APPENDICES

APPENDIX A : LEGISLATIVE AND REGULATORY RESPONSIBILITIES

Federal Laws

National Park Service Organic Act (1916) was passed in 1916 and the National Park Service was created. As the act clearly states, the National Park Service has the responsibility to:

> promote and regulate the use of the Federal areas known as national parks, monuments, and reservations ... conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations. (National Park Service Organic Act, 16 USC 1).

Legislation in reinforcing this act states that all parklands are united by a common purpose, regardless of title or designation. Under this law, all water resources of the park are protected by the federal government. Only an act of Congress can change this fundamental responsibility of the National Park Service.

Public Law 87-126: Cape Cod National Seashore Enabling Legislation (August 7, 1961) provides for the establishment of the Cape Cod National Seashore. The legislation provides a detailed description of the lands included within the National Seashore boundaries:

> Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the area comprising that portion of the land and waters located in the towns of Provincetown, Truro, Wellfleet, Eastham, Orleans, and Chatham in the Commonwealth of Massachusetts, and described in subsection (b), is designated for establishment as Cape Cod National Seashore.

Safe Drinking Water Act (1974) and Amendments (1986) set national minimum water quality standards. This law requires regular testing of public drinking water supplies.

Federal Water Pollution Control Act (Clean Water Act) 1972 and Amendments (1977,1987) provide for actions needed to restore and maintain the chemical, physical, and biological integrity of the nation's waters.

Coastal Zone Management Act (1972) and Amendments (1990) provide coastal states with assistance in careful protection and development of the coastal zone.

Water Quality Improvement Act (1970) requires federally regulated activities to have state certification stating that the activity will not violate water quality standards.

National Environmental Policy Act (1969) requires that all major federal actions which significantly effect the quality of the human environment be evaluated by an environmental impact statement which is reviewed by the public and approved by a federal agency.

Executive Orders on Wetlands and Floodplain Management, and Pollution Control (1977) - Executive Order 11990, "Protection of Wetlands" requires all federal agencies to minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Federal agencies must avoid activities which could adversely effect the integrity of a wetland ecosystem unless no other practical alternative exists. Executive Order 11988, "Floodplain Management" requires federal agencies to implement floodplain planning and properly mark where flood plains occur in order to increase public's awareness of flood hazard areas. Executive Order 11752 requires the Park Service to exercise leadership in the prevention, control, and abatement of environmental pollution from activities including sewage treatment and disposal, disposal of solid waste, and electrical power generation.

Massachusetts State Laws

Massachusetts Clean Water Act (Mass. G.L. Chapter 21, Section 26-53) is a set of regulations which classifies all surface waters of Massachusetts and sets minimum criteria for water quality. These water quality standards designate all surface waters in and adjacent to the Cape Cod National Seashore as National Resource Waters (Regulation 4.4 of the Massachusetts Water Quality Standards). This regulation is meant to preserve the value of surface waters by prohibiting all new additional pollutants and requiring the elimination of existing discharges unless alternative means of disposal are not reasonably available, or unless the discharges do not affect the quality of the water as a natural resource.

Ocean Sanctuaries Act, 1978 (Mass G.L. Chapter 132A, Section 13-16 and 18) establishes the Cape Cod Ocean Sanctuary, which completely surrounds Cape Cod National Seashore. Under this designation, certain activities such as excavation, drilling, construction and dumping are prohibited within the sanctuary.

Massachusetts Wetlands Protection Act (Mass. G.L. Chapter 131, Section 40) gives local Conservation Commissions the authority to protect wetland areas as well as consider impacts on public water supplies and marine resources in their review of proposals for activity in or adjacent to wetland areas. The Wetland Restriction Acts (Mass G.L. Chapter 131, section 40A and Mass. G.L. Chapter 130, section 105) allow the Commissioner of the Department of Environmental Management (DEM) to place deed restrictions on development in significant inland and coastal wetlands.

Massachusetts Community Sanitation Program (Mass. G.L. Chapter 111, State Environmental Code, Title 5) enables Massachusetts Department of Environmental Protection (DEP) and local Boards of Health to set standards and issue permits for subsurface discharge for the protection of water quality from subsurface waste disposal.

Colonial Ordinance of 1641, amended 1647 states that a pond greater than 10 acres located within the Commonwealth of Massachusetts is a "great pond". Under this designation, the title of the pond bed is held under the jurisdiction of the Commonwealth. Massachusetts has the right to control and regulate the use of the great ponds and can limit their use under certain circumstances.

APPENDIX B: SPECIAL DIRECTIVE 78-2

To: Field Directorate and all Park Superintendents

From: Director

Subject: Sale or lease of services, resources or water available within an area of the National Park System

Section 3(e) of Public Law 91-383, 84 Stat 827, authorizes the Secretary to enter into contracts which provide for the sale or lease to persons, States or their political subdivisions, of services, resources, or water available within an area of the National Park System if such person, State or its political subdivision:

1. Provides public accommodations or services within the immediate vicinity of an area of the National Park System to persons visiting the area; and,

2. Has demonstrated to the Secretary that there are no reasonable alternatives by which to acquire or perform the necessary services, resources, or water.

On the basis of the Assistant Solicitor's comments and findings, which are applicable Servicewide, see enclosed February 2, 1978 memorandum, relative to Public Law 91-383, the November 24, 1970 "Standards for Implementation" memorandum signed by former Director Hartzog is hereby rescinded. The revised standards for implementation of New Authorities under Public Law 91-383 are as follows:

> In the granting of permits for services, resources or water, the Directors of the Regions will have exercised this authority satisfactorily when the following conditions have been met:
>
> 1. The services provided by the applicant are of direct benefit to the park, or to the National Park Service for the direct or indirect benefit of park visitors;
>
> 2. It has been determined that the applicant has no reasonable alternative to the use of park resources or services;
>
> 3. Effects of use of the resource or service on the park's environment, administration, management and protection, and visitors have been examined and these effects have been determined to be acceptable. The environmental impacts of the use or service will be assessed and an environmental impact statement prepared if required according to NPS Guidelines for Environmental Assessment and Statements;
>
> 4. When it is determined that use of water by the applicant will be in accordance

with laws and regulations governing ownership and use of Federal water and rights;

5. Charges have been established for services, resource or water use that permit recovery of the full cost to the government of providing the services, resource or water use in accord with 31 U.S.C. 483 a and OMB Circular A-25;

6. An application docket containing a draft of the special use permit, background materials and recommendations has been received by the Washington Office for submission to appropriate congressional committees for review and concurrence prior to consummating any legally or morally binding commitments. The application docket should reflect multidisciplinary regional involvement and clearance of the proposed application.

7. The permitted use is for a short term period (one year or less) and is revocable at the discretion of the Secretary at any time without compensation and no permanent property rights are conveyed to the user for any resource or water within an area of the National Park Service. Water use agreements provide for National Park Service review and approval of planned development by the applicant that would create increased water demands.

It should be emphasized, that while Public Law 91-383 conditionally allows the Secretary of Interior to authorize the sale of services, resources or park water, the Secretary's primary commitment, as mandated by the Congress, is the preservation and protection of National Park System resources which includes the conservation of System area water resources and related water dependent environment. In this regard, Service management policy limits water development and use, assuming no adverse impact on the natural environment, to the minimum required to meet visitor and employee water needs. In essence, water is a vital part of the park environment and a natural resource the Service is committed to protect and in reality cannot be "excess" or "wasted" water, as viewed by some applicants.

APPENDIX C: GROUND WATER MODELING

Summary of Groundwater Modeling on Cape Cod

Management of ground water resources is made difficult by several problems: (1) hydrologic properties of aquifers are fundamentally dependent on geology, and their determination is usually complex and expensive; (2) local stresses can have regional hydraulic effects on an aquifer; (3) ground water movement is slow, and therefore, the consequences of management decisions may not be seen for decades, at which time, the results may be irreversible; and, (4) ground water can not be observed directly and must be inferred from indirect measurements and abstract mathematical reasoning (Guswa and LeBlanc, 1981).

Computerized ground water models attempt to circumvent these difficulties and simulate aquifer dynamics as accurately as possible. The aquifer is divided into discrete blocks or cells, each of which is assigned an approximating finite difference equation to describe flow into and out of it. A computer is utilized to simultaneously solve large numbers of these equations and converge on a numerical answer and to calculate the hydraulic head in the aquifer at specified locations under specified conditions. The hydraulic properties, boundaries and water budget for the model area must be defined and used as input data for the model. The reliability of the model is dependent on the accuracy of the input data, the size of the aquifer element which the flow equations describe, and the discretization scheme (scale of the blocks within the model grid) (Guswa and LeBlanc, 1981; Barlow, 1994a). The model scale determines the level of detail at which hydrogeologic boundaries can be represented, the accuracy of velocity calculations, and the ability to represent internal boundaries and sinks accurately (Barlow, 1994a).

Many of the input variables in the computer simulations are unknown or at least imprecisely known. Of these, recharge and hydraulic conductivity are probably the most influential (Masterson and Barlow, 1994). Most ground water models broadly apply an average recharge value over a wide area and a long time period rather than accurately reflecting recharge variability. Average recharge is estimated principally by observing precipitation records rather than directly observing recharge. Hydraulic conductivity is exceptionally spatially variable and must be estimated over broad areas based on limited point data and an interpretation of the geologic processes that formed the deposits. There are few deep boreholes on the lower Cape to provide the necessary subsurface information (Masterson and Barlow, 1994; Barlow, 1994a; Guswa and LeBlanc, 1981). Estimates of hydraulic conductivity are, however, limited to a range of values experimentally determined at various locations on the lower Cape. Horizontal conductivity ranges between 100 to 300 feet per day with a large horizontal to vertical conductivity ratio between 10:1 and 30:1. Vertical conductivity through silt and clay lenses has been estimated to range from 10^{-5} to 10^{-3} feet/day (Guswa and LeBlanc, 1981; Masterson and Barlow, 1994). Both recharge and hydraulic conductivity are adjusted in the calibration procedure in order to minimize the differences between observed and computed head values at specific locations. Model accuracy might be improved if recharge rates and hydraulic conductivity were better constrained.

Two types of computer ground water modeling programs have been used to model the lower Cape lenses. Most models have been developed in MODFLOW, the modular, three-dimensional, finite difference, single fluid flow model created by McDonald and Harbaugh (1988) of the U.S. Geological Survey. The model can be used to predict the response of the system to any variety of stress scenarios. On the lower Cape, the program has been used to simulate water table declines, freshwater discharge reductions, zones of contribution for a well, and travel times to a well. SHARP, the three-dimensional, finite difference, dual fluid flow model developed by Essaid (1990) of the U.S. Geological Survey has been used to simulate the movement of the freshwater-saltwater interface in response to pumping (Masterson and Barlow, 1994; Sobczak and Cambareri, 1995).

Conceptual Modeling - Lower Cape Ground Water Models

Guswa and LeBlanc, 1981

Guswa and LeBlanc (1981) created the first computer simulations of the lower Cape lenses using a predecessor of MODFLOW. In their models they utilized a set of assumptions and basic input parameters that have been more or less mimicked by all subsequent modelers. Their model is three-dimensional, because existing hydrogeologic information indicated that the aquifer was too variable for two-dimensional modeling, and steady state, because there were not sufficient long- term records of head and stress changes to accommodate a transient model. The model's approximation of the fresh water-salt water interface as a static, no flow boundary is valid only for equilibrium conditions (Guswa and LeBlanc, 1981). Eighteen inches of average annual recharge were applied universally across the land surface except in dry low lying areas, where recharge was reduced by 10 percent to approximate the effect of locally high evapotranspiration rates, and submerged low lying areas, which were treated as discharge zones with no recharge capability. Additional artificial recharge was simulated to occur in areas where the water disposal site is not in the same model cell as the withdrawal site (i.e., disposal lagoons of wastewater treatment plants and private homes serviced by public water but using a private septic system) (Guswa and LeBlanc, 1981). The models were calibrated to steady state conditions by comparing calculated values with 150 observed head measurements, 27 positions of the fresh water-salt water interface, and 2 measurements of ground water discharge rates. Model head calculations at most locations are within a few tenths of a foot of observed measurements and only a few are off by more than a foot (Guswa and LeBlanc, 1981).

LeBlanc (1982) utilized the model to assess the impacts of ground water withdrawals on water table elevation, aquifer discharge, and movement of the fresh water-salt water interface. The model indicated that, except in the immediate vicinity of the pumping wells, changes in water levels caused by simulated ground water withdrawals are smaller than the water table fluctuations caused by seasonal and long term recharge variability. Average modeled water table elevations declined less than 0.6 feet in the Pamet lens under the following scenarios: (1) with only Test Site #4 Wellfield running between 0.75 MGD and 1.08 MGD; (2) with Knowles Crossing and North Truro Air Base running at the 1979 average year round rate of 0.88 MGD; (3) with combined pumping from all four wellfields at the 1979 average summer rate of 1.44 MGD (LeBlanc, 1982). LeBlanc suggested that water table elevations within 700 feet of the pumping wells may decline by more than a foot, but the model grid resolution was not fine enough to quantify these changes. Aquifer discharge to Pilgrim Lake and the Salt Meadow area was decreased by more than 50 percent in the peak summer pumping scenario and by as much as 20 percent in the 0.88 MGD average pumping scenario (LeBlanc, 1982). Large withdrawals of 1.0 MGD at Test Site #4 were modeled to interfere with withdrawals from Knowles Crossing and contribute to saltwater intrusion at both wellfields. Modeled changes in the position of the fresh water-salt water interface were greatest in the immediate vicinity of the wells (LeBlanc, 1982).

Wilson and Schreiber, 1981

This model is also a MODFLOW predecessor and uses a similar protocol and set of assumptions as the Guswa and LeBlanc work. The regional impacts of ground water withdrawals were modeled to be similar to the impacts of recharge reduction. Freshwater discharge to streams and marshes is shown to be more sensitive to long term changes in natural recharge than changes in water table elevations, fresh water-salt water interface depths or freshwater storage volume. When modeled recharge dropped from 18 inches per year down to 12 inches per year, a 33 percent "drought" reduction, total freshwater discharge dropped a full 33 percent in order to preserve the freshwater mass balance. Local discharges to the Pamet River and Little Pamet River were reduced by more than 50 percent. In contrast, the freshwater volume in storage dropped by only 16 percent, the water table declined 20 percent and the interface rose about 20 percent of the way to mean sea level (Wilson and Schreiber, 1981). Simulated ground water withdrawals at maximum "safe yield" from either Long Nook Road or South Hollow produced smaller reductions of discharge than those simulated for the drought recharge conditions outlined above (25 percent reduction to the Pamet River and a 40 percent reduction to the Little Pamet River). Simulated pumping at maximum safe yield from either Knowles Crossing or Test Site 4 reduced discharge to Salt Meadow to almost zero This is within the range predicted for drought recharge conditions. Long term average pumping rates at Knowle's Crossing indicate a current 50 percent reduction in discharge to Salt Meadow compared to the undisturbed, pre-development value (Wilson and Schreiber, 1981).

Because of the Ghyben-Herzberg Principle (refer to section 2.5.6), the volume of freshwater in storage is primarily dependent on the position of the fresh water-salt water interface. Stress induced changes in water table elevations are predicted to fall orders of magnitude faster than the interface will rise. Consequently, the volume of water in freshwater storage also does not respond quickly. As modeled, it would require a sustained drought of 10 years or more with only 14 inches of annual recharge to raise the interface 10 feet and seriously deplete storage volume. The worst drought in recent memory occurred in the mid-1960's, lasted 6 years, and averaged 15.5 inches per year of recharge (Wilson and Schreiber, 1981).

Long term, simulated, sustained pumping above safe yield often led to a rapid and significant localized rise in the interface, particularly under the influence of multiple well withdrawals. In general, the influence of one well on the fresh water-salt water interface location at another is determined by the pumping rates, geographic proximity, and distances to the coastline. Wells near the coastline have a lower "safe yield" than those located inland. All wells were modeled to be susceptible to accelerated salt water intrusion with a greater than 10 percent increase in pumping over safe yield (refer to Chapter 4, page 66) (Wilson and Schreiber, 1981). The Knowles Crossing Well field was found to be especially sensitive to sea water intrusion. The combined use of Test Site #4 Well field with Knowle's Crossing Well field increased the degree of salt water intrusion at both locations. Use of South Hollow Well field showed a marginal effect on the interface position at Knowle's Crossing. Withdrawals from the Long Nook Road Wellfield and the North Truro Air Force Base Wellfield had almost no effect on the degree of salt water intrusion at Knowle's Crossing Well field or Test Site #4 Well field and vice versa. Combined withdrawals from the North Truro Air Base, South Hollow, and proposed Long Nook Road wells are modeled to contribute to salt water intrusion at each other. A conservative maximum "safe yield", in the absence of all other pumping, is estimated at 0.5 MGD for Knowle's Crossing, 0.7 MGD for Test Site # 4, 1.5 MGD for South Hollow, and 0.75 MGD for Long Nook Road (Wilson and Schreiber, 1981)(refer to figure 4.3 for well field locations).

Cambareri, Belfit, Janik, Irvin, Campbell, McCaffery and Carbonell, 1989a

The Cape Cod Planning and Economic Development Commission also utilized a MODFLOW predecessor and followed a similar protocol as the prior models. In the calibration procedure, however, the Commission monitored 47 usable observation wells in the Pamet lens. This is an increase of 15 wells or a 50 percent increase in data points over prior modeling efforts. Additional data points improved the calibration procedure and significantly expanded the accuracy and precision of the ground water contours for the Pamet lens. The new (1989) contours are at a half foot interval and more accurately reflect the interaction between the Pamet River, Little Pamet River, Salt Meadow, and Pilgrim lake with the edge of the ground water lens (Cambareri et al., 1989a). The new information was used to model the Zones of Contribution (ZOC) and travel times to each of the public wells. Two potential new well locations were identified based on water quality criteria without consideration of ecological impacts. Both locations are outside of but in close proximity to National Seashore boundaries.

Martin, 1993

Martin used MODFLOW to simulate the effects of ground water withdrawals from 4 existing well fields and two potential well fields on freshwater discharge to the perimeter of the Pamet aquifer. He did not attempt to simulate movement of the freshwater-saltwater interface. The model utilized a very dense grid spacing of 416 feet per cell edge to obtain better resolution near sensitive discharge areas (Martin, 1993). The model grid consists of only one layer with a single value of hydraulic conductivity because sufficiently detailed hydrogeologic data did not exist to accurately portray the variability of hydraulic conductivity. The hydraulic conductivity value was adjusted in the calibration procedure to best match calculated with observed head measurements. The limited input data restricts model accuracy on a site specific basis but large scale results should not be affected. Simulated changes in aquifer discharge were not verified with field measurements and the calculated results are intended for comparative purposes only (Martin, 1993).

Simulated discharge to the Salt Meadow area is most greatly reduced by withdrawals from the Knowles Crossing Well field. At a withdrawal rate of 0.25 MGD almost half the water withdrawn from the well is predicted to come from a reduction of discharge to Salt Meadow. Withdrawals from the South Hollow and North Truro Air Base Well fields will reduce discharge to Salt Meadow by 0.03 MGD. Simulated discharge to the Little Pamet River is reduced most by withdrawals from the South Hollow, North Truro Air Base and Long Nook Road wellfields. Combined withdrawals from the three wellfields of about 1.25 MGD, regardless of distribution, produced a reduction in discharge by about 10 percent of the withdrawal rate (0.12 MGD). Simulated discharge to the Pamet River is most greatly reduced by withdrawals from the proposed well fields at Long Nook Road or the Mitre site. Modeled discharge declined by about 15 percent of the amount removed from these two wellfields. Simulated withdrawals from existing well fields create a negligible reduction of discharge to the Pamet River. Simulated reductions in discharge to Bound Brook and the Herring river occur only from use of the proposed Mitre site (about 30 percent of the withdrawal rate) (Martin, 1993).

Barlow, 1994a & b

Barlow's model is intended to assess the effectiveness and limitations of numerical flow modeling coupled with particle tracking for the delineation of contributing areas to existing and hypothetical supply wells. Two flow systems were selected that were representative of the range of hydrogeologic complexity of Cape Cod flow systems. The simple system is the Nauset lens located in Eastham and Wellfleet. It was modeled as a 100 foot thick single layer aquifer with near ideal boundary conditions and no large capacity public supply wells. The complex system is the Sagamore (West Cape) lens in Barnstable and Yarmouth. It was modeled as a 250-500 foot thick multi- layered aquifer with non-ideal boundary conditions (including streams, ponds, wetlands and spatial variability of recharge rates) and multiple public supply wells. The two-dimensional model for each system is, by definition, only one layer thick. The three-dimensional model of the simple system consisted of five layers, while that for the complex system had eight layers. Precipitation is the only source of recharge to the simple system while the complex system receives wastewater return flow as an additional recharge component. Contributing areas were delineated using the U.S. Geological Survey particle tracking program MODPATH (Barlow, 1994a; 1994b).

The choice of either a two-dimensional or three-dimensional model for the delineation of contributing areas depends largely on the complexity of the flow system in which the well is situated. Contributing areas calculated for the two-dimensional and three-dimensional models in the simple system did not differ significantly provided the pumping rate was greater than 0.25 MGD. In the complex system, however, contributing areas from the two-dimensional models were not always accurate because two-dimensional models did not account for vertical flow and did not adequately represent many of the hydrogeologic and well design variables present. In particular, accurate delineation of contributing areas was complicated by the presence and continuity of discrete lenses of low hydraulic conductivity, non-ideal ratios of horizontal to vertical conductivity, shallow streams, partially penetrating supply wells, pumping rates less than about 0.1 MGD, and spatially variable recharge rates (Barlow, 1994a; 1994b).

Time related capture zones delineated by the two-dimensional models substantially under predict the size of the land area contributing water to a well over a specific time interval for both the simple and complex flow systems. This effect is most likely caused by the inability of two-dimensional models to account for the high horizontal : vertical conductivity ratio common in most aquifers. During the calibration procedure for the two-dimensional model the single value of horizontal conductivity must be artificially lowered to match the calculated heads to the observed heads influenced by the low vertical conductivity. The unrealistically low horizontal conductivity utilized in a two-dimensional model artificially lengthens modeled travel times and under represents contributing areas (Barlow, 1994b).

Masterson and Barlow, 1994
Massachusetts Department of Environmental Management, 1994

Both studies utilize the same model and employ the SHARP program to assess the regional response of the boundary between the fresh water and salt water flow systems to changing stress conditions. SHARP is a transient, 3D, finite difference model capable of simulating dual density fluid flow separated by a sharp interface (Masterson and Barlow, 1994). The Pilgrim lens was not modeled. The Nauset and Chequesset lenses, which currently contain no large capacity wells, were modeled to simulate only natural, pre-development conditions. For these lenses, the MODFlow program was used to calculate the current position of the fresh water-salt water interface and the amount of discharge to salt water borders of the aquifer. That information was then used as boundary conditions for MODFLOW freshwater flow models. The Pamet lens, where salt water intrusion at the Knowles Crossing Wellfield precludes MODFLOW's assumption of a static fresh water-salt water interface, was modeled using only the SHARP program. The model grid subdivided the aquifer into seven layers to accurately reflect lithology and extended from the water table to the contact between unconsolidated sediments and bedrock (Masterson and Barlow, 1994).

On a regional scale, both seasonal and climatic (drought) conditions have a greater simulated impact on surface waters than do current or future water supply withdrawals. Simulated seasonal reductions in discharge, declines in water table elevations, and increases in interface elevations resulting from increased pumping at constant recharge were negligible on a regional basis. The greatest regional impacts were produced by the cumulative effects of a hypothetical 30 percent drought lasting five years, when winter and spring replenishment of the aquifer did not occur, combined with in-season withdrawal demands. At the small scale however, impacts in the immediate vicinity of a pumping well may be severe. Under 1975 pumping and recharge conditions at Knowles Crossing, for example, the simulated water table decreased by 2 feet and the simulated fresh water-salt water interface rose by 55 feet contaminating the well (Masterson and Barlow, 1994; Massachusetts Department of Environmental Management, 1994).

Sobczak and Cambareri, 1995

In 1995, the Lower Cape Task Water Management Task Force, a multi-jurisdictional group of state, local and national agencies, undertook a resource-based screening process to select potential new well sites without regard for political boundaries. The criteria used for site selection were: (1)water table elevation greater than 4 feet; (2) low density land use areas; and, (3) significant distance from surface water features. The selected sites were ranked based on their impact to surface water natural resources. A computer model for each of the three aquifer lenses was constructed and the various well positions tested with all other factors remaining constant from simulation to simulation (well depth, recharge, and pumping rate =0.5 MGD). The impact of multiple pumping wells was not addressed (Sobczak and Cambareri, 1995).

Model results are only useful for comparing relative impacts of one site with those of another. Absolute impact on any specific resource cannot be accurately determined (Sobczak and Cambareri, 1995). Of the 32 selected sites, five were modeled to have an insignificant impact and 15 to have a moderate impact. Significant impacts created discharge reductions of greater than 10 percent of natural discharge rate and water table declines greater than one foot. Moderate impacts created discharge reductions of greater than 5 percent and water table decline greater than six inches. Moderate and insignificant impact sites received further consideration. In the Nauset lens, three sites (the NE Eastham, Marconi Beach, and Nauset Road sites) were modeled as optimal well locations with insignificant impact to identified surface water resources. In the Chequesset lens, no sites were identified with insignificant impacts to surface water bodies. There were, however, six sites with moderate impacts which might warrant further consideration provided that individual well yields are small, withdrawals are well spaced, and return flow occurs in appropriate areas. These sites are the Great Pond, Dyer Pond, Coles Neck, Ryder Pond, Mitre and Prince valley sites. In the Pamet lens, two sites (the North Truro Air Base (already in use) and the Coast Guard sites) were modeled to have insignificant impacts. South Hollow site (already in use) and Long Nook site are modeled to have moderate impacts. Knowles Crossing (already in use) and Test Site #4 were modeled to have significant impact and to experience saltwater intrusion (Sobczak and Cambareri, 1995).