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A Methodology for Power Plant Site Selection At the Reconnaissance Level

MATTHEW C. CORDARO, PH.D.
Manager, Environmental Engineering
Long Island Lighting Company
WILLIAM T. MALLOY
Vice President
Grumman Ecosystems Corporation

ABSTRACT

A methodology was developed and applied to identify the principal candidate sites at which major steam electric generating facilities to serve the Long Island area could be located. The selection criteria included not only economic and engineering considerations but social and environmental factors reflecting changing and often intangible public values. From a total of 68 candidate sites, five were selected through a series of steps in which analysis and judgment were combined to overcome the problems of preliminary information and uncertainty. These successive steps eliminated unsuitable sites on the basis of a qualification review and a preference review. A refined analysis of the favorable sites revealed patterns of value-free dominance among them.

Introduction

Land use on Long Island ranges from densely urban at the western end to rural open space at the eastern end, with the major part of Long Island Lighting Company's service provided to semi-urbanized or suburban areas. Continued growth in the area's population and increased usage by existing customers will expand the need for electric power during the coming decades. The growing public awareness of environmental values has been intensely felt on Long Island, and the recreational and aesthetic importance of its long coastlines are duly recognized.

The purpose of the study was to select several candidate sites for major steam electric generating facilities for the early 1980's. Candidate sites identified in the reconnaissance study will receive more detailed study to satisfy the objectives of

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the New York State Public Service Law for a Certificate of Environmental Compatibility and Public Need and the Atomic Energy Commission for a Construction Permit in the case of a nuclear facility.

Candidate Selection

Initial consideration was given to siting power generating facilities outside LILCO's service territory, including offshore areas, as well as areas throughout the service territory. A map of the region is shown in Figure 1. Nearby land areas outside LILCO's service territory are either highly urbanized with little undeveloped land, or would require prohibitively expensive underground and underwater construction of new transmission facilities. Furthermore, residents of other areas undoubtedly would resist siting new power plants serving only LILCO's customers. At the present time, offshore siting poses technical,

Figure 1.

environmental, economic, and jurisdictional questions that could not be reconciled in time to meet an operational need by LILCO before the mid 1980's.

Siting away from the shore would entail either lengthy intake and discharge pipes to seawater, or the use of fresh water from Long Island's groundwater reservoir for cooling. Long Island's groundwater is too scarce to be used as a source of fresh water makeup, whether cooling towers, cooling ponds, or spray ponds were used. Dry closed cycle systems, on the other hand, are not commercially available in the size required for large base-load generating units. Accordingly, the choice of cooling medium for power plants on Long Island must be seawater, and the high piping costs and associated environmental impact of inland siting restrict acceptable site choices to near-shore locations.

After eliminating further consideration of inland and offshore Long Island and regions outside LILCO's service area for practical siting purposes, a total of 68 specific candidate sites near the shoreline of Long Island were identified. Most of these sites had been previously considered in site reconnaissance studies in 1962 and 1970, having been selected from tracts of land indicated to be undeveloped on maps provided by the Nassau-Suffolk Regional Planning Board. Revisions of the site listing and new additions were made from a review of recent aerial photography.

The process of site selection from the 68 candidates was conducted in three main steps, using a qualification review, preference review, and recommendation review to reach a final choice of sites most suitable for further detailed investigations.

Table 1. Required Areas

Generating unit description	*Cooling means*	*Area required (acres)*
Two 1200 MW Nuclear Units:[a]	Once Through	225
	Natural Draft Cooling Tower	250
	Mechanical Draft Cooling Tower	250
	Spray Pond	325[b]
	Cooling Pond	3,600[b]
Three 800 MW Oil-Fired Units:	Once Through	150
	Natural or Mechanical Draft Cooling Tower	250
	Spray Pond	375
	Cooling Pond	2,550

[a] Based on a 1,400 ft. exclusion distance from containment.
[b] This area does not include the generating unit requirements. The area listed should not be directly added to the generating unit requirements, however, as a portion of the exclusion area can be used for the cooling or spray pond requirements.

Qualification Review

Each suitable site was required to be capable of accommodating 2400 MW_e of generation consisting of two 1200 MW_e nuclear units or three 800 MW_e fossil units, with assumed area requirements listed in Table 1.

The study found that, on Long Island, a major criterion limiting the number of qualified sites is the availability of sufficiently large tracts (150 acres) not already subject to other development.

Each of the 68 site candidates was reviewed for current status. In many instances, previously acceptable sites were found to be no longer available because of subsequent development or designation for park or conservation purposes. Furthermore, preservation of wetlands has received high priority on Long Island, contributing to many site disqualifications.

Of the 68 sites initially considered, 47 were thus disqualified from further review.

Preference Review

The 21 sites that survived the qualification review procedure all had sufficient area of undeveloped land not preempted for park or conservation purposes to warrant further investigation. In the preference review, these sites were classified as favorable or marginally favorable, taking the parameters listed in Table 2 into consideration. Color stereo aerial photography at a scale of 1:24000 was obtained for current data on the candidate sites.

The preference review eliminated sites that, although not unequivocally unsuitable, were likely to be highly controversial or very expensive. In particular, sites on Long Island's South Shore bays could create thermal problems in highly productive estuarine waters, even if cooling towers were used, and outfalls across the bays and barrier beach to the ocean would be extremely costly. Sites on Peconic Bay to the east, would have similar thermal problems. Other sites were considered marginal because of lengthy distance to cooling water, tortuous land access, proximity to sensitive residential or conservation areas, possible marsh encroachment, or extensive fill requirements.

After this screening, 11 sites remained that could be rated as favorable candidates.

Table 2. Evaluation Parameters

○ Area	○ Access by sea
○ Topography	○ Access to cooling water
○ Geology and soils	○ Access to bulk transmission system
○ Meteorology and air quality	○ Aquatic quality and ecology
○ Wetlands	○ Terrestrial ecology
○ Present use	○ Aesthetics
○ Overland Access	

Recommendation Review

All favorable sites were then investigated in greater detail, subjected to judgmental comparisons for the series of evaluation parameters previously listed using a matrix tabulation, rated on a scale of zero to minus 4 for degree of unsuitability in each parameter, and ranked by their unweighted score for relative siting suitability.

The 11 favorable sites were characterized by proximity to fast-flushing or deep water and the presence of little or no marshland. None of the sites was perfectly satisfactory in all respects, however, and each was derated for various deficiencies, no one of which would be expected to absolutely preclude site usage.

This type of rating where various diverse characteristics are compared cannot be established rigorously with complete satisfaction, depending as it does on judgment and values that are often highly subjective. However, it does provide a format by which others may apply their own weightings and judgments, if they disagree with those presented. The purpose of presenting these ratings was to add insight into the qualifications of the various sites, and to provide a means of ranking the most favorable sites.

The rating scale indicated the degree of deficiency, inconvenience, or controversy that could be expected for each site with respect to each characteristic. Those sites that were relatively most satisfactory for a particular attribute were rated 0, while those with increasing degrees of deficiency were given increasingly negative ratings. The rating scale was judgmental and should not be construed to represent analytical precision. However, a rating of -3 or more was meant to represent a fairly severe penalty with respect to a particular characteristic.

All of the favorable sites had a minimum area available of 250 acres. Thus there were no sites disqualified for lack of area for cooling towers (250 acres) while being qualified for once-through cooling (225 acres).

Cooling pond consideration was constrained by area requirements of 2550 to 3600 acres. The high cost and low availability of land in such quantity on Long Island make this cooling means prohibitive. Furthermore, cooling ponds would require the use of salt water, since fresh water supplies are insufficient for this purpose, and prevention of salt water percolation to the water table would be a serious problem.

Some sites were adaptable to accommodate spray ponds, if desired, the criterion being availability of 375 acres of relatively-level land. While such adaptability provides more engineering options for cooling technique, it was not considered in the comparative ratings. Sample ratings are shown for present use in Table 3, in which the site names are suitably coded.

The individual characteristic ratings for each site, as derived from the rating tables, were retabulated in a matrix as shown in Table 4, and the ratings summed

Table 3. Present Use Rating[a]

Site	*Discussion*	*Rating*
Mediterranean	8 homes on site	−1
States	8 homes on site; airport 2-1/2 miles away imposes structure height limit of 255' (MSL)	−2
Oriental	No homes on site	−1
Boardwalk	3 homes on site; extensive planning underway for proposed Planned Unit Development; expensive to acquire	−2
Baltic	4 homes on site	−1
Pacific	2 homes on site	−1
Atlantic	No homes on site; airport 4-1/2 miles away imposes structure height limit of 425' (MSL)	−1
Ventor	No homes on site; existing camp to be phased out; airport at 4-3/4 miles imposes structure height limit of 425' (MSL); owned by LILCO	0
Marvin	No homes on site; existing camp to be or already phased out; only site zoned for industrial use; owned by LILCO	0
St. Charles	9 homes on site	−1
Park Place	No homes on site	−1

[a] General: All sites meet an exclusion radius criterion of 1400', and would have no impact other than aesthetic on land uses outside the site boundaries. However, airports near some sites impose structure height restrictions on these sites, making them less flexible for power plant alternatives. Also, some sites would require acquisition of some homes existing within the site boundaries. Also derated if site purchase required.

to give a rough composite indication of site suitability. The sites were then given a comparative ranking, with the more negative the rating summation, the less suitable the site.

To account for two major uncertainties in evaluating site suitability, the summary ratings took into account some alternative assumptions. In each matrix, States was evaluated separately for good or poor foundation stability, which was indeterminate at this particular site without soil boring tests. The uncertainty is carried in the analysis of treating States as if it were two different sites: States 1 with good foundation stability, and States 2 with poor foundation stability.

Similarly, the aesthetic acceptability of overhead transmission over rural areas of Long Island could not be judged at the time of the study. Thus, separate matrices were prepared for two major alternatives for connection to LILCO's bulk transmission system: either overhead transmission would be permitted in rural areas (with results as shown in Table 4), or underground transmission would be required (with the results not reproduced here), the latter reducing somewhat the suitability of the more remote sites. The overall rank order of each favorable site is tabulated in Table 5.

Table 4. Summary of Site Characteristic Ratings[a]

Sites	*Area*	*Topography*	*Geology and Soils*	*Meteorology and Air Quality*	*Wetlands*	*Present Use*	*Overland Access*	*Access By Sea*	*Access to Cooling Water*	*Access to Bulk Transmission Systems*	*Aquatic Quality and Ecology*	*Terrestrial Ecology*	*Aesthetics*	*Rating Summation*	*Rank*
Mediteranean	0	0	0	0	−1	−1	−1	−1	−1	−1	−2	0	−1	−9	Tie for 6
States (1)	0	−2	0	0	0	−2	−1	−1	−1	−1	0	0	−2	−10	Tie for 8
(2)	0	−2	−4	0	0	−2	−1	−1	−1	−1	0	0	−2	−14	12
Oriental	0	0	0	0	0	−1	−1	−1	−1	−2	−2	0	−1	−9	Tie for 6
Boardwalk	0	0	0	0	−1	−2	−3	−1	−1	−3	−1	0	−1	−13	11
Baltic	0	−3	0	0	0	−1	0	−1	−1	0	−1	0	−1	−8	5
Pacific	0	−4	0	0	0	−1	0	−2	−2	0	−2	0	−1	−12	10
Atlantic	0	−4	0	0	0	−1	0	−2	−1	0	−1	0	−1	−10	Tie for 8
Ventnor	0	−1	0	0	−1	0	0	0	0	0	−2	0	0	−4	Tie for 1
Marvin	0	0	0	0	0	0	0	−1	−2	0	−1	0	0	−4	Tie for 1
St. Charles	0	0	0	0	0	−1	0	−1	−2	0	−1	0	−1	−6	3
Park Place	0	−2	0	0	0	−1	0	−1	−1	0	−1	0	−1	−7	4

[a] Overhead transmission through rural areas is assumed to be acceptable.

(1) good foundation
(2) poor foundation

Table 5. Overall Rank

Sites	*Rank*
Ventnor	tie for 1st
Marvin	tie for 1st
St. Charles	3rd
Park Place	4th
Baltic	5th
Mediterranean	tie for 6th
Oriental	tie for 6th
States 1	tie for 8th
Atlantic	tie for 8th
Pacific	10th
Boardwalk	11th
States 2	12th

Dominance

Review of the ratings revealed two types of relationships between pairs of the eleven favorable sites. In some cases, one site proved to be inferior to another judged by one or more parameters, and superior in none. The preference for the dominant site is thus value-free; i.e., the choice is independent of how important any one parameter is judged to be compared with another.

In Table 6, dominance relationships are combined with the previous rank order. Rank order is shown by vertical location in the table, decreasing as a staircase diagonally across the page; dominance relationships are shown in the same column. Five of the sites were thus found to be dominated by one or more of the others; specifically:

St. Charles is dominated by Marvin

Baltic is dominated by Park Place

Atlantic is dominated by Baltic and Park Place

Pacific is dominated by Atlantic, Baltic, Park Place, St. Charles, and Marvin

States 2 is dominated by States 1

Regardless of the relative importance of one parameter with respect to the others, as we have noted, the five dominated sites can be eliminated from the final evaluation. Notice that this eliminates sites which, judged by rank order alone, would be contenders; namely, St. Charles (which ranks third); and Baltic (which ranks fifth). Among the remaining dominant sites, on the other hand, the choice is influenced by the relative importance of the parameters affected.

On comparing Ventnor with Marvin, for example, it is apparent that neither site dominates the other. Ventnor is superior from the standpoint of access by sea and access to cooling water; Marvin is superior from the standpoint of topography, wetlands, and aquatic quality and ecology. The choice between the two therefore depends upon the relative importance of these parameters as well as the extent of the impact.

There are areas, therefore, in which further study is required in order to make a selection among the final candidates. Further attention will be given to the top five dominant sites shown boxed in Table 6: Ventnor, Marvin, Park Place, Mediterranean and Oriental.

States and Boardwalk are regarded as being too far down the list to deserve further study. In view of the availability of preferable sites, the uncertainty as to States' foundation stability will go unresolved as research is directed to the more significant factors influencing the comparison of the five top sites.

Similarly, the uncertainty as to the admissibility of overhead transmission lines in rural areas does not significantly affect the outcome. While it breaks the tie in rank order between Ventnor and Marvin, both of these are too attractive for one or the other to be dropped from further consideration at this stage. The

Table 6. Dominance and Rank Order Relationships of Finalists

Rank Order of Sites	*Columns of Value-Free Dominance*						
1	Ventnor	Marvin					
2							
3		St. Charles					
4			Park Place				
5			Baltic				
6				Mediterranean	Oriental		
7							
8			Atlantic			States 1	
9							
10		Pacific	Pacific				
11							Boardwalk
12						States 2	

only other effect is to reverse the rank order of Pacific and Boardwalk, neither of which is among the top contenders.

Conclusion

Within the scope of a reconnaissance study, a further refinement among the five selected sites does not appear to be justified. On the basis of this preliminary information and coarse judgments as to the extent of impacts, any scheme for "weighting" the values of the several parameters would tend to obscure rather than clarify the choices to be made. The final choice of a site is best made by a more detailed study with a side-by-side comparison using more detailed data than that developed in the reconnaissance study. The best choice will depend in part upon the public's perception of environmental and social values, an uncertain and changing set of standards. The purpose of a reconnaissance investigation is satisfied when sixty-eight candidates have been screened to identify those five deserving further detailed analysis.