to the health and safety of the public. Although there are no specific regulations limiting population density in the vicinity of nuclear power plants, the Commission has had a long-standing policy of encouraging applicants to locate nuclear power plants away from densely populated areas.

As one means of assuring that this policy will be implemented, the staff has taken the position that sites with surrounding populations greater than the populations at Zion and Indian Point are not presently suitable for the location of nuclear power plants. With the passage of NEPA, the staff has included population as an important factor to be considered in the evaluation of alternative sites. Criteria on population density have been published in USNRC Regulatory Guide 4.7 (Revision 1, November 1975), "General Site Suitability Criteria for Nuclear Power Stations," for use in identifying suitable candidate sites. These criteria, which are not

part of the Commission's regulations but which do offer guidance on staff review practices, state with respect to population considerations the following:

"Areas of low population density are preferred for nuclear power station sites. High population densities projected for any time during the lifetime of a station are considered during both the NRC staff review and the public hearing phases of the licensing process. If the population density at the proposed site is not acceptably low, then the applicant will be required to give special attention to alternative sites with lower population densities.

"If the population density, including weighted transient population, projected at the time of initial operation of a nuclear power station exceeds 310 persons per square kilometer averaged over any radial distance out to 48 km (cumulative population at a distance divided by the area at that distance), or the projected population density over the lifetime of the facility exceeds 620 persons per square kilometer averaged over any radial distance out to 48 km, special attention should be given to the consideration of alternative sites with lower population densities.

"Transient population should be included for those sites where a significant number of people (other than those just passing through

the area work, reside part time, or engage in recreational activities and are not permanent residents of the area. The transient population should be taken into account by weighing the transient population according to the fraction of time the transients are in the area."

As indicated by the staff criteria, a site that exceeds these population density guidelines can nevertheless be selected and approved if, on balance, it offers advantages compared to available alternative sites when all of the environmental, safety, and economic aspects of the proposed site and the alternative sites are considered.

In comparing the population in the area surrounding the Rocky Point site to that of the alternative sites and in determining when there is a significant difference in population density, the staff recognizes that the population density of a site is a relatively crude measure of the residual risk associated with the accidental releases of radioactivity. The residual risk from any accidental releases would depend not only upon the population density of the site but also upon many other factors that would enter into the determination of the actual consequences of an accident.

Based upon limited studies performed to date, the staff concludes that population density, by itself, is a sufficiently crude indicator that

relatively large differences in the population densities between two sites would be required to exist before significant differences in residual risks at these sites could reasonably be expected. These studies indicate that population density differences by a factor of at least two or more would be required before significant differences in residual risk could reliably be expected.

Based upon the above considerations, the staff has adopted the following position for this study:

> In order to be regarded as having a "significantly lower" population density, an alternative site should have a population density that is at least a factor of two lower than a primary site at all incremental distances out to 48 km.

The staff has used this test in the present study comparing the population density characteristics of the alternative sites to the Rocky Point site.