1985

The Role of Individual Sewage Disposal System Regulations in Land Use Planning: An Application For Carrying Capacity Analysis

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The Role of Individual Sewage Disposal System Regulations in Land Use Planning: An Application For Carrying Capacity Analysis

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A Research Project Submitted In

Partial Fulfillment of the Requirements for the Degree of

Master of Community Planning

University of Rhode Island

1983

Master of Community Planning

Research Project

of

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Acknowledgements

I would like to thank Dr. John Kupa for his patience and helpful comments in the review of this research. Also deserving of recognition is Ms. Joan Bentley, for her efforts and support in the preparation of the draft and final copy of this report.

PREFACE

This paper attempts to define the role of current individual sewage disposal system (ISDS) programs as they relate to the overall land development process. Specifically, the focus is on residential development with emphasis given to the criteria used to determine site suitability. Two state programs, Rhode Island and New Hampshire, will be evaluated in this manner in order to provide some insight into the scope of this type of regulation and its potential impact on development. To demonstrate the effect of each program on residential land use, a case study of a Rhode Island subdivision proposal is included. This discussion will focus on soil suitability minimum lot size, setbacks and other factors affecting residential density and distribution within the subdivision.

The concluding chapters will introduce the concept of carrying capacity as a planning tool and its applicability in areas of "ecological significance." The emphasis here will be on the role of ISDS suitability as one of the critical limiting factors for determining an area's overall threshold capacity. The need for comprehensive, land use planning prevails as the growth of alternative and innovative approaches to on-site sewage disposal threatens to overcome the physical constraints of the land and nullify this type of de-facto zoning in the near future.

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CHAPTER 1

INTRODUCTION

"In a profound reversal of a 160 year pattern, more people 3.5 million more, to be exact - moved into non-metropolitan areas of the United States during the 1970's than moved out. Moreover, the non-metro population increased at a faster rate than did the metro population, 15.4 percent for the former compared with 9.1 percent for the latter."[1] This migration to the suburbs as it's come to be known, has turned out to be somewhat of a mixed blessing. Originally enthusiastic about the prospects of increased tax base, expanding economic development and a general boom to the housing industry, many small suburban and rural communities have found themselves largely unprepared to cope with the demands of their rapidly expanding population. With this population growth comes the increased need for public services and facilities, such as schools, libraries, police and fire protection, utilities and recreation areas. As much of the land is converted to residential uses, one of the first concerns a growing community faces is sewage disposal. Unprepared to deal with large scale sewage treatment problems or unable to afford the enormous cost of a centralized sewage treatment facility, many communities have relied upon on-site sewage treatment regulations as a kind of "de-facto" zoning device. Communities in many states are prohibited by law from issuing building permits for lots prior to the certification of an approved on-site sewage disposal system. Since many areas with poor soils and drainage may not meet the minimum standards established for on-site sewage disposal, local governments have enjoyed the benefits of this indirect growth control mechanism without having to share the responsibility for its effect. The effect, until recently, has been to slow or prohibit development altogether in these so called "marginal" areas. The impact of this type of regulation is most apparent when one examines the conversion of large tracts of vacant land into single family residential use. The selection of suitable home sites is in large part dependent upon the ability to meet sewage disposal requirements. Perhaps second only to zoning and subdivision regulations, sewage disposal regulation controls the development of land.

Over the past decade, we have experienced substantial increases in our understanding of natural environmental systems, spurred largely by legislation to protect dwindling and ecologically sensitive resources. Along with this effort have come advances in environmental and land-use planning techniques that allow, as Robert A. Lemire so simply states "preservation of what needs to be preserved and development of what needs to be developed."[2] Techniques like cluster zoning, overlay districts, conservation easements and transfer of development rights all allow for a much more flexible approach to land development than is available using standard "Euclidian" zoning controls. Moreover, as a steady decrease of "prime buildable real estate" continues, these flexibility devices may actually encourage the development of sites previously thought to be unsuitable or too difficult to develop.

NOTES

1. Joseph Doherty, Beyond the Fringe, Planning, Vol. 47, No. 6, 1981.

2. Robert A. Lemire, Creative Land Development: Bridge to the Future.

CHAPTER 2

Introduction

This chapter introduces some of the basic concepts about individual sewage disposal systems (ISDS) necessary for a complete understanding of the following discussions on regulation and carrying capacity. Beginning with a simplified description of the component parts and functions of a typical system, the discussion moves to a detailed account of the potential pollutants and health hazards associated with the improper use of this common facility.

INDIVIDUAL SEWAGE DISPOSAL SYSTEMS

The use of individual sewage disposal systems (ISDS) is receiving increased attention due to the availability of reliable treatment units, the development of accurate design criteria, financial and technical support from federal and state agencies for their use and the high cost to construct and maintain centralized sewage treatment facilities. It has been estimated that up to 20 percent of the nation's population rely upon on site sewage disposal systems.[1] This figure is expected to increase as more people migrate to rural areas without centralized sewage treatment facilities. The percentage of households relying on ISDS for wastewater disposal is slightly higher in New Hampshire than in Rhode Island; over 35 percent for the former and from 25 to 35 percent for the latter. While the majority of the population of these states are tied into centralized sewage treatment facilities, the majority of the land available for future development must rely on ISDS.

In the past, it was generally felt that on-site sewage disposal systems were only temporary means for treating wastewater and at some future date centralized sewer and water systems would be needed to overcome this problem. This idea, known as the transport concept, may be accurate for densely populated urban areas, but renewed interest in ISDS design and performance indicated that, if designed and constructed correctly, these systems can effectively serve most rural and suburban area's long-term needs.[2]

Concern over the use of ISDS has arisen for a number of reasons. Primarily, septic systems, as they are commonly called, are prone to failure due to either improper design, faulty construction or a combination of these factors. Older homes typically disposed of wastewater into a simple cesspool, usually nothing more than a glorified hole in the ground. Little or no consideration was given to design capacity or site characteristics. This began to change however when in 1967 the U.S. Public Health Service issued the Manual of Septic Tank Practice. This document introduced the modern sewage disposal system encompassing the septic tank, distribution box and leaching field. Many of the standards for design, location, construction and maintenance that are found in current sewage disposal regulations are modeled after those found in this manual.

This new approach to on-site sewage disposal was a vast improvement over the cesspool. Standards were established for determining wastewater capacities and minimum distances recommended between the various components of the system and such things as wells, water lines, basements and streams. Even with these improvements however, many communities continue to experience problems associated with individual sewage disposal systems. The nature of these problems can range from simple design and/or construction flaws to serious areawide water pollution. The following discussion is provided to acquaint the reader with some of the issues involved with ISDS use and how some communities have dealt with problem situations.

A conventional individual sewage disposal system consists of a septic tank, distribution box and a seepage field. The septic tank functions as a collection and pretreatment unit. Raw sewage entering the septic tank from the houseis stored in the tank for approximately two days. During this time, separation and sedimentation of the sewage into floatable (grease, fats and scum). partially clarified and settleable solids occurs. The main by-products of this process are the gases methane (CH_4), carbon dioxide (CO_2) and sludge. What remains is the bulk of the partially clarified liquid waste or effluent. The effluent is then filtered over the seepage system by way of a series of perforated pipes known as distribution lines. The lines originate at a distribution box located at the beginning of the seepage field. The final step of the treatment process occurs as the effluent infiltrates the soil layers beneath the seepage field. At this point much of the harmful components of the effluent are either consumed by soil bacteria or adsorbed through chemical reactions with the soil particles. Figure 2-1 shows a typical diagram of one such system.

This simplified description of on-site sewage disposal merely serves to acquaint the reader with the physical components and their operation. In order to fully understand

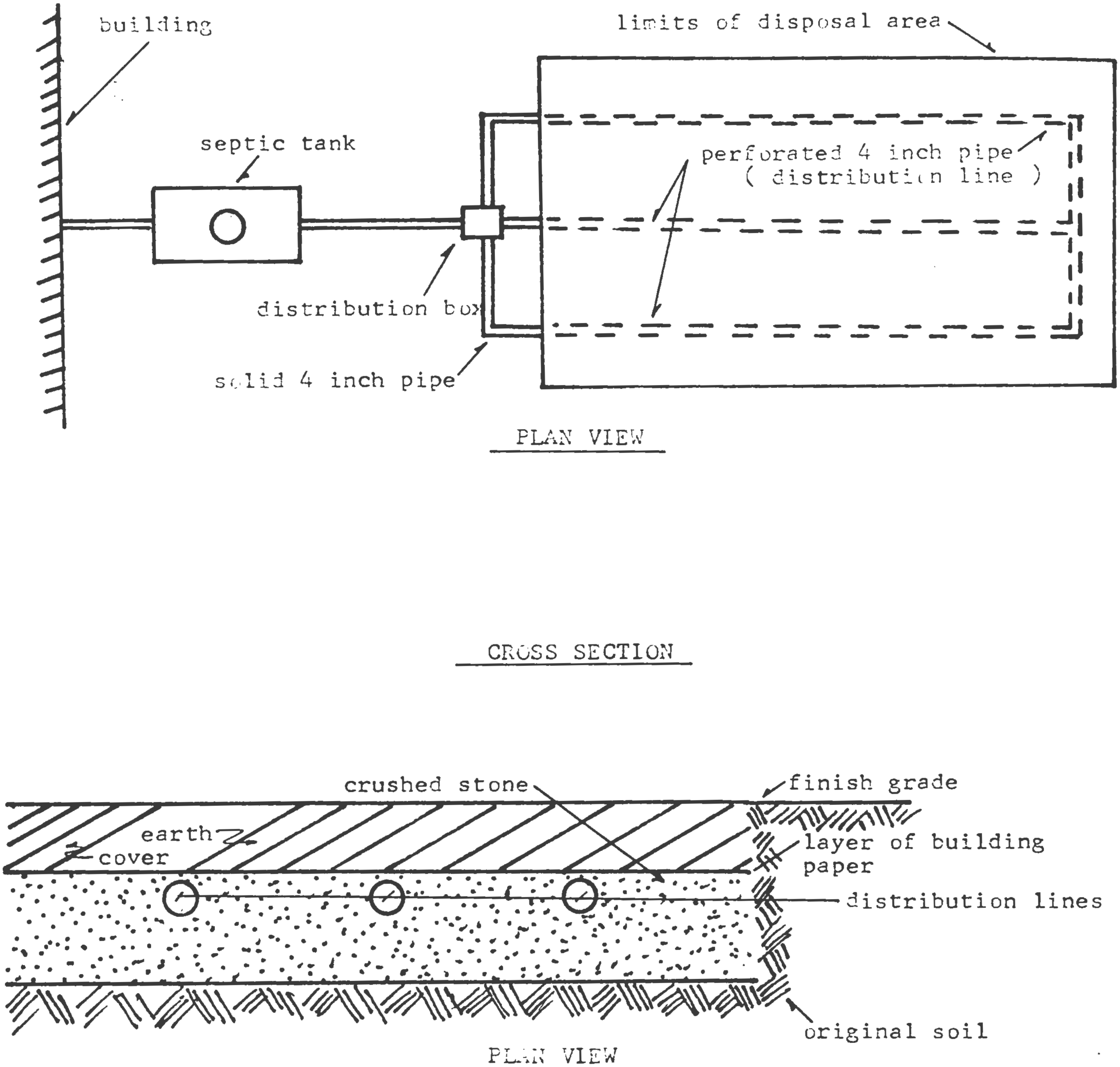


Figure 2.1 Typical Individual Sewage Disposal System.

the effects of improper sewage disposal on human and natural environments one must be familiar with the potential hazards from ISDS faulure. The following sections are included for this purpose.

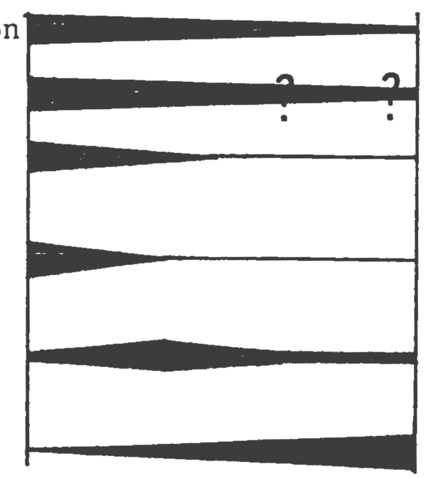
Potential Pollutants from ISDS

The success or failure of a septic tank/filter field system has traditionally been measured by one factor, whereas several factors deserve consideration. This factor has been the soils capacity to absorb water as measured by a percolation test. Measured by this standard, a successful installation is one that does not result in sewage effluent coming out at the surface of the ground or backing up through household plumbing. The percolation test has come under much criticism lately as to its ability to accurately measure soil infiltration rates and design capacities.[3] Studies indicate that over a period of six months to one year seepage fields develop a scum layer at the interface of the soil layer that slows effluent filtration rates to a relatively stable long term acceptance rate. The formation of this layer actually enhances the treatment process leading many researchers to conclude that seepage field size should be based on long term acceptance rates and not percolation rates, as is the common practice now.[4] Moreover, a soils ability to treat sewage effluent and its hydraulic conductivity (as determined by percolation testing) may not necessarily compliment one another. Normally, a soils ability to "percolate" liquid is directly related to soil particle size, compactness, organic content, relative stratification of particles and moisture content. Generally speaking, loosely packed, granular soils, such as sand or gravel, will allow liquid to pass through it faster than tightly packed, fine grained soils like silt and clay.

The treatment of sewage effluent on the other hand is enhanced by the soils absorptive capacity, chemical and biological constituents. Table 2.1 clearly illustrates the relationships between selected soil types and degree of purification.

Table 2.1 Different Soil Limitations for Achieving Different Processes of Purification as a Function of Construction and Management.

Conductivity Types	I II III IV		
Pathogenic Purification		I.	Sands
Nitrogen Removal			
Phosphous Removal		II.	Sandy loam, loam
BOD & Susp. Solids Removal			
Biological Clogging		III.	Silt loams, Silty clay loam
Compaction & Puddling		IV.	Heavy silty, clay loam, clays



* Potential limitations and Problems Increase as Bands Widen

Source: Bouma, J. "Innovative On-Site Soil Disposal and Treatment Systems for Septic Tank Effluent." A.S.A.E. Published Proceedings 1975.

Bouma (1975) has found that the slower the percolation, the greater the degree of wastewater renovation, but slower rates also require larger leaching areas. From a practical standpoint a tradeoff between hydraulic conductivity (percolation), degree of purification and size of the leaching field must be sought. Ironically the soil type most compatible with these requirements is a moderately course, medium textured sandy loam, also known for its exceptional qualities in agricultural production.

Domestic household wastewater contains a number of substances that threaten human health as well as the normal functioning of aquatic environments in general. The most prominent of these substances have been identified as nitrogen, phosphorons, B.O.D., dissolved and suspended solids, fecal coliform bacteria and viruses and methyl blue active substances. Each of these pollutants and their effects on human health or natural systems will be discussed.

Nitrogen Nitrogen, as present in household septic tanks, is about 80% ammonia (NH_4) and 20% organic nitrogen. As the effluent passes from the anaerobic conditions in the septic tank through the aerobic soil layers, the process of nitrification occurs. This results in the ammonia being transformed first into nitrite and eventually to nitrate. Nitrate is readily soluable in the groundwater and may travel considerable distance in this form.[5] Once in the groundwater, nitrates may contaminate nearby wells or eventually reach surface water bodies. The danger to human health stems from the ability of nitrate to be transformed back into nitrite in the gastrointestinal track. Nitrite reacts directly with the hemoglobin in the blood to produce a substance called methemoglobin, which impairs oxygen transport through the bloodstream. Unborn infants and children under three months of age are particularly susceptable to this reaction known as blue baby disease.[6] The U.S. Environmental Protection Agency (EPA) has set the maximum acceptable level of nitrates in drinking water at 10mg/1.

Another potential danger of nitrogen contamination, for coastal areas in particular, relates to the concept of limiting factors and eutrophication of aquatic environments. Ecologically, limiting factors refer to the availablity of the essential ingredients necessary to sustain life. Of these ingredients the one that is least available will usually limit the growth of those organisms dependent upon it for life sustaining processes. In marine aquatic environments, nitrogen is often the limiting factor in controlling the level of algae and macrophytic plant growth. Normal balances in the nitrogen cycle may be disturbed by the increased loadings of nitrate from septic system leachate. The excessive plant growth often associated with this occurence may result in "eutrophic" conditions of the waterbody.[7] Excessive plant growth stimulates bacterial consumption which can deplete oxygen supplies, thus leading to fish kills and other maladies on up though the food chain.[8] Table 2.1 further illustrates that soil conditions typically found in coastal areas (i.e. sands, sandy loams) present problems in the treatment of nitrogen from sewage effluent. This condition is particularly noteworthy in this research because coastal communities often have to rely upon saturated sand and gravel deposits from potable water supplies. The protection of these so-called aquifer areas from pollution is often on the most critical problems a community must address as residential growth occurs in areas relying upon subsurface sewage disposal. Unfortunately studies of this problem often lend to conflicting results. Nitrate nitrogen has been found to be an insignificant constituent of groundwater contaminated by sewage effluent where anaerobic soil conditions prevail.[8] This finding is supported by other research documenting the denitrification of ammonia in sewage effluent.[9] In other cases however, nitrates have been found to travel in significant concentrations (10mg/l) for considerable distances.[10] Pruel (1966) found concentrations of nitrate nitrogen at these levels as far as 90 feet from the point of discharge. The results of these and other such findings makes the location and construction of ISDS particularly critical in coastal communities.

Phosphorous. Phosphorous, usually present in sewage effluent as phosphate (PO_4---), is not present in high enough concentrations to be toxic.[11] However, phosphous may be the limiting factor in fresh water bodies and as such becomes a potential threat.

Phosphorous, however does not readily travel through the soil as it is quickly absorbed by soil particles and utilized by plants. The only threat of phosphorous reaching a nearby waterbody through groundwater, comes once the soils absorbitive capacity is reached. This can occur under conditions of heavy loading over a period of time and is usually enhanced by high water tables and course sandy soils.[12]

Another source of phosphorous contamination, usually of greater significance is through surface water runoff. Development around the lake shores that increases runoff has been shown to contribute high concentrates of nutrients, particularly phosphorous.[13] Residential and agricultural uses are of particular note here.

<u>Biochemical Oxygen Demand</u>. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen used by biological and chemical processes to decompose organic material in water. To protect acquatic life it is necessary to maintain dissolved oxygen content above certain levels. Much of the organic matter found in sewage effluent is high in BOD. However, through normal septic tank settling and soil treatment, most of the BOD is removed.[14] Excessive BOD loadings may become a threat in the event of ISDS failure resulting in surface ponding of raw sewage or through direct discharge.

The E.P.A. has set maximum BOD levels necessary to support good fish populations at 5.0 mg/l.

Suspended and Dissolved Solids. Suspended solids are particulates that are suspended in waterbodies due to their turbulent nature. If provided with a quiescent environment, they will eventually settle out and be deposited as sediment or sludge. In suspension; they can reduce the clarity of the water column, increase water temperature and reduce the penetration of light, thus reducing photosynthetic activity and food production. Due to the quiescent environment that ISDS provide, suspended solids generally settle out and are not a pollution threat. Approximately 80% of the suspended solids settle out in the septic tank with the remaining 20% being well filtered by the soil.[15]

Dissolved solids consist of organic salts, small amounts of organic matter and dissolved materials that do not settle readily even in calm, non-turbulent environments. The principle inorganic anions in sewage effluent include carbonates, chlorides sulfites and nitrates; the principle cations are sodium, potassium, calcium and magnesium. These ions can pose a health hazard ranging from laxative effects to aggrevated cardiovascular or renal disease for certain individuals.[16] However, they are seldom present in properly treated sewage effluent in suffient quantities to be regarded as a major threat. Some of these ions can present problems under situations where soil conditions may be inadequate for proper treatment. The property of a soil that is responsible for the adsorbtion of cations in solution is called the cation exchange capacity. This phenomena has been defined as the sum total of exchangeable cations that a soil can adsorb. Cation exchange is considered the interchange between a cation in solution and another cation on the surface of any surface-active material such as clay or organic matter.[17] In coastal areas and along the shores of inland water bodies where nutrient loadings from subsurface sewage disposal may be a concern, the cations exchange capacity of a soil should be a consideration in locating individual disposal units.

Coliform Bacteria and Viruses. The presence of coliform bacteria in water is used as an indicator of the presence of pathogenic organisms. Among those found in domestic wastewater are the bacteria Salmonella, Shigella, Mycobacterium and Vibrio, the protozoans Entamoeba; the parasitic worms Taenia and Ascaris and numerous viruses and fungi. These can all transmit disease to humans if introduced into the gastrointestinal system. This category represents some of the most serious health hazards from ISDS failure. Raw sewage or effluent contaminated water may become a disease vector to animals and humans who come into contact with it. It has been well established however that the soil mantle is highly efficient in removing pathogens from sewage effluent.[18] It is generally agreed upon however that at least three feet of unsaturated soil must be present below the bottom of the leaching field for this function to operate effectively. In fact studies have shown that the three most common conditions that prevent the safe treatment of bacteriological contaminants are shallow soils (less than 3') over creviced bedrock, shallow soils over a high groundwater table and impermeable soils.[19]

The full implications of the fecal coliform bacteria methodology are not understood at this time and therefore require further research. In the meantime the Rhode Island Department of Health has established the following guidelines (standards presented refer to the number of colonies per 100 milli litre sample):

> For Class A waters, a median of 20 per 100 ml, not more than 200 per 100 ml in more than 10% of the samples, and for Class B waters, a median of 200 per 100 ml, not more than 500 per 100 ml in more than 20% of the samples.

Methylene Blue Active Substances (MBAS) A constituent of synthetic detergents, MBAS though non-toxic are used as indicators of the presence of other toxic chemicals and pathogens. These substances are not taken up by plants or animals as nutrients and as such rely entirely upon soil retension for treatment and removal.[20] The presence of MBAS in sewage effluent has largely served as a basis for plume analysis associated with concentrated flows from densely situated dwelling units relying upon ISDS.[21] These studies have helped to establish some of the standards required for proper ISDS use.

Besides the contaminants normally associated with domestic wastewater follows the U.S.E.P.A. has listed numerous other toxic compounds that may be introduced into surface and groundwater from ISDS. The concentration of these compounds in the waste stream will vary greatly with product use and the water use habits of each household member. For the most part these compounds are present only as trace elements in the waste stream, however very little is known about their concentration and persistence in the environment. Table 2.2 illustrates those substances typically found in association with certain uses and consumer products.

DISTRIBUTION OF COMMON CONSUMER PRODUCTS

Table 2.2

CONSUMER PRODUCTS	TOXIC COMPOUND
Toilet Flush	
medical-ointments	benzene, bis (2-chlorethyl) ether, 2,4,6-trichlorophenol, chloroform, 2-chlorophenol, 2,4-dimethyphenol napthalene, phenol, antimony, Cu, Hg, Zn arsenic Cd
disinfectants	2,4,6-trichlorophenol, 2-chlorophenol, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, phenol, Hg
deodorizer	benzene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 2,4-dichlorophenol, methylene chloride, trichlorofuoromethane, dichlorodifloromethane, chlorodibromomethane, napthalene

cleaner	benzene, 1,1,1-trichloroethane, 1,2 2-trichlorethane, chloroethane, 2,4,6-trichlorophenol, 2-chlorophenol, 1,2-cichlorobenzene, 1,4-dichloropropane, 1,3-dichlorophlene, phenol, Cr, Cu, Zn
<u>Garbage Disposal</u>	
pesticides	carbon tetrachloride, 1,1,2, 2-tetrochloroethane, tetrachloroethylene, aldrin, dieldrin, chlordane, 1,4-dichlorobenzene, arsenic, Cd, Cr, Cu, Pb, Hg, Zn, cyanide
deodorizer	benzene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 2,4-dichlorophenol, methylene chloride, trichlorofluoromethane, dichlorodifluoromethane, napthalene, Zn
<u>Kitchen Sink</u>	
hand soaps and cleaners	1,2-dichloroethylene, phenol, diethylphtalate, dimethylphtalate, toulene, asbestos
polish	1,2-dichlorobenzene, 1,2-dichloroethane, chloroethane, 1,3-dishlorobenzene, 1,2-dichloropropane, methylene chloride, bromoform, dichlorobromethane, isophorone, diethylphthalate, tetrochloroethylene, trichloroethylene, Zn
pesticides	carbon tet, 1,1,2,2-tetrachloroethane, tetrachloroethylene, aldrin, dieldrin, chlordane, 1,4-dichlorobenzene, arsenic, Cd, Cr, Cu, Pb, Hg, Zn, cyanide.
cosmetics	benzene, p-chloro-m-cresol, 2,4-dimethylphenol, napthalene, phenol, PAH's, toulene, 1,2-dichlorobenzene antimony, Cd, Cu, Pb, Hg, Ni, Ag, Zn

cleaners	benzene, carbon tet, chlorobenzene, 1,2-dichloroethane, 1,1, 1-trichloroethane, 1,1,-dichloroethane, cholorethane chloroform, 2-chlorophenol, 1,2-dichlorobenzene, 1-3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloropropylene, bis (2-chloroisopropyl) ether, methylene chloride, hexabutadiene, phenol, tetrachloroethylene, toulene, trichloroethylene, Cr, Cu, Zn.
<u>Automatic Dishwasher Waste</u>	
detergents	benzene, 2,4,6-trichlorophenol, 2-chlorophenol, 2,4-dimethylphenol, napthalene, phenol, toluene
silver polish	diethylphthalate, dimethyl, phthalate, Ag
<u>Bath and Shower Waste</u>	
soaps (perfumed)	1,2-dichloroethylene, phenol, diethylphthalate, dimethylphthalate, toluene
medical ointments	benzene, bix (2-chloroethyl) ether, 2,4,6-trichlorophenol, chloroform, 2-chlorophenol, 2,4-dimethyphenol, fluoranthene, napthalene, phenol, PAH's, Cu, Hg, Zn
shampoo	benzene, p-chloro-m-cresol, 2,4-dimethylphenol, fluoranthene, napthalene, PAH's, toulene, Cd, Cu, Pb, Ni, Ag, Zn
disinfectants	1,1,2-trichloroethane, chloroethane, 2,4,6-trichlorophenol, 2-chlorophenol, 1,4-dichlorobenzene, 2,4-dichlorophenol, 1,2-dichloropropane, 1,3-dichloropropylene, naphtnalene, phenol, Hg

cosmetics (make-up, anti-perspirants) (hair dyes)	benzene, 1,4-dichlorethylene, 2,4-dichlorophenol, nitrobenzene, bis (2-ethylhexyl) phthalate, butylbenzylphthalate, diethyl-phyhalate, dimethylphthalate, anitmony, Cd, Cu, Pb, Hg, Ni, Se, Ag, Zn

<u>Utility Sink Waste</u>

preservatives and dyes	hexachlorobenze. 1,1,1-trichloroethane, 2-chloroethyl vinyl ether, p-chloro-m-cresol, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1, 4-dichlorobenzene, 2,4-dichlorophenol, pentachlorophenol, Cd, Cr. Cu, Db, Ni, asbestos, cyanide
polish	1,1, 1-trichloroethane, 1,1, 2-trichloroethane, 1,2, -dichlorobenzene, 1,3-fivhlorobenzene, nitrobenzene, diethylphthalate, dimethylphthalate, Zn
photographic products	1,1, 1-trichloroethane, 1,1, 2-trichloroethane, 2,4-dinitrophenol, Cr, Pb, Hg, Ag
paint products	benzene, bix (2-chloroethyl) ether, 2,4,6-trichlorophenol, 2-chlorophenol, bis (2-chlorosopropryl) ether, isophorone, phenol, toluene, antimony, arsenic, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn, asbestos
pesticides	carbon test, 1,1,2-tetrochloroethnae, tetrochloroehylenes, albrin, dieldrin, chlordane, endrin, heptachlor, BHC, toxaphene, TCDD, arsenic, Cd, Cr, Cu, Pb, Hg, Zn, cyanide
cleaners	1,1, 1-trichloroethane, 1,1, 2-trichloroethane, Cr, Zn
bleach	2,4,6-trichlorophenol

Bathroom Sink Waste

medicine	benzene, bis (2-chloroethyl) ether, 2,4,6-trichlorophenol, chloroform, 2-chlorophenol, 2, 4-dimethylphenol, Fluoranthene, napthalene, phenol, PAH's, antimony, arsenic, Cu, Hg, Zn
soaps (hard and body)	1,2-dichloroethylene, phenol, diethylphthalate, dimethylphthalate, toluene
disinfectants	2,4,6-trichlorophenol, 2-chlorophenol, phenol, Hg
cosmetics	p-chloro-m-creso, 1,2-dichlorobenzene, phenol, bis (2-ethylhexyl) phthalate, diethylphthalate, dimethylphthalate, antimony, Cd, Cu, Pb, Hg, Zn
shampoo	benzene, p-chloro-cresol, 2, 4-dimethylphenol, fluoranthene, napthahalene, PAH's, toluene, Cd, Cu, Ag, Zn
cleaner	1, 1, 1-trichloroethane, 1,1, 2-trichloroethane, Cu
public chlorinated drinking water	carbon tet, dichlorobromomethane
PVC water supply piping	bis (2-ethylhexyl) phthalate, tetrachloroethylene, toluene, vinyl chloride.

This section presented some of the fundamental concepts about on-site sewage disposal systems as well as some of the potential hazards associated with their improper use. It is not the intention here to make an argument for or against ISDS, but rather to familiarize the reader with the issues in preparation for the following discussion on administrative and regulation.

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CHAPTER 3

THE REGULATION OF INDIVIDUAL SEWAGE DISPOSAL SYSTEMS

In order to identify the appropriate role of ISDS suitability in the overall land development process, we must first have an understanding of the scope of the regulatory programs in use and the criteria for evaluating the proper design, location and construction of a typical system. For this purpose, two current state ISDS programs will be reviewed focusing on those factors that are used to "measure" a site's suitability for subsurface sewage disposal. The Rhode Island program was selected for the simple reason that the subdivision evaluated in the case study is in Rhode Island and subject to the requirements set forth in the Rhode Island program and as such establishes a "benchmark" against which other regulatory programs may be measured. The New Hampshire program was chosen for comparison primarily due to its unique approach regarding soil drainage capability and recommended minimum lot sizes.

Rhode Island began the regulation of individual sewage disposal systems in 1968. At that time it was the responsibility of the Department of Health to establish the applicable rules and regulations for the issuance of permits. In accordance with a broad spectrum of public health concerns, the Health Department was charged with the enforcement of the rules and regulations to assure the proper location, design, construction and maintenance of all such systems throughout the State. By 1977, the administration of the ISDS program had switched from the Department of Health to the newly created Department of Environmental Management (DEM). This change resulted from a State effort to reorganize the previous Department of Natural Resources in order to consolidate all of the agencies concerned with environmental matters under one department. The DEM's Division of Land Resources established the ISDS Section to handle the administration and enforcement of the ISDS program. The ISDS Section is responsible for administering the "Rules and Regulations Establishing Minimum Standards Relating to Location, Design Construction and Maintenance of Individual Sewage Disposal Systems." These regulations, delegated authority under Section 23·55·4 of the General Laws of Rhode Island of 1956, as amended, are the backbone of the ISDS program in Rhode Island.

In December of 1980 the Rules and Regulations underwent extensive revisions to facilitate new management procedures by the DEM and incorporate advancements in the field of sanitary engineering. Some of the most notable changes pertain to the types of systems allowed, required minimum setback distances, sewage effluent application rates and construction certification procedures.

The administration of New Hampshire's ISDS program lies with the New Hampshire Water Supply and Pollution Control Commission* (NHWS & PCC). Pursuant to the require-metns of Chapter 149-E of the Revised Statutes Annotated, the Commission has adopted rules and regulations to implement the provisions of this law. The evolution of this law is especially interesting with respect to this paper. In 1967, the General Court of New Hampshire enacted legislation to prevent pollution of the State's surface waters and to protect underground water supplies from inadequate waste disposal systems. This legislation, Chapter 149.E of the Revised Statutes Annotated (RSA), became known as the "Shoreline Law". Originally, this legislation encompassed only land within 1,000 feet of the surface water. In July 1971, the statute was amended to include all of the land area of the state. While the expanded scope of this law more than likely indicates the inadequacy of the original undertaking, it also illustrates a primary concern for water quality as the basis for regulation as opposed to sanitation, as is the case with the original Rhode Island effort.[1] Today however, both programs are designed to encompass a broad range of concerns from disease control to protection of public recreation resources. The 1978 Guide for the Design, Operation and Maintenance of Small Sewage Disposal Systems (Guide) is New Hampshire's most recent publication containing the rules and regulations for

* herein-after refered to as the Commission.

implementing RSA 149-E. A significant portion of the guide deals with determining site suitability based on soils. As we shall see, the Commission's influence over the subdivision of land is considerable greater than the Rhode Island DEM's as a result of the requirements included within their ISDS program.

ISDS Regulation and Land Use

As mentioned at the outset of this paper, many suburban and rural communities have enjoyed the indirect benefits of ISDS regulations, as they apply to land development suitability. The focus of this section is to examine each state program concentrating on those particular sections that establish the minimum standards for suitability. The following statement from the Rhode Island ISDS Rules and Regulations illustrates clearly the impact that this type of regulation exerts on development.

"No person shall install, construct, alter or repair or cause to be installed, constructed, altered or repaired any individual sewage disposal system, nor shall he begin construction on any improvement to his property from which sewage will have to be disposed of by means of an individual sewage disposal system until he has obtained the written approval of the director of the plans and specifications for such work.

Note: A municipality may grant a building permit pursuant to Section 23-27. 2-12 and chapters 23-27.3. of the Rhode Island General Law of 1956, as amended, only when written approval by the director as required... herein is presented to the municipality.".

Several factors pertaining to the site must be carefully examined before one can establish suitability. The following sections will describe the factors considered important when determining land suitability as presented in Rhode Island's and New Hampshire's regulations.

Critical Factors

Before a designer can make an accurate determination of a site's suitability for subsurface sewage disposal, he must collect information about several factors, including; the number of occupants anticipated to use the facility, the topography of the site, the soil characteristics pertaining to the function of sewage disposal and treatment, the depth to ground water and bedrock or any other impervious layer and the location of all surface water bodies and wetlands within a prescribed distance for the site. Once this information has been gathered, a system can be designed utilizing the standards set forth in the applicable regulations. What I would like to establish in this section is exactly how the two states view these "critical factors" of ISDS design and construction and what, if any, advantage one program has over the other in terms of a positive influence upon land development and management. It should be stressed that this comparison concentrates only on selected sections of the respective programs deemedto have some influence on the ultimate determination of land suitability.

Wastewater Volumes

The Rhode Island program establishes a 75 gallon/person/day minimum effluent discharge estimate for residential applications. In addition, it requires designers to base the total sewage flow estimate on a three bedroom household as a minimum, with two persons per bedroom. Less than three bedroom designs may be submitted provided that proof is filed in the municipal land evidence records verifying the number of bedrooms allowed. Once the maximum daily flow is set the size of the leaching area can be figured based on the appropriate application rate (gals/sq.ft./day). The New Hampshire regulations also use 75 gal/person/day as a minimum residential capacity, with two persons per bedroom and two bedroom designs as a minimum. Similarly, the leaching area is computed using the percolation rate (determined in the field) and a minimum square footage per bedroom matrix. See Table 3.1.

The size of the leaching area is an important consideration in terms of general layout, but also plays a role in the overall evaluation of site suitability. Here the emphasis is more on cost factors than physical constraints, however combined problems of poor soil condition, high ground water and steeply

Table 3.1 Minimum Leaching Areas by Percolation Rate

Percolation Rate Minutes/Inch	Bedrooms 1	2	3	4	Each Additional	Square Feet Per 100 Gallons
2	300	400	560	750	188	125
4	300	425	617	825	216	140
6	300	450	675	900	244	155
8	300	500	750	1000	263	170
10	300	550	825	1100	282	185
12	300	600	900	1200	300	200
14	300	675	1010	1350	338	225
18	375	712	1065	1425	357	237
20	400	750	1120	1500	375	250
22	410	775	1158	1550	387	258
24	420	800	1196	1600	400	266
26	430	825	1234	1650	412	274
28	440	850	1272	1700	425	282
30	450	875	1310	1750	437	290
32	460	900	1348	1800	449	298
34	470	925	1386	1850	462	306
36	480	950	1424	1900	475	314
38	490	975	1462	1950	488	322
40	500	1000	1500	2000	500	330
50	625	1250	1875	2500	625	415
60	750	1500	2250	3000	750	500

Scurce: New Hampshire Water Supply and Pollution Control Commission, <u>Guide for the Design, Operation and Maintenance of Small Sewage Disposal Systems</u>, 1978 sloping terrain may render the installation of a large system impractical in some situation. It's interesting to note that while Rhode Island and New Hampshire share the estimated figure of seventy-five (75) gals/person/day as the average daily flow, other agencies; most notably the U.S. Environmental Protection Agency, place that figure around forty-five (45) gals/person/day. This wide margin of descrepancy attests to the fact that water use practices vary greatly throughout the country and that averages can therefore be misleading. The Rhode Island rules and regulations address this problem by allowing the homeowner the opportunity to document water usage if less than the required minimum is sought as a basis for design.

Taken alone the requirements pertaining to average daily flow and leaching areas are of minor importance when determining site suitability, however this information is so basic to any discussion of ISDS, that to leave it out would be remiss.

Slope

When addressing the issue of "suitable" land for development purposes, it is common practice to exclued certain areas due to excessive slopes. Just what determines whether or not a slope is excessive for building purposes relates directly to the difficulty and costs involved. Given that a foundation has to be constructed in manner providing a level surface for building, slopes become excessive when one end of the foundation wall is excavated into the slope for its full height and the other end is exposed at its lowest point. Slopes of twenty-five (25) percent or greater generally present this difficulty. The same principle applies to the construction of an ISDS, however in this instance the entire system must remain a specified distance below the surface of the ground thereby creating additional concerns. Figure 3.1 illustrates this situation.

The primary concern when designing an ISDS on a sloping site is guarding against "lateral seepage; or the discharge of partially treated effluent on the downhill side of the system. To protect against this possibility a minimum distance is usually required within which only a slight change in the verticle elevation of the ground surface is allowed. The Rhode Island standards establish a twenty-five (25) foot minimum from the edge of the system to the edge of any bank sloping to a level lower than the invert of the distribution line. This requirement is easily satisfied on relatively level ground (0-3% slope), however it becomes increasingly more difficult to comply as the slope increases. As one might expect, the New Hampshire standard is somewhat more flexible on this point, presumably due to the extensive mountainous regions of the state. Generally speaking, the requirements attempt to accommodate steep slopes and not prohibit construction on them. "Stepped" trenches are recommended in steep areas in order to follow the contour

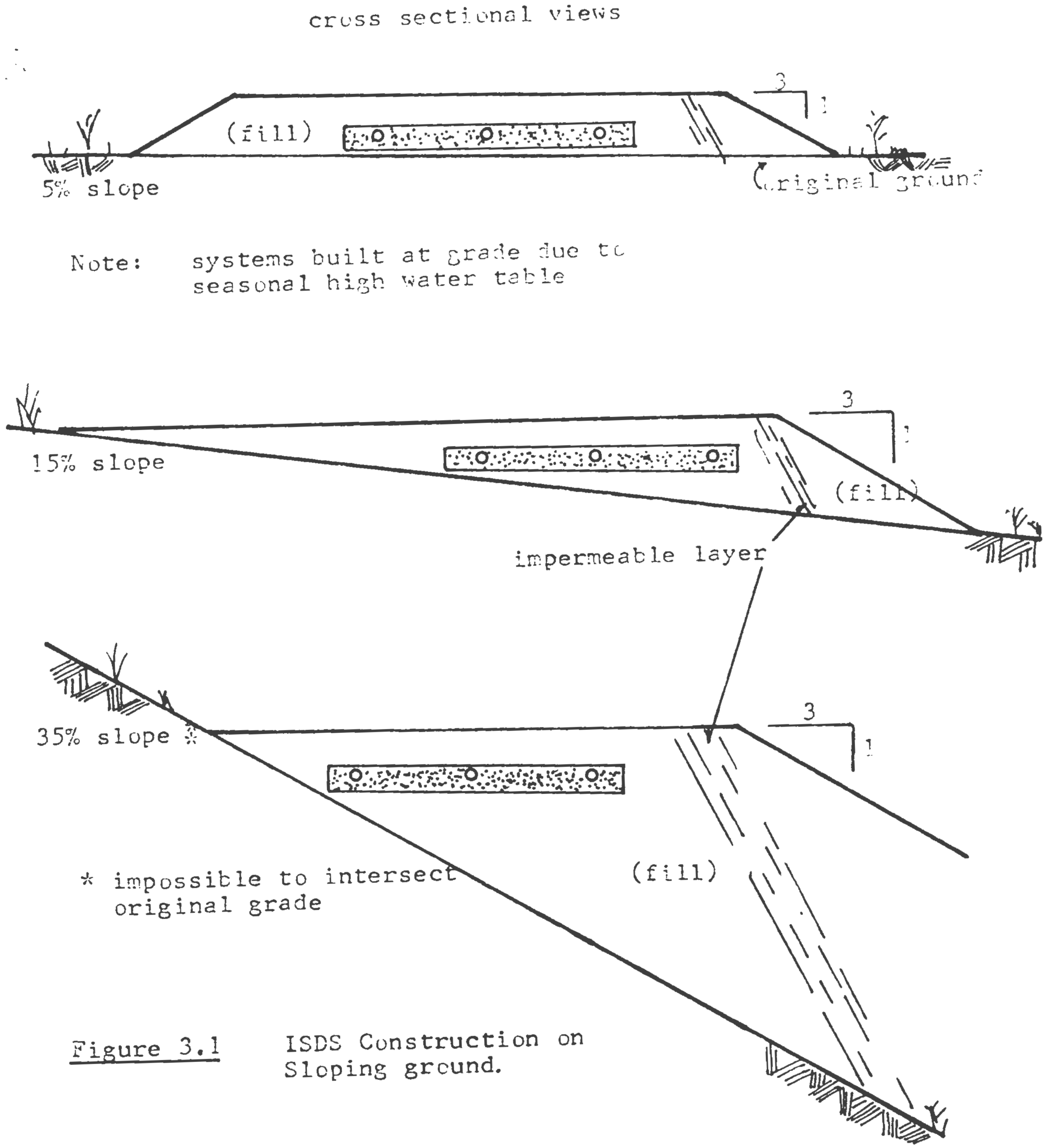


Figure 3.1 ISDS Construction on Sloping ground.

of the land. Where a high water table is also a problem and an above ground (fill) system is required, slopes in excess of 35% may become impossible to build on maintaining the recommended grading of 3 on 1. In this case extensive earthwork may be necessary to accomplish an acceptable design. It is interesting to note that in reviewing subdivision proposals the Commission requires that each lot contain an area with slopes less than 25% that are suitable for the construction of a leaching area. Areas within the subdivision with slopes in excess of 35% do not count as part of the minimum lot requirements.[2]

From an overall land management perspective, restricting development in steeply sloping areas appears to be an effective way of reducing development costs and mitigating the environmental problems associated with this factor. The difficulty with this approach is where to draw the line. Some guidelines have established slopes greater than 10% as a severe constraint to development, primarily due to the limitations on road construction. Others, including the New Hampshire ISDS regulations recognize areas with slopes up to 35% as developable. It is clear from these two examples that while slope does influence the suitability of a site for ISDS construction and use, the precise degree of slope imposes a constraint which is directly related to the cost of development, the type of system required and the extent of area to be disturbed, but does not necessarily preclude the use of an area. From a management standpoint, the evaluation of "steeply sloping" areas should give consideration to local conditions and other local minimum requirements which are likely to be affected, ie. maximum road grades, maximum allowable regrading slopes, home construction and ISDS requirements.

Soils and Groundwater

Perhaps the most important factors to consider when evaluating land for ISDS suitability are soils and ground water. The soil and ground water are inextricable associated with each other. Soil particle size and shape, the degree of compactness, texture and stratification directly influence ground water levels and percolation rates. The degree of saturation of a soil will influence its chemical and biological properties thereby reflected in a particular soil type. The U.S. Soil Conservation Service (SCS) has identified literally thousands of soil types or "series" throughout the nation. This inventory or Soil Survey as it is known, contains information about soils' measurable properties including depth and characteristics of distinctive layers, frequency of flooding; pH and depth to bedrock. This type of information is used to identify soils with similar characteristics for the purpose of classification. Once classified as a particular soil series, the SCS can provide extensive information on its suitability for a wide variety of uses. This information is invaluable to any land planning effort and of course is used widely.

When considering a site for subsurface sewage disposal, a good place to start is with the Soil Survey. The survey provides the user with matched aerial photos of the entire survey area (usually conforming to Local, State and County boundaries) upon which the soil series are mapped. From these maps one can get a general idea of which soils are located within the parcel and what characteristics one can expect to find in association with each series. The various properties of soil vary enormously however, depending on the local geological conditions affecting its formation. For this reason on-site analysis is required to make an exact determination. Both the Rhode Island and New Hampshire programs require soil analysis and percolation tests as part of the application process for ISDS approval. Soil analysis test pits must be dug in the general area of the proposed ISDS. The information requested from the analysis includes, but is not limited to the following: the depth, color, texture and compactness of the various soil layers (horizons), the depth to the watertable and the depth to bedrock or any other impermeable layer. With this information in hand, one can begin to apply the standards.

Table 3.2 shows the minimum standards pertaining to the above referenced factors. As mentioned above the percolation rate of a soil; or the rate at which water will infiltrate downward through the soil particles, is directly related to soil particle size and compactness. Generally speaking, fine

Table 3.2 Minimum Standards Relating to Soil and Water Characteristics: New Hampshire and Rhode Island

	Rhode Island	New Hampshire
Maximum Allowable Percolation Rate	40 min/inch	60 min/inch
Minimum Soil Depth to Watertable	3 feet	4 feet
Minimum Depth to Bedrock or Impermeable layer	5 feet	8 feet (6' with municipal water)

textured, tightly compacted soil will have a much slower percolation rate than course, loosely compacted soil. Any soil with a percolation rate slower than the maximum allowable rate is determined to be impermeable and as such, unsuitable for subsurface sewage disposal. Practically speaking, the slower the percolation rate the larger the leaching area must be in order to function properly without backing up or ponding at the surface. The New Hampshire regulations allow soils with rates as slow as 60 minutes per inch, compared to the Rhode Island maximum of 40 mins./in. It is assumed that these standards reflect the general soil infiltration capacities found throughout each state and the resulting limitation set in reasonable accordance therewith. For example, approximately 44 percent of the soil series in New Hampshire are poorly or very poorly drained compared with only 29 percent in Rhode Island.[3] It should be noted, however, that a soil's drainage classification may only be an indicator of its permeability - and in some instances the two can be inversely related.

Two other criteria used to measure the soils capability for sewage disposal, depth to watertable and bedrock, also differ between the states. Studies have indicated that most of the bacteria and viruses associated with domestic household wastewater are adequately filtered after passing through approximately three feet of natural soil.[4] Both state standards meet or exceed this requirement. This requirement dictates the relative position of the bottom of the leaching area to the ground water table. When a high watertable necessitates, above ground or mounded systems are permitted. The minimum depth to bedrock or other impervious layer merely reflects the depth needed to install a system retaining the minimum soil depth required for adequate filtration. This parameter is included to assure that a system is not located too close to an impervious layer thereby permitting untreated sewage to travel horizontally and possibly pollute the ground water or nearby surface water bodies. An impervious layer is comprised of soil material that has a percolation rate slower than the allowed maximum.

In summary, we can see that Rhode Island and New Hampshire have established standards relating to ground water and soil analysis that are substantially similar in terms of measuring site suitability. In order to fully understand the impact of these standards, the concept of a "receiving layer" must be introduced. Generally speaking, a receiving layer is the area below the bottom of the seepage system that absorbs and purifies the effluent before reaching the ground water table or impervious material. A receiving area must also meet minimum standards of suitability. According to the Rhode Island regulations, the installation of an ISDS is prohibited in any area where the ground water table is within 4 feet of the original ground surface, or where an impervious layer (slower than 40 min/in perc rate) is within 6 feet of the original ground surface. However, if certain additional requirements are met, approval may be granted in areas where the ground water table is within 2 to 4 feet of the original ground surface or where an impervious layer is within 4-6 feet of the original ground surface.[5] Based on the foregoing information, the only areas deemed to be unsuitable for ISDS installation in Rhode Island are those where the ground water is with 2 feet or an impervious layer in within 4 feet of the original ground surface; or where the slope is prohibitive.

By comparison, New Hampshire's regulations define the receiving layer as a layer of permeable soil (less than 60 min/in percolation rate) at least 2 feet deep (except with at least 3 feet of soil over shallow ledge) and with a seasonal high water table at least 6 inclhes below the original ground surface. A simple comparison of this criteria establishes the relative constraints each program poses from a development standpoint. The bottom line is that while both states require at least 2 feet of permeable soil, New Hampshire allows for a much higher seasonal high water table elevation and a slightly slower percolation-rate. This information alone may tend to indicate that New Hampshire is less stringent in its standards for minimum design and location of ISDS than is Rhode Island, however this information must be weighed in context with the other applicable standards (see Table 3.3), as well as against

Table 3.3 Comparison of Minimum Standards Pertaining to ISDS Location*

Feature	Rhode Island	New Hampshire
private well	100 ft.	75 ft.
public well	400 ft.	400 ft.
surface water	50 ft. (150' in erosion-prone areas)	75 ft.
subsurface drains	25ft.	75 ft.
foundations (full cellar)	15ft.	10 ft.
Property lines	10 ft.	10 ft.

*distance from leaching area to identified feature the respective enforcement policies of each administering agency.

The point I would like to stress here again is while these "critical" factors (percolation rates, depth to groundwater and depth to hardpan or bedrock) are indeed constraints to ISDS design and construction, the standards to not impose absolute limitations per se; that is in many cases measures can be taken to design around such conditions.

Wetlands

Marshes, swamps and bogs are well known landscape features, but only recently have attemps been made to group them under the single term "wetlands." Historically wetlands were treated as useless areas only to be filled or drained for a more "beneficial" use.[6] As our knowledge of these diverse areas increased, so did the appreciation of the many values afforded by these systems. Technically speaking, wetlands are lands saturated with water either periodically or continuously; where water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and or its surface. Deepwater habitats, ecologically associated and often contiguous of many wetland types are permanently flooded lands lying below the deepwater (usually greater than 2 meters, 6.6ft) boundary of wetlands.[7]

Wetlands perform many valuable functions in nature, that when disturbed or destroyed by man, usually require replacement by artificial means at great expense. For example, encroachment of the floodplain of a river may result in a net reduction of flood storage capacity, thus raising the level of flood waters and necessitating the construction of man-made barriers to contain the flood waters or suffer the expense of any damage as a result. Besides flood protection, wetlands are valued as essential breeding, rearing and feeding grounds for many species of fish and wildlife. Some wetlands also function to control pollution, while still others may serve as valuable groundwater recharge areas.

One of the most controversial aspects of ISDS use arises from situations where freshwater and coastal wetlands have been or may be contaminated by high nutrient and/or bacteriological pollution. Other potential destructive activities, like dredging and filling often occur in association with an application to construct and maintain a residential or commercial structure relying upon subsurface sewage disposal. In recognition of the many values inherent to wetlands in general, both Rhode Island and New Hampshire have passed laws protecting these areas from various destructive activities. Under Chapter 213 of the Public Laws of 1971, as amended, and Chapter 46-23 of the General Laws, the Rhode Island Department of Environmental Management and Coastal Resources Management Council are authorized to administer programs pursuant to this legislation respectively. DEM's Fresh Water Wetlands Section must review and approve any application for an ISDS located within fifty (50) feet of a marsh, swamp, bog or pond, or within one-hundred (100) feet of a river of less than to (10) feet in width during normal flow, of within two-hundred (200) feet of a river ten(10) feet or more in width during normal flow, or within a flood plain or other fresh water wetland as defined by the Act. The Coastal Resources Management Council (CRMC) has authority over any construction proposal in the coastal region of the State. The coastal region includes: all salt water beaches, barrier beaches and all land within two-hundred (200) feet of tidal waters; salt water ponds, salt water marshes, salt water wetlands or any other land subject to CRMC furisdiction.[8] In addition to this review authority, Section SD 3.05 of the ISDS regulations sets forth minimum distances to be maintained between parts of an ISDS and selected items, including watercourses. The minimum horizontal distance required between any of the various types of leaching "areas" and a watercourse (includes wetlands) is fifty (50) feet, A special provision relating to erosion-prone areas, as defined by CRMC's Coastal Zone Management Program, requires that the minimum setback from the spring (mood) tide elevation to the edge of the system shall not be less than 150 feet. (see Table 3.3)

New Hampshire has similar legislation protecting its fresh water wetlands and tidal areas. Chapter 521 of the Laws of 1971, as amended, grants to the Commission the authority over any proposal to dredge, excavate, place fill, mine or otherwise alter the characteristic of the terrain in or on the surface waters of the state. Chapter 483-A, of the Revised Statutes Annotated, establishes the Water Resources Board for the purpose of protecting and preserving the submerged lands of the state under tidal and fresh waters and its wetlands. While no specific minimum setback distances are setforth in these statutes, RSA 149.E does require a minimum of seventy-five (75) feet between the edge of the system and any surface water.

Subdivisons

Perhaps the most important aspect of ISDS regulation involves the subdivision of undeveloped land. The initial planning stages of the subdivision process allow for a comprehensive evaluation of the land by examining the various alternatives available for road design, lot layout, building sites, landscaping and drainage. The minimum standards for ISDS design, construction, and location have no greater impact on land development than at this time. The following paragraphs will discuss the minimum standards set forth in each program concentrating once again on site suitability.

Section SD 18.01 of Rhode Island's ISDS regulations require that:

> No person shall begin construction in any subdivision located in areas where sewage will have to be disposed of by means of individual sewage disposal systems until he has obtianed certification from the director that the subsoil is suitable for disposal of sewage by individual sewage disposal systems.

The so-called preliminary suitability determination requires evidence that the percolation rates and ground water table depths will be served by municipal sewers, subdivisions in which all lots are greater than five (5) acres in size, and exchanges of land between abbutters when the number of ownere does not increase and no sewage disposal system is to be constructed on the exchanged land.

The factors affecting lot size include soils, slope and surface water. Other features such as deeded right of ways are also taken into consideration. Essentially, lot sizes are determined in the following manner:

> Soils- Lot sizes are calculated on the bases of the predominant soil type. There should be a minimum of 20,000 contignous square feet of soil with a receiving layer, of which at least 40,000 square feet of contiguous area should be suitable for the placement of an ISDS (i.e., 5' to ledge, 75' to water, 10' to property boundaries, etc.). A receiving layer is a layer of permeable soil at least 2 feet deep (except with at least 3 feet of soil over shallow ledge) and with a seasonal high water at least 6 inches below the surface.
>
> Slope - The slope of the lands is figured in the lot size requirement. Land with a slope in excess of 35% is not counted. Each lot must have an area with a slope of less than 25% suitable for the location of a leaching area.
>
> Surface water - Ponds, streams and perenially wet swamps are not included in calculating minimum lot size, even though lot boundaries may include these areas.

To aid the applicant in calculating lot sizes, the Commission has formulated a soil grouping classification system that can be easily cross references with slopes to attain a recommended minimum lot size. Table 3.4 shows the soil groupings according to drainage characteristics and permeabiltiy. Group 6 soils are not considered suitable for subsurface sewage disposal and with the exception of thosesoils classified as Group6 because they are in a flood plain, cannot be considered in computing

Table 3.4 New Hampshire Soil Groupings According to Drainage Class and Permeability

The NHWSPCC has established minimum recommended lot sizes based on the following soil groupings. Use this in conjunction with Minimum Lot Size Chart, Table 3.5

Group I Well-drained to excessively well-drained soils with rapid permeability	Group 2 Well-drained soils with moderate permeability	Group 3 Moderately well-drained and well-drained soils with hardpan
Adams	Agawan	Acton
Colton	Berkshire	Becket
Danby	Brookfield	Belgrade
Gloucester(Canton)	Charlton	Croghan
Hermon	Groveton	Deerfield
Hinckley		Duane
Jaffrey		Elmwood
Merrimack		Essex
Stetson		Hartland
Warwick		Madawaska
Windson		Marlow
		Melrose
		Ninigret
		Paxton
		Peru
		Scituate
		Skerry
		Sudbury

Group 1 cont'd.	Group 2 cont'd.	Group 3 cont'd.
		Sutton
		Waumbek
		Woodbridge

TABLE 3.4 (concluded)

Group 5 Bedrock relatively close to surface	Group 5 Poorly drained soils	Group 6 Floodplain soils or very poorly drained soils	
Brimfield	Au Gres	Biddleford	2
Canaan	Buxton	Hadley	1
Hollis	Leicester	Limerick	1,2
Lyman	Raynham	Ondawa	1
Shapleigh	Ridgebury	Pondunk	1
	Saugatuck	Rumney	1
	Scantic	Saco	1,2
	Suffield	Scarboro	2
	Swanton	Suncook	1
	Walpole	Whatley	2
		Whitman	2
		Wiooski	1
		Muck	
		Peat	

1- Floodplain

2- Very poorly drained

in the areas of proposed ISDS use, are in accordance with the standards set forth as discussed above (see Soils and Groundwater). This determination is based upon existing soil and watertable conditions and does not take into account individual ISDS designs for each lot. For example, the certification may stipulate a minimum size leaching area for portions of the land with very slow percolation rates or require a wetlands determination for areas bordering on wetlands. Moreover, the suitability determination is only a general opinion of whether the proposed parcel has sufficient area suitable to meet the minimum design standards and for this reason should not be viewed as a land use suitability determination. The distinction here is that the ISDS suitability is perceived as an engineering problem, whereas land use suitability encompasses a much broader range of concerns including overall density and compatability of uses, design, protection or preservation of valuable natural resources, municipal costs for services and so on.

Also included under subdivision review is an interesting provision requiring an impact assessment for subdivisions bordering on or within fresh water or coastal wetlands if a substantial question exists regarding the cumulative impact of the operation of ISDS on the water quality of a unique or valuable body of ground water or surface water. Such an assessment may include an evaluation of the following potential impacts:

1. Whether the operation of such systems will result in a loss of a use assigned to that class of water quality as desingated by the Department's Rhode Island Water Quality Regulations for Water Pollution Control.

2. Whether the operation of such systems will result in a reduction in the ability of the wetland to support indiginous animal and plant life.

This provision clearly marks a departure from the balance of the rules and regualtions which are geared toward meeting the specification standards where no attempt is made to broadly assess impacts. The inclusion of this provision points toward a major shift in public attitudes toward growth and development. The public is no longer willing to accept the problems associated with various developments, without first studying the alternatives and identifying the impacts. The following case study (see Chapter 4) of one such subdivision undergoing an impact assessment hopefully will shed some light on this process and how and why it may be better addressed under a broader scope of public concern.

Chapter 8 of the New Hampshire Guide, "Subdivisions under RSA 149-E," charges the Commission with determining adequate lot sizes in accordance with the soil's ability to absord waste without polluting water supplies or adjoining waters. The Commission defines a subdivision as "the division of a tract or parcel of land into two or more lots, tracts or parcels for the purpose of sale, rental, lease, building development or any other reason. Mobile house park sites, condominiums and campground sites come under this classification."[9] Specifically excluded from the subdivision requirements are lots that acceptable lot areas. In those areas with flood plain soils, only land above the 50 year frequency flood elevation can be counted. Table 3.5 shows the recommended minimum lot sizes for single family residential lots with up to four bedrooms. Additional units are considered in terms of bedrooms and are proportionally larger depending on the total sewage loading. It should be noted that the lot sizes shown in Table 3.5 pertain to residential uses with both on-site sewage disposal and water supplies. Lots served be a municipal or otherwise approved off-lot water supply must be at least one-half the size shown or 20,000 square feet, whichever is larger.

The review of proposed subdivisions by the New Hampshire Commission stipulates several requirements beyond the scope of Rhode Island DEM's subdivision review under the Rhode Island law. While in Rhode Island no building permit may be issued for a building without an approved ISDS application, New Hampshire's regulations also mandate that no lot shall be sold in any subdivision without having received Commission approval. Most notable, the required minimum lot size section poses some interesting questions from a land use planning standpoint that apparently rarely become issues in New Hampshire communities. The Commission does not view itself as a land planning agency, despite the potential influence over local land use decision making the minimum lot size requirement might have. While no effort is made here to evaluate the status of local land use

TABLE 3.5 New Hampshire Minimum Lot Sizes According to Soil Group

Slope Classification	% Slope	Soil Grouping 1	2	3	4	5
AB	0-8%	30,000	39,000	48,000	43,500	90,000
C	8-15%	33,000	43,000	53,000	48,000	n.a.
D	15-25%	36,000	46,800	62,000	52,000	n.a.
E	25-35%	39,000	50,700	72,000	57,000	n.a.

Footnotes:

1. The above lot sizes are for single-family residences of not more that four bedrooms.
2. For individual lots served by a municipal or approved "community" of lot water supply, the lot size should be at least one-half the size shown above or 20,000 square feet, whichever is larger.
3. Where ledge is encountered at less than eight feet, Group 4 soils rules apply: a test pit is required on each lot.
4. Group 6 soils are not suitable due to either frequent flooding or no receiving layer, except as noted on Page 80.

controls in New Hampshire, it is interesting to note that approximately 57% of New Hampshire communities have zoning ordinances and 94% have subdivision regulations (see Appendix A). Of these communities, almost 90% have established standards relating to lot sizes more stringent than those required under RSA 149-E. For this reason, according to Commission personnel, little controversy has surfaced in the course as a result of these requirements.[10] In fact, due to New Hampshire's relatively large percentage of undeveloped land, the Commission has generally taken a pro-development stance in enforcing these regulations and seeks to aid the developer to overcome the limitations of the land, rather than prohibit development on it.

In summary, it can generally be shown that the factors considered by both New Hampshire and Rhode Island for making site suitability determinations are comparable. That is, both programs are set up to evaluate soil percolation rates, slopes, depth to ground water, depth to impervious materials (bedrock, hardpan) and location relative to features susceptible to contamination by sewage effluent, i.e., wells, ground water, wetlands, etc.). While there is little uniformity between the two states regarding these criteria, the range of standards appears to fall within acceptable tolerances as established in the literature.[11] The most notable deviations from established findings in the field relate to percolation rates and the minimum distances established to protect surface and ground water (wells) from contamination.[12] Moreover, the minimum lot size criteria used by the New Hampshire Water Supply and Pollution Control Commission appears to fly in the face of recent findings regarding the soils ability to treat sewage effluents and the nature of soils most likely to contribute to gronnd water pollution through excessive nutrient loading.[13]

In the following chapter, the application of the New Hampshire minimum lot sizes is tested in a Rhode Island coastal subdivision to exemplify these apparent deficiencies in ISDS site suitability criteria.

Variances and Appeals

A word about variances and appeals may be helpful at this point. Both programs provide the applicant with the opportunity to appeal a decision of the administering agency. Based on finding of fact such appeals may be granted relieving the applicant of any requirements found to be unreasonable or unlawful. The Rhode Island program specifically lists procedures to be followed when requesting a variance from any of the minimum standards setforth. Whereupon the findings of the variance review committee reveal that the granting of said variance will not be contrary to the public interest or public health, and where a substantial hardship exists if a strict interpretation of the standards is adhered to, a variance may be granted subject to any conditions or terms that the review committee may deem necessary.

Although the opportunity for a variance or appeal in the terms of any administrative decision is typically provided for as a matter of due process of law, the impact that this may have on effectiveness of ISDS regulations as a form of land use control is clear. If the aggrieved party can substantiate a claim that a variance and or appeal is warranted, then any of the so-called "critical siting factors" may be waived. This is not to imply that variances or appeals are granted haphazardly or without adequate cause, but merely to point out that procedures do exist under both programs allowing the applicant relief from the requirements.

NOTES

1. The original Rhode Island Program made no reference to water quality per se in establishing standards for ISDS.

2. This apparent inconsistency in addressing maximum allowable slopes relates to the concept of the "receiving layer" (see section on Soils and Ground water), and generally illustrates a more stringent approach in the review of subdivisions as opposed to individual lot applications.

3. Percentage based upon Soil Conservation Service drainage classes and an inventory of Rhode Island and New Hampshire's soils by this investigator.

4. J. Bouma, "Unsaturated Flow Phenomena During Sursurface Disposal of Septank Effluents," 1975.

5. According to Section SD 15.00 (6) of the Rhode Island Rules and Regulations (1980), the following additional requirements must be met:

   a) only disposal trenches shall be constructed on such property and the minimum sidewall to sidewall trench spacing shall be 10 feet with no credit allowed for sidewall area.

   b) The trench design percolation rate shall be based on percolation tests run in the original ground; however, in no case shall the design percolation rate be less than 5 min/inch.

   c) At least two soil exploration holes shall be dug over the area of the proposed disposal system. The soil exploration holes shall assess the soil and ground water on both the uphill and downhill sides of the proposed system.

   d) All applicable tests may be witnessed by the Director

   e) The excavation preparation procedures given in Section SD 11.06 shall be followed.

   f) The design shall consider the need for diversions of surface water runoff.

   g) Where excavation into the ground water table is a potential problem the excavation work shall be limited to the dry season period, unless otherwise authorized by the Director.

6. John and Mildred Teal, Life and Death of a Salt Marsh, 1969.

7. U.S. Fish and Wildlife Service, Classification of Wetlands and Deepwater Habitats of the United States, 1979.

8. Rhode Island's Coastal Zone Management Program authorizes CRMC to extend regulatory powers over specifically designated non-coastal uses where potential impacts may affect coastal areas. Examples of these uses are landfills, sewage treatment plants and energy production facilities.

9. New Hampshire Water Supply & Pollution Control Commission, Guide for the Design, Operation and Maintenance of Small Sewage Disposal Systems, 1978.

10. F.Elkind, staff meber of NHWS & PCC, personal interview, July 1981.

11. Reference is to Chapter II of this report.

12. K.H. Healy and R. Laak, "Problems with Effluent Seepage Fields," 1974. D.R. Lee, "The Role of Groundwater in Eutrofication of a Lake in Glacial Outwash Terrain," 1976.

13. J. Bouma, "Innovative On-site Soil Disposal and Treatment Systems for Septic Tank Effluent," 1975. University of Rhode Island, Coastal Resources Center, "Salt Ponds" No. 2, 1981.

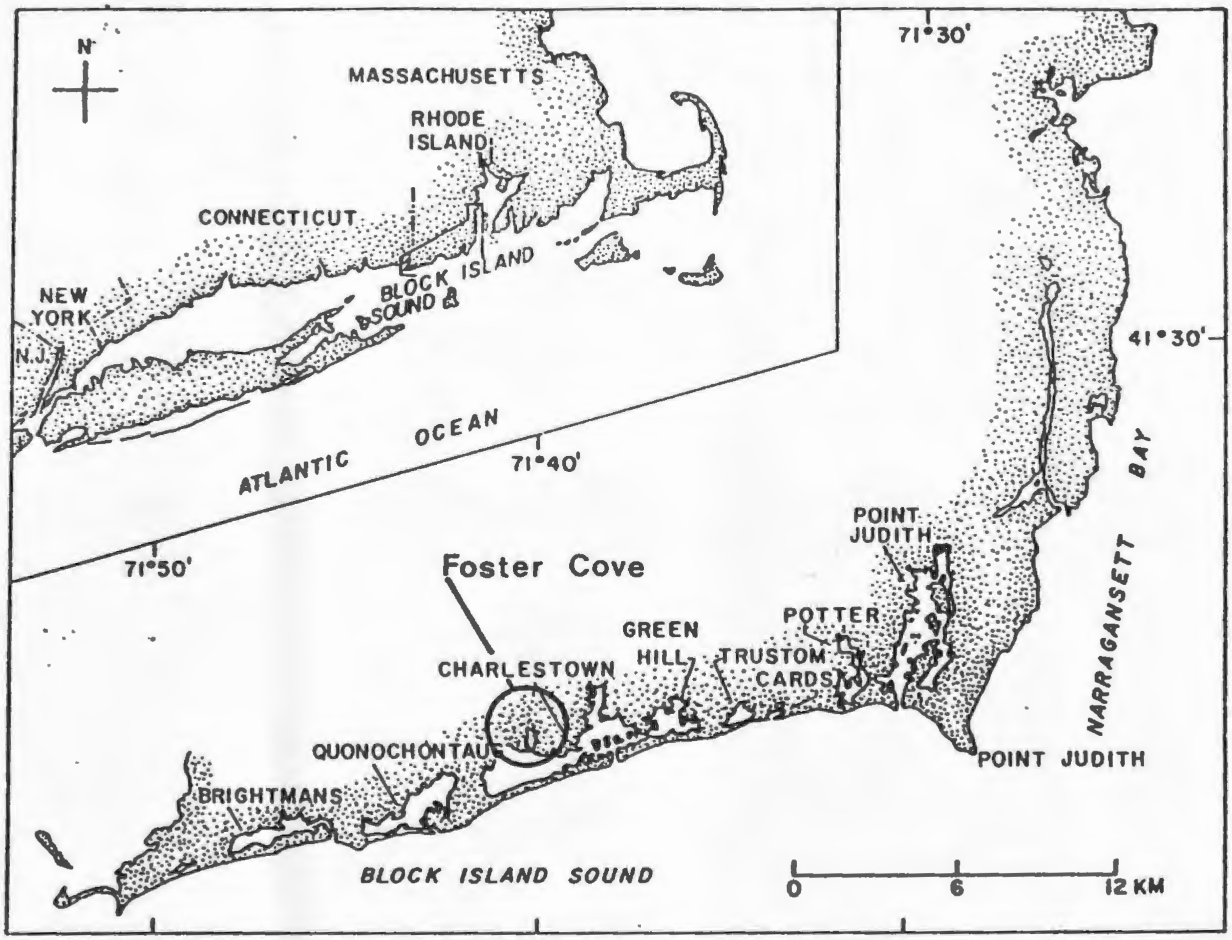
CHAPTER 4

ISDS AND THE SUBDIVISION PROCESS

The subdivision of land engenders the full range of individual sewage disposal requirements necessary for making accurate site suitability determinations. This chapter examines this process as it relates to the overall density and distribution of dwelling units within a selected subdivision. The purpose of this section is twofold. First, it provides a framework for a comparison of the Rhode Island and New Hampshire ISDS programs with regard to site suitability factors. The emphasis here is to determine whether or not these programs provide sufficient protection for the delicately balanced ecosystem of a fragile coastal environment. This determination will be based upon the density and distribution of dwelling units in relationship to the critical factors mentioned above. Secondly, from this analysis I intend to isolate potential areas of concern for the followup discussion on carrying capacity.

The Study Area

The selected subdivision lies along the northern edge of Charlestown pond on Rhode Island's south shore. Charlestown pond is one of several salt ponds or lagoons that lie parallel to the coast along the south shore. (Map 1). These shallow embayments are separated from the sea by narrow strips of land called barrier beaches. In some cases the ponds are connected



Map 1. Rhode Island's South Shore salt ponds.

to the sea by man-made breachways, while others may be subject to occasional wash over or may be breached naturally by severe winter storms or hurricanes. The glacial origin of this area accounts for two very distinct landforms. Approximately parallel to, and one mile north of Block Island Sound lies an irregular ridge of unstratified, upland material known geologically as a recessional moraine. Deposited nearly 10,000 years ago as the last stages of the Wisconsin glacier receded from this area, the moraine is actually made up of earth, stones and other debris carried along by the glacier and finally dumped, marking the approximate location of a temporary stagnation in the ice flow. Associated with the moraine is the extensive, low lying outwash plain to the south, running from the foot of the moraine to the Sound. The outwash plain is made up of stratified sand and gravel carried, sorted and deposited mostly by the melt waters of the glacier.

In addition to the unique geologic features of the coastal pond environment, the area is also rich in ecological diversity. Because of the shallow, unturbid nature of the pond system, sunlight penetrates through the water to the bottom, supporting dense beds of eelgrass and algae. The energy fixed by these benthic (bottom dwelling) plant communities together with that fixed by other phytoplankton in the water column makes the ponds very productive ecosystems.[1] Extensive areas of salt marsh and tidal flats also add to the productivity of these systems. Animal life is also abundant in the ponds. The brackish water environment provides suitable habitat for both fresh water and marine organisms during certain stages of their life cycles. Anadronmous finfish migrate to the ponds from off shore to spawn. Species including striped bass, alewife, tautog, white perch and winter flounder have been identified in large numbers in larval form.[2] Presently the ponds support a limited fishery consisting mainly of flounder, eels, scallops, and quahogs.

The natural amenities found on the South shore add to the area's value as a public recreational resource. The ponds are used extensively for boating and recreational fishing. Several small marinas operate here as well as one of the States largest commercial fishing ports in Galilee. Studies have indicated that more than half the total value produced by the natural resource sector of Rhode Island's economy is attributable to the fishing industry.[3] Estimates of the ponds value as a nursery for winter flounder range as high as 25 percent.[4]

Another significant attribute of the area is the large amount of land used for agricultural purposes. Crops of corn, potatoes and nursery stock make up the majority of the commercial crop. These products not only add to the local economic vitality, but also contribute substantially to the aesthetic value of the area as well.

Until recently, the south shore had remained relatively undeveloped due to its considerable distance from major employment centers and the unattractiveness of the shallow ponds for major port facilities. However, as transportation corridors improved and urban populations migrated to outlying areas, pressure for residential and recreational uses began to increase. Today, the rate of residential development in the South shore area is ranked among the highest in the State. Unfortunately, since the south shore does not conform to any particular political boundary, accurate data on housing and population are lacking at this time. It is possible however, to estimate the relative population growth by examining local building permit records. Information compiled for 1980 reveals that two south shore communities ranked among the highest for the number of building permits used during that year. The City of Warwick topped the State with 100 permits issued, followed closely by South Kingstown, with 95 and Charlestown with 94.[5] Figure 4.1 shows the dramatic increase in the number of houses built around four south shore ponds since the 1950's. Preliminary population estimates for the Charlestown area alone suggest a growth rate of approximately 40 percent for the 5 year interval between 1975-1980. By comparison the growth rate for the state as a whole was .9 percent for the same five year period. Moreover, preliminary census data for 1980 indicates that approximately 1,930 new residents moved into Charlestown since 1970, accounting for a 60 percent increase in the total population.

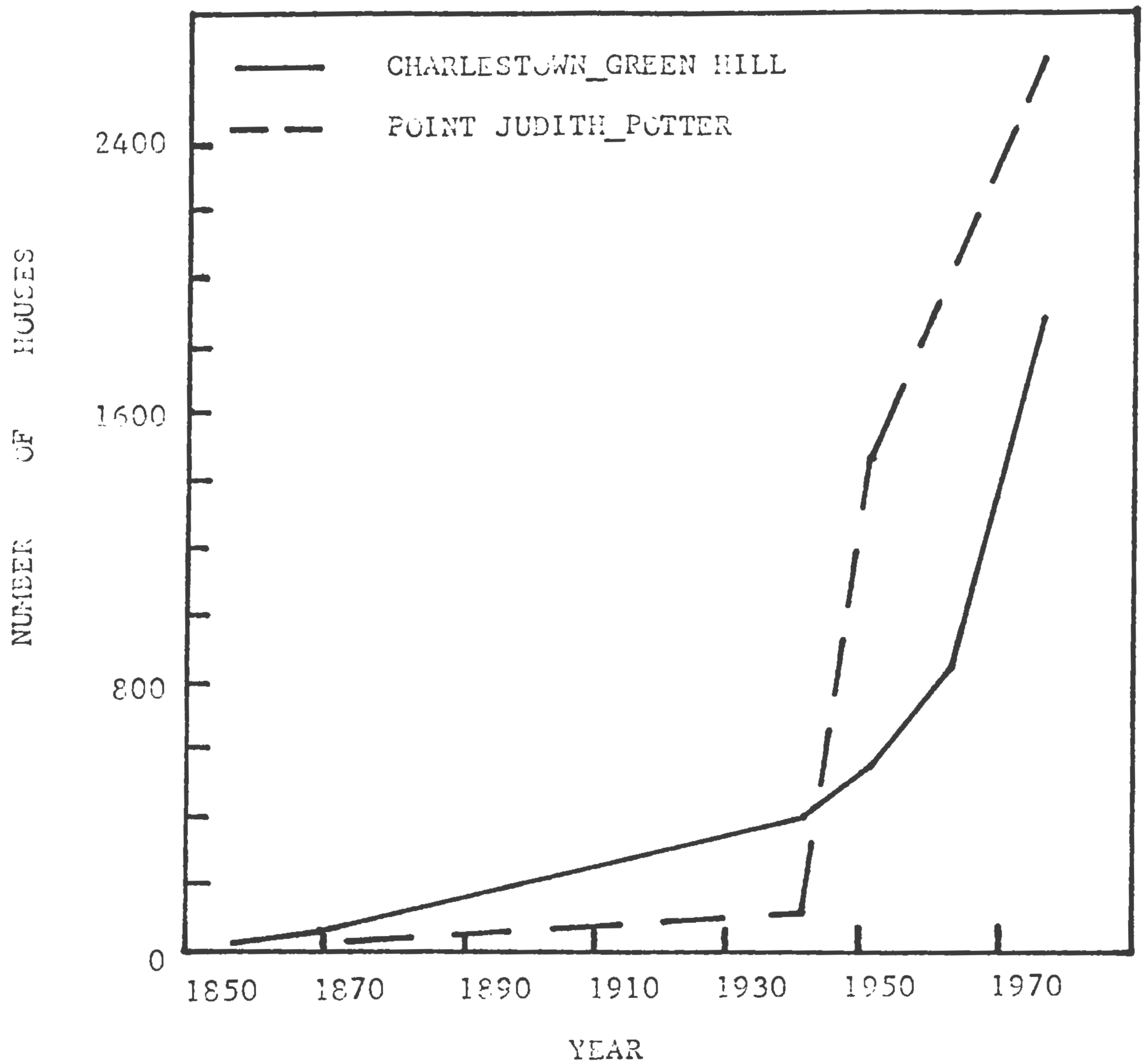
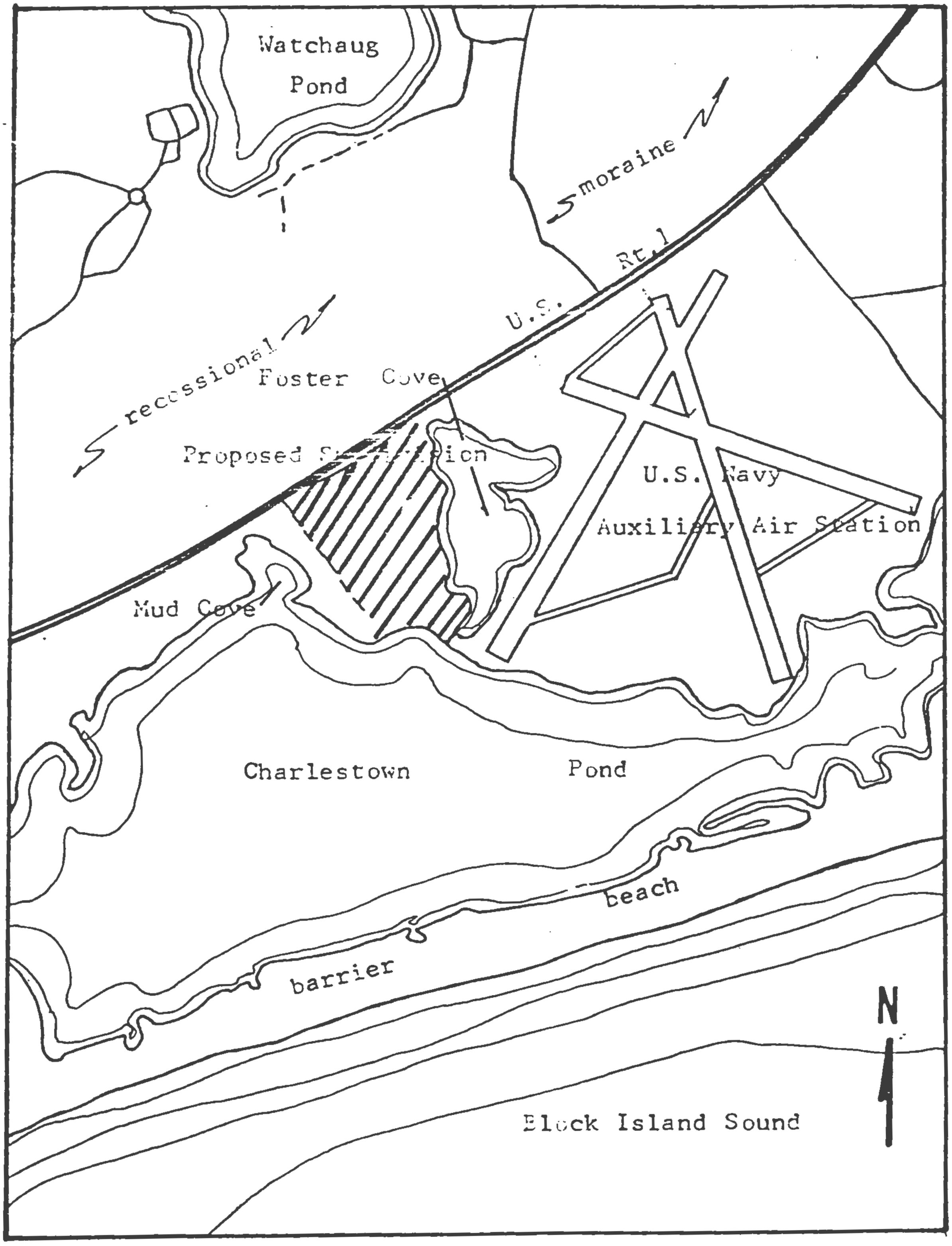


Figure 4.1 Increases in Housing for Selected South Shore Ponds, 1850-1970. (Source . Lee, Virginia, 1980.)

The Foster Cove Plat

Foster Cove is a shallow, poorly flushed embayment located along the northern shoreline of Charlestown Pond in Charlestown, Rhode Island. The site is essentially an undeveloped, open field at this time, with the exception of two residential dwellings on the western shore of the Cove and a commercial motel operation in the northern boundary of the site bordering along U.S. Route 1. (See Locus Map). This particular subdivision proposal was chosen for analysis for a number of reasons. First and foremost, the proposed subdivision of this parcel has raised considerable controversy and ensueing legal action as this development became the test case for the CRMC to assess the cumulative impact of ISDS use in a coastal environment. Second, the physical characteristics of the land are relatively easily identified, thereby reducing the chance that "unknown" variables may affect the outcome of the study. Finally, this subdivision was selected because it is located within a sensitive ecological area, thus providing the backdrop for the concluding discussion on the carrying capacity methodology.

The total parcel contains approximately 70 acres of land zoned for residential development with 40,000 square feet being the maximum lot size for a single family dwelling. In October of 1978, the final Foster Cove Plat containing 59 lots was filed in the land evidence records of the Town of Charlestown. The lots range in size from 40,000 square feet to 53,800 square feet with the average lot size being 44,000± square feet (see Map 3).

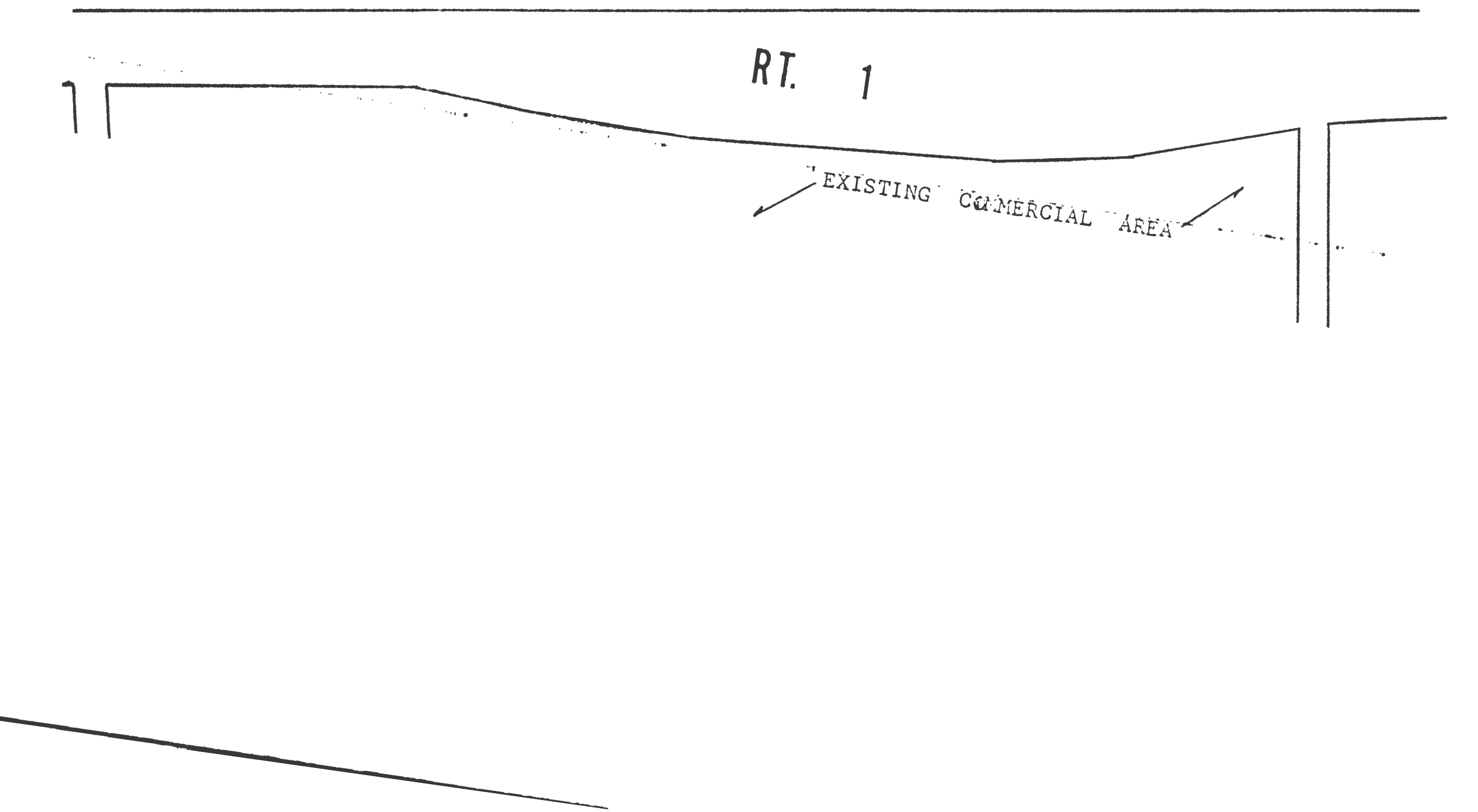


MAP 2. The Study Area in Charlestown, R.I.

Foster Cove Plat

ZONING: RESIDENCE R-40

MINIMUM LOT SIZE: 40,000 sq. ft.



A great deal of discussion has centered around the importance of minimum lot size as a method of controlling pollution from ISDS use, but often, as in the instant case, lot size has already been determined through local zoning laws necessitating some other form of control to protect vulnerable resources. The RI 208 Water Quality Management Planning Program recommends that areas served by public water and ISDS should have minimum lot sizes of 15,000 sqqare feet. Areas dependent on both wells and ISDS should have minimum lot sizes of 60,000 square feet. While hopefully there is a margin of safety built into any minimum lot size requirement to account for the wide variation in soil and groundwater characteristics, some evidence has indicated that the use of minimum lot sizes and setbacks alone may be in sufficient, contending that consideration must also be given to subsurface geology, slopes, groundwater and other pertinent factors of ISDS design.[6] The following description of the site conditions at Foster Cove is included to aid in the evaluation of the New Hampshire minimum lot size requirement as it would affect the density of housing and quality of water resources.

The soils found at Foster Cove formed from parent material of underlying glacial outwash, as mentioned in Chapter 3. According to the Soil Conservation Service (S.C.S.) Soil Survey, the site contains five (5) soil series. They are; Enfield silt loam, 0-3 percent slope; Enfield silt loam, 3-8 percent slope; Matunuck mucky peat; Scarboro mucky sandy loam and Tisbury silt loam. The mapping unit for each respective series is as follows: EfA, EfB, Mk, Sb and Tb. The following information, mostly from the Soil Survey, describes the physical properties of each series necessary for allocating it to one of the six (6) New Hampshire classification groups.

Enfield silt loam, 0 to 3 percent slopes. This nearly level, well drained soil is on terraces and outwash plains. The permeability of this soil is moderate in the surface layer and subsoil (0-25") and very rapid in the substratum (25-60+"). Runoff is slow. ISDS need careful design and installation to prevent pollution of ground water. Slopes in excavated areas are commonly unstable requiring measures to control erosion during construction.

Matunuck mucky peat. This nearly level, very poorly drained soil is in tidal marshes and is subject to tidal inundation. Most areas are in salt marshes. Slopes are generally less than 1 percent. The permeability of this soil is rapid in the surface layer, rapid to very rapid between depths of about 12 to 18 inches, and very rapid at a depth of more than 18 inches. Runoff is very slow, and water is ponded on some areas. Daily tidal flooding and a high salt content make this soil unsuitable for most uses except as habitat for saltwater-tolerant wildlife.

Scarboro mucky sandy loam. This nearly level, very poorly drained soil is in depressions and drainageways of terraces and outwash plains. Slopes range from 0-3 percent but are adominantly less than 1 percent. The permeability of this soil is moderately rapid in the surface layer (0-6") and rapid on very rapid in the substrature (6"-60+"). Runoff is slow. This soil has a seasonal high water table at or near the surface from late fall through midsummer.

Tisbury silt loam. This nearly level, moderately well drained soil is in depressions in terraces and outwash plains. Slopes range from 0-3 percent but are dominantly less than 2 percent. The permeability of this soil is moderate in the surface layer and subsoil (0-28") and rapid or very rapid in the substratum (28"-60+"). Runoff is slow. This soil has a seasonal high water table at a depth of about 20 inches from late Fall through mid-Spring.

Portions of the southern and western boundary of the parcel contain wetland plant communities. A shrub type wetland dominates this area interspersed by smaller sections of fingne salt marsh. A larger salt marsh is located just to the east of the property near Mud Cove. As indicated by the previous soil descriptions, the slope of this parcel is very slight. The average elevation of the parcel is generally 8-10 feet above mean sea level (MSL). The property gains in elevation slowly as one moves from the water's edge toward U.S. Route 1. The elevation of Route 1 at the property boundary is approximately 50 feet above MSL. Overall the parcel has an average slope of less than 1 percent.

A major consideration of the subdivision analysis under the Rhode Island ISDS program is whether the operation of subsurface sewage disposal systems will result in a degradation of an assigned water quality classification. This concern stems, of course, from the ability of some constituents of sewage effluent to persist in the ground water, thus presenting the possibility of eventual contamination of the ground water itself or nearby surface water bodies receiving ground water discharge (see Chapter 2). Recall that the effectiveness of a properly designed system for treating sewage is directly related to the soil and ground water characteristics. Loosely compacted, sandy soils tend to have excessively rapid percolation rates that can lead to inadequately treated effluent. In addition sands and gravels are largely mineral soils and as such may have a lower cation exchange capacity and hence a lower ability to adsorb potential chemical pollutants. Furthermore, seasonal high ground water levels may saturate the soil below a system thus reducing the effectiveness of aerobic decomposition within the receiving layer. Table 4.1 shows some of the pertinent soil and water features of the four soil series described above. Enfield soils are considered together.

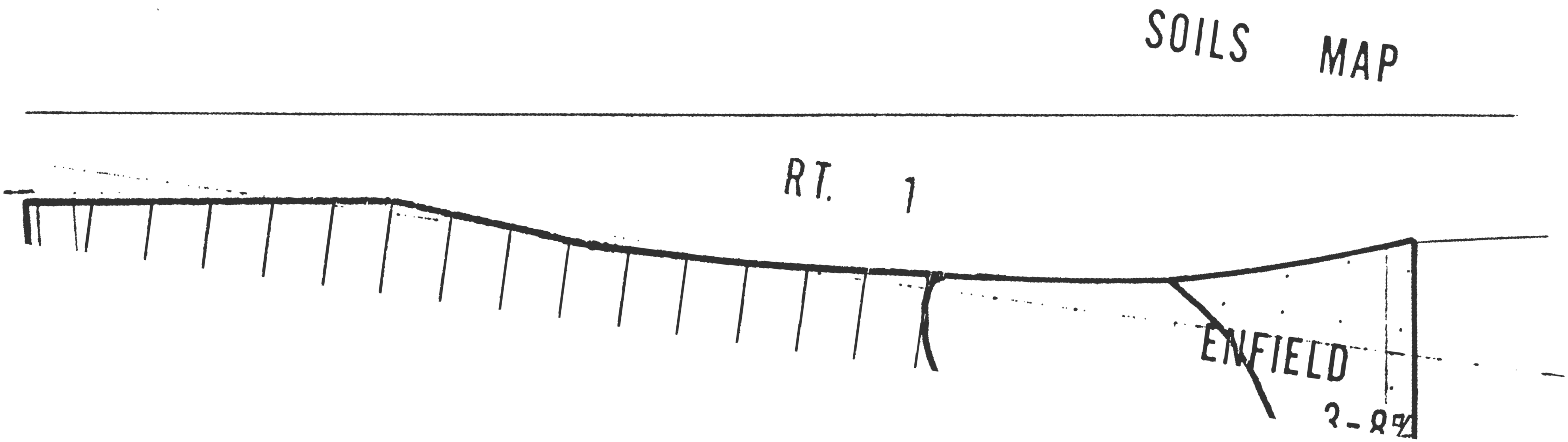
Table 4.1 Soil and Water Features

Soil name and map symbol	Permeability min./ in.	High Water Table Depth ft.	Months	Bedrock Depth in.
Enfield, EfA, EfB	3-30	>6.0		>60.
Matunuck, Mk	3-10	0-1.0	Jan-Dec.	>60.
Scarboro, Sb	10	0-1.0	Nov-July	>60.
Tisbury, Tb	10-30	1.5-3.5	Nov-April	>60.

The permeability rates shown in Table 4.1 may be used as an indication of a soils percolation rate, however one should recognize that there is difference in the way that these two measurements are derived. The permeability of a soil is that quality which enables it to transmit water or air, while the percolation rate is the downward movement of water through the soil. Both characteristics are calculated in inches per hour (or min/in) and therefore provide a rough indication of the rate at which water will move through the soil. From Table 4.1 one can see that the soils found at Foster's Cove present some constraints for siting ISDS. By combining the Enfield series, the data indicates that three of the four soils exhibit seasonal high water tables and all have moderate (30 min/in) to very rapid (3 min/in) permeability. Under normal conditions, it might be considered an asset for a site to have rapid percolation rates because this is after all, one of the criteria that must be met in designing an acceptable system. Unfortunately, in the instant case this characteristic actually worked against this particular subdivision proposal. In order to evaluate the impact of using the New Hampshire minimum lot size approach in this case, existing density restrictions, based upon local zoning requirements will be discussed.

Based on the current zoning of 40,000 sq. ft. per unit, the maximum allowable number of dwelling units, excluding areas occuppied by roads, is 66. Since the Rhode Island ISDS program has no authority over establishing minimum lot sizes, this means that in accordance with the existing zoning, the subdivision could theoretically contain 66 individual lots of 40,000 sq. ft. each. For reasons unknown, the developer chose to include some larger lots and ultimately ended up with only 59 lots. Assuming that all lots meet the minimum requirements for on site sewage disposal according to Rhode Island standards, this development has an average net density Of.84 dwelling units per acre. The following soils map illustrates how these lots overlay the various soil types. As expected there appears to be little correlation between soil type and lot size. This is due of course, to the fact that the 40,000 sq. ft. lot size allows ample space to meet the minimum setback distances in the Rhode Island ISDS program ie. 100' to wells, 50 to wetlands, 10' to property lines etc. The broaden issue of the cumulative impact of this development will be addressed following an analysis of the site using the New Hampshire, minimum lot size.

Foster Cove Plat



The Subdivision Under the New Hampshire Guidelines.

It should be stressed that the existing subdividion plan is based upon the minimum requirements contained in the Town of Charlestown's subdivision and zoning ordinances. The layout of lots and roads must conform to the provisions contained in these regulations and are not the result of any specific requirement of the Rhode Island rules and regulations governing ISDS. The validity of applying the New Hampshire criteria for minimum lot size necessarily rests with the assumption that the lot sizes, conforms in every aspect to the site suitability factors discussed in the previous chapter. In order to evaluate the effectiveness of a minimum lot size requirement, the New Hampshire standards are applied, assuming undeveloped conditions, and the resulting lot layout and density compared to the existing plat of record. For ease in comparison the existing road layout is retained.

The first order of business necessary to conduct this evaluation is the allocation of each soil type to the appropriate "Soil Grouping" established by the New Hampshire Commission for establishing lot size. Reference is made to Table 3.4 for a complete list of soil grouping for New Hampshire soils. It should be realized that not all soils found in New Hampshire also occur in Rhode Island, although there is some overlap. According to the criteria used for designating each soil to a particular "grouping" as shown on Table 3.4, the Foster Cove soils fall into the following categories: Enfield-Group 1, Matunuck-Group 6, Scarboro-Group 6, Tisbury-Group 3. The minimum lot size for each category can easily be determined from Table 3.5. In order to calculate density based on this criteria, a soils map must be prepared for the parcel to determine what areas fall into each category (see Map 4). Based on the soils map, a relative density is attainable from dividing each area (square footage) by the respective minimum lot size. Table 4.2 summarizes this data yielding the total number of lots allowed under the New Hampshire requirements. Road areas as shown comprise about 9 acres or 12% percent

Table 4.2 Development Data-New Hampshire Criteria

Soil	Acres	% of Total *	N.H. Soil Group	min. Lot size	No. of lots
EfA	22.0	31.0	1	30,000	31.9
EfB	2.0	4.0	1	30,000	2.9
Mk	1.0	1.0	6	N.A.	0
Sb	10.0	14.0	6	N.A.	0
Tb	35.0	50.0	3	48,000	31.7
TOTALS	70.0	100.0			66.5

*including area occupied by roads, values rounded

According to the New Hampshire criteria for establishing minimum lot size, well-drained to excessively well drained soils with rapid permeability are viewed as posing little constraint to ISDS and therefore are designated for the smallest lot sizes. The system is uniformly applied in this regard; i.e., as drainage

60. This of course assumes development of each lot at no larger than the minimum allowable area. Recall that the maximum number of lots allowable under existing zoning restrictions is 66, utilizing the same road pattern.

<u>Comparative Analysis: Rhode Island and New Hampshire</u>.

The application of the New Hampshire criteria for minimum lot sizes provides an interesting example of the difficulties involved in assessing the cumulative impacts on water quality from diffuse sources. In this case, two separate methodologies for controlling density, zoning and ISDS site suitability yield essentially the same maximum number of units. However, the ISDS requirements are based on the single purpose mandate to provide adequate area for sewage disposal, while zoning is based in much broader public policy issues of health, safety and welfare. The assessment process conducted by the State of Rhode Island's Coastal Resources Management Council may illustrate some of the issues involved. But first a summary of the findings resulting from the application of the two ISDS approaches is offered.

There are several ways of evaluating the impact from development relying on subsurface sewage disposal. One might be satisfied to rely upon a maximum number of units per acre as sufficient or the location of the systems might be deemed more essential, further still, a combination of these two approaches may be more appropriate. Or perhaps none of these approaches are satisfactory and other criteria should be sought for this type of analysis. This discussion focuses on the most apparent aspects of this subdivision comparison, the density and distribution of ISDS.

In accordance with the existing zoning at Foster's Cove, 66 units, each with an ISDS and private well is permissible. Since the zoning requirements are not soil dependent, these lots would be laid out uniformly across the entire tract. The level of protection afforded to the water resources now comes solely from the specification standards contained in the ISDS regulations. Under the Rhode Island law, all designs must be submitted as at least three bedroom capacity unless otherwise recorded in the land evidence records of the local community, so assume the sewage loading to be constant at approximately 450 gals/unit/day. The combined discharge to the ground water from this mode of development is 29,700 gals./ day of sewage effluent. Although the New Hampshire regulations allow for two bedroom designs, the typical single family home has at least three bedrooms, so this multiplier repeats itself yielding 27,000 gals./day for the development under the New Hampshire criteria. With these figures alone it is extremely difficult to assess the impact that either loading may have on the gound water quality or the waters of Foster Cove and Charlestown pond. Several additional factors need to be considered before an assessment can be made.

One of the critical factors in this type of analysis is the direction and rate of ground water flow. Relatively little is known about ground water flow, however some methods do exist for measuring this phenomena. The most common practice available at reasonable cost is the use of dye tracers or radioactive isotopes. Give an unobstructed path, ground water generally flows in the direction of the hydraulic gradient, that is from areas of high ground water levels to areas with lower ground water levels. This flow can be measured by injecting dye(and/or isotopes) into a series of test wells and measuring the reoccurance of the dye at wellsdown gradient from the original wells or at its point of discharge (springs) into surface waters. In addition to ground water flows, a complete assessment of ground water impacts from ISDS should include thorough water quality analysis of both the ground water and any potential receiving surface water bodies. A decision to limit the number of units or consolidate leaching areas, must also give consideration to potable water supplies and well draw down. Obviously, neither of the two state programs reviewed here contain provisions for such a comprehensive analysis of ground water. Rather, the assumption is that the design standards contain sufficient margins of safety to mitigate potential problems.

One the the principal reasons for selecting the New Hampshire program for comparison in this research is to test the provision for allocating minimum lot sizes based upon soil "suitability." Based on the subdivision lot sizes afforded in accordance with the New Hampshire criteria, the allocation of lots is as follows: 52% of the lots located within the areas occupied by the Enfield series and 48% on the remainder within the Tisbury areas. Recall that no lot credit is given for either Matunuck mucky peat or Scarboro muck. Essentially this allows the majority of the high density lots (30,000 sq.ft.) to be located adjacent to Foster Cove, the area least capable of absorbing additional nutrient loading. The remainder of the lots (@48,000 sq. ft.) would be interspersed throughout the site. Under the New Hampshire regulations, the actual area of a lot depends upon the predominant soil type included within its boundaries, so practically speaking, lot sizes would probably vary somewhat from those mentioned above.

In conclusion, it appears that the New Hampshire regulations governing minimum lot sizes affords no substantially greater guarantee of systems site suitability than the Rhode Island ISDS regulations. In fact in terms of cumulative impacts, the New Hampshire program may actually invite situations where density becomes a problem, particular where well-drained soils occupy areas adjacent to water bodies. The reason for this is that the minimum lot size requirement is based solely upon the soils drainage capability, with little consideration given to the other "critical factors" (excluding slope) that affect the treatment level afforded through subsurface sewage disposal.

Before turning to the concluding chapter on carrying capacity analysis, a review of the Rhode Island Coastal Resources Management Council proceedings regarding the use of ISDS within the Foster Cove plat is given.

The Coastal Resources Management Council (CRMC), created by the General Assembly in July 1971, is charged with the expressed purpose of addressing the confrontation between coastal growth and development on the one hand and environmental preservation on the other. The following policy statement describes this role both forcefully and eloquently:

> ...it shall be the policy of this state to preserve, protect, develope, and where possible, restore the coastal resources of the state for this and succeeding generations through comprehensive and coordinated long range planning and management designed to produce the maximum benefit for society from such coastal resources; ...preservation and restoration of ecological systems shall be the primary guiding principal upon which environmental alterations of coastal resources will be measured, judged and regulated.

Given this general mandate, CRMC has developed the Rhode Island Coastal Resources Management Program, which consolidates the Council's rules and regulations pertaining to all uses of the coastal zone. The program is the legal yardstick against which all proposals are measured.

As part of an overall planning program, the Council has established subcommittees to consider specific management strategies in areas designated as "Geographic Areas of Particular Concern." The south shore is one such area and is now the subject of an extensive research project being conducted jointly by CRMC staff and the University of Rhode Island. A Special Area Management Plan is being formulated which will address the effects of past developments on the coastal pond's water quality and adjacent environment and how best to preserve them in the future.

Unfortunately, local efforts at managing growth and preserving the environment here vary greatly. The area described as the south shore is actually the south coastal watershed which spans portions of four coastal communities. Narragansett, South Kingstown, Charlestown and Westerly all share the responsibility of protecting this valuable ecological system. Each town has at least the traditional land use controls in force with zoning and subdivision regulations being the predominant techniques in use. However, South Kingstown stands alone as the only community enforcing specific land use regulations in an effort to control development here. In addition to the existing "High Flood Danger" zoning category which prohibits development on the barrier beach, the Town is now considering implementing rural cluster zoning and transfer of development rights.

On August 31, 1979, eleven (11) applications were submitted to the Department of Environmental Management for approval to construct and maintain said number of dwelling units and individual sewage disposal systems on this property. Prior to consideration by the CRMC, the applicants and the DEM met to discuss alternative sewage disposal systems to those already approved by DEM. Presumably these meetings were held by DEM in an effort to force a consensus on an appropriate methode of sewage disposal for the plat as a whole; signaling a growing concern by both the DEM and CRMC that this area deserved special consideration. After these discussions concluded without a consensus, the applications were scheduled for public hearings as a single, consolidated application under the rules and procedure of a duly appointed subcommittee of the CRMC. After extensive hearings on the matter, at which evidence was submitted by the applicant, CRMC staff, reviewing state agencies and other interested parties, the subcommittee recommended to the entire Council and in turn the Council granted final approval with modifications on October 29, 1982. The modifications generally attempt to mitigate the negative impacts to the cove and pond from surface water runoff and subsurface seepage from ISDS. The most significant modification imposed as a part of this assent in terms of being unique to a proposal of this nature is the mandate to use denitrifying sewage disposal units. See Appendix B for the complete list of findings and modifications.

One of the results of the ongoing research effort by CRMC/URI is that very low levels of nitrate nitrogen added to the salt pond water will stimulate measurable changes in the aquatic plant community. Most notable are the effects of nitrogen on floating green algae in Charlestown pond. The resulting high growth rate or "blooms" indicate that nitrogen may be the limiting factor in these coastal ponds. The total amounts of nutrients added were comparable or smaller than the amounts that are likely to be seeping into the ponds from surrounding developments.[7] In assessing the impacts to the pond from the Foster Cove development, concern was raised about the amount of additional nutrient loadings to be expected to enter the groundwater and eventually the pond. Measurements were taken of gound water depths and experiments were conducted to determine the direction of flow. Based on these studies it was concluded that the ground water levels did fluctuate during the course of the year and that ground water flow was probable toward the pond and Cove. This information, together with the findings of the U.R.I. research team, allowed the CRMC to set conditions on the initial building permit applications what would mitigate any adverse effects on the adjacent water resources.

While the actions of the Council do not account for the appropriateness of the overall density of this plat, they do raise some additional questions about the effectiveness of a minimum lot requirement. First, all the lots in the Foster Cove plat must rely upon individual wells and ISDS. As stated earlier, the Rhode Island Areawide Quality Management Program recommends minimum lot sizes under these conditions of at least 60,000 square feet. This recommendation is primarily to assure adequate distances between the sewage discharge area and the area influenced by the well draw down. Based on this, the average density for the entire parcel would equal .72 dwelling units per acre. The average density attained utilizing the New Hampshire standards for minimum lot size equals .85 D.U./A. The problem now becomes one of incremental measurement. What is the maximum allowable application rate of sewage effluent that this area can absorb before the soil becomes so saturated that the process of aerobic decomposition no longer takes places? Is the minimum lot size sensitive to the treatment capabilities of the soil and the biological requirements of nearby waterbodies, or is it merely reflective of percolation rates? Furthermore, are fixed setback distances adequate in all cases or should these distances reflect the sensitivity of the receiving environment. Research in this area appears to indicate that a variety of factors must be considered before establishing an appropriate lot size or overall density for any given area.[8]

In summary it appears that minimum lot size, as defined by drainage class and permeability under the New Hampshire regulations is inadequate to afford desireable protection of water quality for all situations. Consideration must be given to composite site characteristics to evaluate potential contaminant problems and measures to mitigate undesirable impacts. While a system such as New Hampshire's does restrict the location of lots to these areas most capable of absorbing effluent, it does not provide any additional safeguards in areas where conventional ISDS use may be questionable.

The following chapter introduces the concept of carrying capacity analysis. This methodology, based on performance standards, may provide the necessary "hardware" for guiding comprehensive land use programs in areas where environmental quality is of the highest priority.

NOTES

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CHAPTER V

INTRODUCTION

Carrying capacity is a term applied to a broad range of methodologies aimed at determining the "limits of growth." This concept stresses the dependent nature of man's relationship to his environment while giving due consideration to man's ability of alter the environment as technology advances and needs change. Carrying capacity has been used successfully in many areas of planning, however the data requirements and management expertise needed to implement such a program has limited its widespread application. The following discussion begins with an overview of the concept, its origin and some examples of its use.

The final section of this paper is devoted to an explanation of how ISDS suitability requirements may be integrated into the carrying capacity framework as one of the limiting factors of community growth and development.

CHAPTER V

A LOOK AT CARRYING CAPACITY ANALYSIS

An Overview

Traditionally, zoning has dealt with the districting of land, that is the division of a territory of local government into use, height and bulk categories intended to regulate land in particular has dealt primarily with the question of "how much land will be needed to accommodate projected growth", rather than "how much growth can the land accommodate?" The distinction here is one of perspective. Historically, the principal means for land use control has been the zoning ordinance. The Standard Zoning Enabling Act of 1926 established that zoning shall "be in accordance with a comprehensive plan." However, since most municipalities had zoning before they engaged in any planning per se, courts have largely interpreted this phrase to mean, in fact, that zoning need only be comprehensive.[1] As a result, zoning ordinances were comprehensive only to the extent that they dealt with allocating a variety of uses encompassing all the land within a given political jurisdication. As planning became a recognized function of local government units, studies of land use trends and desired patterns of growth began to emerge. Comprehensive of "master" plans inventory existing development and establish a framework to accomodate a community's long term needs resulting from anticipated growth and development. Today the zoning ordinance is the primary tool used to implement the recommendations of the master plan and as such is largely in accordance therewith. This marriage of planning and zoning has since shed light on the inadequacies of past efforts to control land use and has helped instigate efforts to develope new approaches. Recently these efforts have concentrated more on "growth management" as opposed to a continuous growth concept. The established principle that unlimited growth means unlimited progress is being challenged by theories indicating that an areas ability to accommodate growth is limited by natural and man-made factors.

One such theory of growth management is refered to as the carrying capacity concept. Borrowing from the biological sciences, this theory advances the idea that there are limits to the amount of growth that certain areas can withstand without serious impairment ot public health and safety or to the natural environment. The carrying capacity concept was first used as a management technique in an attempt to define the relationship between a resource supply, or stock and its sustained yield. Sustained yield is a concept used frequently by resource managers to indicate the maximum level of harvest given a certain supply and rate of replenishment. Ecologically speaking, carrying capacity relates to the upper level of population growth beyond which no major increase can occur. This level is reached when all available energy and space resources are utilized. Under normal circumstances, that is assuming no extrinsic disturbances, populations tend to evolve towards self-regulation. Certain factors that are essential to survival will tend to regulate the rate of growth of organisms as well as the ultimate population level according to their availability in the environment. Thus organisms are controlled in nature by the quantity and variability of materials for which there is a minimum requirement and physical factorswhich are critical, and the limits of tolerance of the organisms themselves to these and other components of the environment.[2] The factors refered to here are known as limiting factors. The previous chapter introduced findings that suggest that nitrate nitrogen may act as the limiting factor for certain aquatic plants in Charlestown pond.

Carrying capacity, as used by planners, generally refers to the ability of natural or man-made systems to absorb population growth or physical development without significant degradation or breakdown. This concept necessarily rests on the premise that resources are limited and thereforecan only withstand a limited amount of use before being destroyed or drastically reduced in quantity and/or quality. This principle also applies to renewable resources where development must be managed on a sustained yield basis. The complexity and dynamics of the concept become clear upon the realization that individuals will assess the threshold of a given limiting factor differently depending on their particular needs and that carrying capacity as a whole can be altered with increased input from technology, energy and materials. The fact that man can alter his environment, forces planners to take a somewhat broader view of carrying capacity in an urban-regional context than ecologists do in an ecosystems approach.

Schneider's description of carrying capacity as a planning tool is probably one of the most precise; he states "Carrying capacity...studies the effects of growth-amount, type, location, and quality-on the natural and man-made environment in order to identify critical thresholds beyond which public health, safety or welfare will be threatened by serious environmental problems unless changes are made in public investment, governmental regulation, or human behavior."[3] From this definition it is clear that, in a planning context, carrying capacity is concerned with identifying tradeoffs between environmental quality and levels of development.

As with any methodology, certain assumptions are associated with its use that should be understood before hand. The following assumptions have been identified regarding this planning concept:[4]

1). There are limits to the amount of growth and development the natural environment can absorb without threatening public health, safety and welfare through environmental degradation.

This is one of the basic premises of the carrying capacity concept and of course is a carry over from the ecological principle concerning limiting factors. As stated in the opening paragraphs, this school of thought marks a significant reversal from traditional land use planning ideas aimed at accommodating as much growth as possible.

2). Critical population thresholds can be identified beyond which continuation of growth or development at greater densities will trigger the deterioration of important natural resources such as water and air.

The notion of threshold capacities is particularly attractive to planners concerned with assessing impacts from development. The idea that long range planning projections (10-20 yrs.) can ben based on the land's capability to accommodate growth is seen as lending a certain "scientific" credibility to comprehensive planning efforts.

3). The natural capacity of a resource to absorb growth is not fixed, but can be altered by human intervention.

It is important to realize that while carrying capacity analysis is based on the idea that there are limits to growth, it by no means stipulates that there is a finite level of development, or population for that matter. The emphasis of this concept in planning is that in order to preserve or protect a particularly valuable resource or "quality of life", certain parameters (i.e. limiting factors) must be evaluated and monitored to determine their resiliency (threshold levels) to development pressures. Once these levels have been identified, limits to development can be established in accordance therewith, or the regions ability to accommodate growth can be expanded at the appropriate time.

4). The determination of the limit of capacity of a given system is, finally, a judgemental act.

This assumption reflects the nature of planning and public policy making as we know it. In the final analysis, the public must decide what the "desirable future" for their particular community. Once all the facts and figures are in, it's the evaluation of it all that becomes important. For example, if preservation of agricultural land is one of the goals for a particular area, a carrying capacity analysis might attempt to identify what aspects of development are detrimental to agricultural lands and what measures would be needed to mitigate any negative impacts. Implementation strategies might range from limiting residential density to instituting performance standards. However, if at a future date agriculture is not longer valued as highly, density may be increased or standards relaxed. Another aspect of the issue is while the concept may be grounded in sound scientific and engineering principles, choice is still necessary to draw the line between an "acceptable" environment.

Applications of the Carrying Capacity Concept

The notion that natural systems pose constraints to human environments, and that these can be identified and utilized in the planning process is relatively recent in origin. Early land use planning efforts recognized the importance of such factors as topography, waterbodies, floodplains and poor soil conditions when formulating a land use plan and allocated uses accordingly. Land capability studies typically recommended the least intensive uses for those areas exhibiting problems to development. The idea that environment quality should play a role in how we plan for the use of our resources was first popularized in 1969 by Ian McHarg. McHarg's approach to planning combines the physical features of the landscape in a way that simultaneously exposes both the best and the worst places for development. In addition, McHarg believes that the benefits derived from this approach are gained through the application of what he terms the "ecological model". A passage from one of his works describes this further:

> Ecosystems can be viewed as fit for certain prospective land uses in a hierarchy. It is then possible to identify environments as fit for ecosystems, organisms and land uses. The more intriniscally an environment is fit for any of these, the less work of adaption is necessary. Such fitting is creative. It is then a maximum-benefit/minimum cost solution.[5]

McHarg's work has been imitated and expanded upon by numerous investigators a variety of applications. In fact some of the more recent carrying capacity studies utilize McHarg's system of composite mapping as the principal method for identifying the natural constraints of the land. The following examples of carrying capacity studies provide a glimpse at the mechanics involved in adopting such a system. Capacity studies cover a wide range of planning concerns and vary considerable in methodology. It must be stressed that as of this writing most practical applications of this methodology are still in the experimental stages and as yet no set format for its use has emerged.

In January, 1971, the Township of Medford, N.J. commissioned a study of the natural processes comprising the region in order that they might protect the environment of their Town from rampart development. The study was oriented toward the formulation of ordinances that would allow for all types of land uses guided by performance standards which could deflect development to areas deemed favorable. The goal of the Medford study was to define the social values inherent in the Township's cultural and natural resources, determine to what extent these values are mutable and still acceptable to society at large, and devise viable means to ensure the realization of these social values.[6] The first step in the study was to identify and describe the observable phenomena that characterize the area. Being situated within the Atlantic Coastal Plains, the two most obvious apsects of the Township are the flatness, lack of relief, and the abundance of water and welands. The Township is also a part of the unique regional resource known as the Pine Barrens. A comprehensive analysis of the natural environment identified the following phenomena; used as the data base for the study: geology, aquifers, microclimate, physiography, hydrology, liminology, soils, water table, runoff units, soil nutrient retention, potential soil loss, vegetation, recreational value of vegetation, wildlife habitats, historic sites and scenic units. Once these phenomena were identified and their operative processes documented, a system was devised that allowed each to be assigned a social value.

Social values were defined in terms of societal objectives which are clearly definable either as mandated by law, arrived at be consensus or decided by majority rule. A format was devised that permits each phenomena to be interpreted in terms of its value to society based on one or more of the following reasons:

A. Inherently hazardous to human life and property;
B. Hazardous to human life and health by specific human action
C. Irreplaceablity unique and scarce resources
D. Vulnerable resources where unregulated utilization will result in social costs.

Charts were prepared for each of the above mentioned phenomena showing the social value of each according to the four stated criteria. Whenever a particular phenomena represented a value to society as depicted, specific management procedures were assigned. Management regulations took the form of performance standards, that is operational standards were established to minimize potential negative impacts. By following this format through for one such identified phenomena, the process is easily understood.

The nutrient retention of soil, expressed as cations exchange capacity (C.E.C.), is the sum of exchangeable cations which can be absorbed. Cations are the positively charged ions of nutrients found in the soil. Soils with a high C.E.C. will absorb nutrients added to the soil readily, while soils with a low C.E.C. will allow the nutrients not absorbed by vegetation to leach through in solution into the groundwater. Based on established standards for C.E.C., the Township soils were classified as either adequate or inadequate and the appropriate areas were so mapped taking into account current land use. Table 5.1 shows the value for this identified phenomena to society according to a selected rating scheme of high, qualified high and low. The table also shows were conflicting uses present problems to appropriate management techniques.

Table 5.1 SOIL NUTRIENT RETENTION AND ASSOCIATED VALUE TO SOCIETY

Phenomena	Value to Society			
Soil Nutrient Retention	Inherently Hazardous to Human Life	Hazardous to Human Life and Health by Specific	Irreplaceable, Unique or Scarce Resource	Vulnerable Resource Requiring Regulation to Avoid Social Costs
High: Urban				● 4
High: Cropland			● 2	
High: Forest			● 2	
Qualified High: Urban				● 4
Qualified High: Cropland				● 3
Qualified High: Forest				● 3
Low: I Hazard		● 1		
Low: II Hazard		● 1		
Low: III Hazard		● 1		

Note: I, II, III, Hazard indicating additional restrictive factors;
I- Excessive or poor permeability
II High Seasonal Water Table and/or slopes greater than 10%
1 - Application of nutrients will result in pollution of ground water as well as adjacent waters.
2 - Limited extent of areas highly suited for accommodation of spray-effluent, subject ot pre-emtion by other land uses.
3 - Limited extent of areas potentially suited for accommodation of spray effluent, subject to pre-emption by other land uses.
4 - Limited extend of areas potentially suited for accommodation of spray effluent, presently pre-empted for this use.

Source: Junejua, 1974

The presence of a dot in any row and column indicates that a conflict exists between the particular value to society (column) and areas exhibiting the particular nutrient retention capability. For example, areas designated as having a low nutrient retention capacity with three additional restrictive factors are considered hazardous to human life and health by specific actions. The numbers reference the nature of the hazard that is in potential conflict with the cited value to society. In this example, the number 1 indicated that the "application of nutrients will result in pollution of ground water was well as adjacent waters." This information is in turn used in establishing specific management criteria for uses reliant on this "operative process" for their successful functioning. The management end of the particular phenomena identifies areas of pollution hazard based on the rating systems shown in Table 5.1 and recommends to following:

- No development of septic tank drainage fields.
- Application of fertilizers restricted to those types and amounts which will ensure their ready absorption by local vegetation. In no case shall the concentration of nutrients in the ground water over these areas be allowed to exceed the acceptable standards of the adjacent surface waters.
- Sewers required to have leak proof joints.

This brief introduction of Medford Township's effort at carrying capacity analysis allows us to gain some insight to the extensive amount of data collection necessary and the level of interpretation required. While this particular study does not mention the application of limiting factors per se, it is mentioned at the outset that the study was undertaken in order to formulate ordinances that would allow for the accommodation of all land uses in a manner consistent with the social values represented by the natural environment. The performance standards developed for the most part to protect these resources from further degradation are in essence defining the limiting factors in terms of environmental quality criteria.

The second example of the carrying capacity concept selected for review deals with a methodology designed specifically for the integration of regional land use planning and coastal zone science. Developed and applied by the Nassau-Suffolk Regional Planning Board under contract with the United States Department of Housing and Urban Development, the methods employed stress the relationships between land use location and resulting impacts on coastal marine resources. The methods are presented in a fashion that can be transfered to other areas for developing regional land use and waste disposal alternatives, ranked on the basis of environmental, economic and socio/political characteristics.

Twelve methods were utilized and combined into comprehensive approach termed the "Integrated Methodology". The methods were designed to compliment particular phases of the planning process identified as the inventory phase, development alternatives, analysis and testing of alternatives and finally implementation. While the details of this multidisciplinary analysis are far too complex to adequately cover in this research, a brief discussion of the scope of the project followed by a synopsis of the conclusions may be helpful in providing some insight into the wide range of analytical techniques currently being used in carrying capacity analysis. Figure 5.1 illustrates the relationship

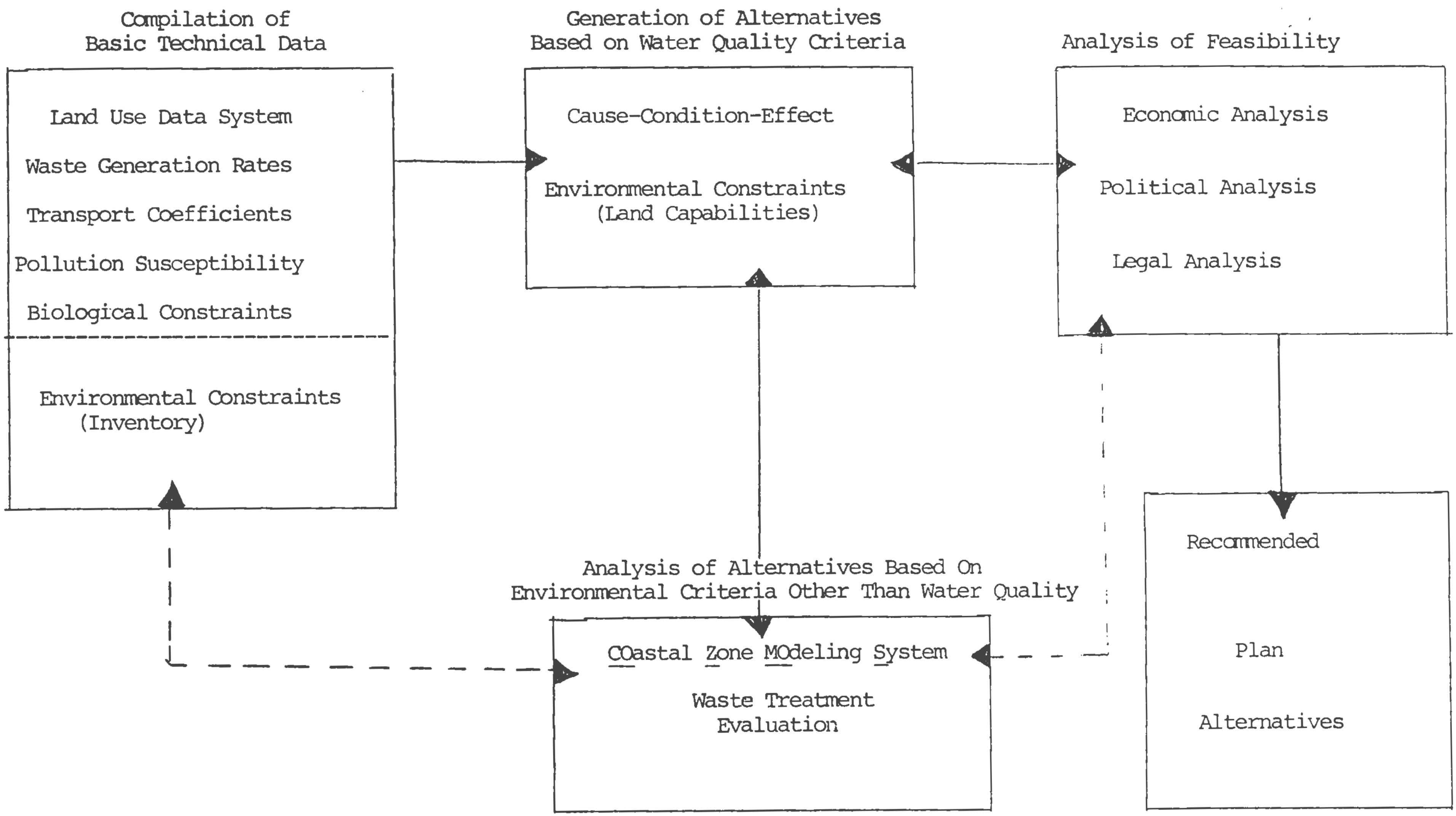


Figure 5.1 The Integrated Methodology Planning Process

of the twelve methods within the overall planning process ending with a plan alternative representing the most desireable use of the land according to the social, economic and environmental factors considered.

Five methodologies were utilized during the inventory phase to compile basic technical data. They are the Land Use Data System, Waste Generation Rates, Transport Coefficients, Pollution Susceptability and Environmental Constraints. In general, the compilation of basic technical data involved: the identification, quantification and manipulation of land use data (Land Use Data System); the determination of waste loads generated by various land uses (Waste Generation Rates); the determination of the mechanisms which transport these loads from the sites of land uses to coastal waters (Transport Coefficients); and, the determination of the resultant tidal water quality implied by these transported pollutant loads (Pollution Susceptibility).[7] The final part of the data collection phase requires the identification, location and assessment of coastal environmental features that may be impacted by land development (Environmental Constraints).

In the next phase alternative land use configurations and technical strategies are developed based on the fulfillment of water quality goals. To do this, a computer program, COZMOS (Coastal Zone Modeling System) was developed to calculate pollutant concentrations in tidal waters resulting from various land use configurations. Water quality criteria are identified

(Biological Constraints) and strategies designed to meet the criteria are developed (Waste Treatment Evaluation).

The land use alternatives and technical strategies are evaluated in terms of their water quality (Cause-Condition-Effect). Land uses are then located in accordance with the constraints identified in the foregoing analysis (Environmental Constraints). Up to this point the Integrated methodology has dealt with collecting data and assessing impacts of various land use configurations. Once the alternative(s) has been selected, it must be assessed form an economic, political and legal standpoint to determine its acceptability. Acceptable alternatives are then evaluated in terms of the existing legal, administrative and institutional tools available for implementation.

The inherent value of the integrated methodology approach described above is not necessarily the quantity and quality of the output, but perhaps more importantly it provides a way of thinking about and organizing diverse data relating to land use and environmental impacts. The integrated methodology can be used either on the regional comprehensive planning level, whereby all twelve methods must be applied on it can be used on a more limited scope to investigate a specific problem requiring the use of a single method or group of methods. The advantage to this approach of course is its flexibility and adaptability to a wide range of circumstances.

A major limitation to any analytical approach such as this is the availability of data and the capabilities of existing methodologies to produce the desired results. Coastal zone planning in particular is limited by deficiencies in our understanding of the complexities of the various ecosystems and their interrelationship with each other. Certainly another key aspect to consider in a study as far reaching as the Nassau-Suffolk endeavor is cost. Staff and consultant costs required for implementing the Integrated methodology in this case were estimated at $225,000.[8] In addition the lead agency must coordinate and manage a multidisciplinary team of researchers, continuously defining the scope of their investigations to keep the project on line. Goals and objectives are needed from the outset to carry out this apsect of the process successfully.

Many of the communities, regional planning agencies and state organizations currently involved in carrying capacity studies of one kind or another became involved in this type of approach to growth management precisely because of existing or anticipated conflicts between a valuable natural resource and encroaching urban development. The "value" of a particular resource is quite often perceived as such for many diverse reasons, depending upon the use of the resource by one or more interest groups. For example, in 1961 Hawaii adopted a statewide land regulatory system to protect limited amounts of prime agricultural land from disappearing as the City of Honolulu began to expand due to the tourism boom of the early

1960's. This economic boom that occurred shortly after Hawaii attained statehood was welcomed by many, however the great preponderance of exports from Hawaii consisted of pineapple and sugar cane grown on the same lands threatened by urban sprawl, therfore any threat to the sugar and pineapple industry was a serious threat to the states balance of trade. On the other hand, many residents and tourists alike saw the vast, open fields that filled the valleys as on intrinsic part of the natural beauty of the island and consequently supported its preservation for reasons other than economics. Thus conflicting interest groups shared a common goal in the development of this far reaching land use legislation, but as we shall see a changing economy soon put these two groups at odds.

The Hawaii Land Use Law divided the entire state into four districts: urban, rural, agricultural and conservation. A state Land Use Commission is responsible for the management and administration of the regulations established for each district.

The thrust of this legislation from a carrying capacity standpoint is the preservation of agricultural land, however the reationale behind the policy decisions made by the Commission necessarily involves economics, preservation of the natural landscape and the provision for adequate housing at reasonable cost. These interests very often represent diametrically oppossed points of view, making the search for common ground a difficult task indeed. The task of balancing these various considerations exemplifies the dynamic nature of limiting factors from a planning perspective. While a majority of the residents on Hawaii favor more limitations on new urban development in order to preserve agricultural land and open space, the fact that much of the land; nearly 50 percent, is held in large, private land holdings forced planners to consider private actions when formulating public policy.[10] Initially the Land Use Commission defined the boundaries of each district according to existing uses, with tight restrictions on future urban development. This action please most of the large land owners who perceived urban sprawl as a threat to the sugan and pineapple industry, then essential to the state's economy. More recently the emphasis has shifted as pineapple exports have declined and the tourism industry has assummed a more formidable role in the economy.[11] Land use policies have also changed in response to this economic shift focusing on growth limitations and resource allocation. This action correspondingly has brought criticism from the large land owners, who see large profits in the conversion of agricultural land into housing and resort developments.

Hawaii's experience illustrates clearly the dynamics of a growth management system based on a limited resource and how such a system responds to change. Carrying capacity studies such as this may vary considerably, however the attractiveness of the methodology remains in its ability to identify the trade-offs involved in formulating long range land use policies. In the instant case it was the availability of agricultural land that became the "limiting factor" in projecting future growth needs. This in turn influenced decisions by both private and public policy makers regarding land use, housing and industry in a regional economic context.

A Systems Approach

As a systems approach to growth management, carrying capacity involves the study of all aspects of community growth and development. Carrying capacity determinations are based upon assumptions about the quality of life in a given area as well as the more inherent physical and environmental factors. Godschalk (1974) states that "carrying capacity results from the interaction of environmental, socio-physchological and institutional factors." Essentially the amount of development that is allowed to take place depends upon natural constraints to development, the perceptions of area residents as expressed in their preference for lifestyle and environment and the ability of the area's governing body and management agencies to provide services and impose the controls necessary to insure that the desired quality of life is maintained.[12]

Much of the emphasis of carrying capacity analysis is placed on the environmental factors, probably as a carry over from its origins in biological science and because they can provide tangible evidence that may be used to support long range plans. As seen from previous examples natural constraints to development often become the focus of this management concept; i.e. water quality in both the Nassau-Suffolk County and Medford Township plans and agricultural preservation in the Hawaii effort. While a strong technical data base is essential to any comprehensive planning effort, those programs that have stressed public participation and have proceeded with the formulation of plans in a straight forward and open fashion, usually stand up well under legal scrutiny. Courts have been reluctant to substitute their judgement for that of a legislative body, especially when the planning process exhibits a strong relationshop of development regulations to community policy objectives and where the process involves a thorough analysis of natural and man-made systems relating to the general health, safety and welfare.[13] Consideration must be given to protecting the health and welfare of present and future residents, as well as to broader constitutional issues of due process of law, equal protection, right to travel, and the indirect impacts that local growth management programs may have on regional housing needs and provision of services.[14] The emphasis here is while environmental protection may serve a legitimate public purpose, a community can't afford to ignore other apsects of community well-being that may appear to conflict with environmental quality. A balancing of interests must be sought whereby development regulations strive to accommodate controlled growth, not prohibit growth altogether.

ISDS as a Limiting Factor

Previous chapters examined the aspects of current ISDS regulations affecting residential land use. These factors are generally recognized as soil permeability, soil depth to bedrock, depth to groundwater, slopes and setback distances required from wetlands, wells and other features susceptable to contamination. The subdivision analysis revealed that minimum lot sizes based on ISDS "site suitability" may be insufficient in some instances to provide adequate protection of vulnerable water resources. A "link" between environmental science and planning has been accomplished through carrying capacity analysis. The carrying capacity concept allows for the identification of key factors responsible for governing an ecosystem's homeostasis . These factors, called limiting factors, have definable threshold levels which if exceeded can lead to serious degradation of the environment. Environmental degradation is a reduction in the performance of certain identifiable functions of a natural system in relationship to predetermined standards of acceptability. The identification of key limiting factors is subject to the nature of the goals and objectives guiding future growth and development. For example, a goal such as maintaining sufficient dissolved oxygen content in surface waters to assure good fish habitat, can be keyed to performance requirements prohibiting any discharges with a biochemical oxygen demand above specified requirements designed to assure continuation of desired environmental quality.

An important aspect of assessing the impacts of residential development on any given unsewered area, is an evaluation of the "suitability" of the land for ISDS use. Commonly, the standards used to measure overall land suitability are those used in the ISDS program itself. It has been shown however that while ISDS suitability standards may be adequate to assess the engineering (design, location and construction) aspects of a system, these criteria are generally not comprehensive enough to be directly utilized within the framework of a land capabilities study form a land use planning standpoint. In other words, from an engineering perspective, the sampled ISDS programs exhibited a general consistency with the established principals of proper sewage disposal, however advanced treatment levels may be required in sensitive ecological areas where conventional effluent standards (w/o nutrient removal) may be incompatable with defined environmental quality goals.

A solution to the problem may be available through the utilization of the carrying capacity concept. It is the premise here that carrying capacity analysis not be recommended for all comprehensive land use studies and that in fact it may only be applicable where unique or complex environmental systems warrant detailed evaluation to adequately assess development impacts theron. For this reason, carrying capacity analysis is particularly useful in coastal zone planning and management. Areas that are under pressure from development tend to exhibit signs of stress that very often aid in identifying limiting factors.

The utilization of ISDS suitability as a limiting factor has considerable appeal from a planning standpoint. First of all, it should be clear that any given environment is likely to have several limiting factors that need to be identified and measured, depending upon the values (goals) attributed to the area. This may aid efforts to assure that the final carrying capacity determination reflects a broad range of concerns as oppossed to a limited number of factors primarily associated with physical constraints to development. In this context, ISDS suitability can also be measured against other known aspects of ISDS use such as waste generation rates and potential pollutant loadings.

For example, in the Medford Township study, ISDS use is recognized as potentially impacting several phenomena recognized as having some social value and therefore needing protection. Performance standards are utilized as the tool here realizing that numerous other uses might also have similar negative impacts upon valuable resources. The south shore of Rhode Island presents a similar problem for evaluating ISDS impacts on the environment. While much of the soil and water features here allow the construction of ISDS under the Rhdoe Island rules and regualtions, this often flies in the face of broader, long term, land use objectives. The state Coastal Zone Management Program has identified this area as a "Geographic Area of Particular Concern (CAPC)." Candidate areas must be found to be of significant value for the purposes of recreation, conservation or habitat preservation and must be subject to pressures inconsistent with preservation of these values.[15] The Council has found that conventional ISDS use in the Foster Cove plat is inconsistent with these values (see Appendix). Fortunately, sufficient knowledge is available about the pond's ecology and ISDS effluent discharges to reach a rational solution to this problem. The limiting factor in this case is water quality. The task is to determine what land uses represent uses inconsistent with the established threshold capacity of this limiting factor. As it turns out nitrate nitrogen, as a consittuent of ISDS effluent and surface runoff from residential development, is also a limiting factor in the pond's ecological balance. Therefore, a specific threshold capacity could be set for nitrate content in the waste stream, however this would prove exceedingly difficult to monitor and enforce. The use of performance standards here is particular attractive within a carrying capacity context because a range of impacts can be identified for different uses, allowing for a systematic allocation of uses based upon a resource's ability to accommodate such uses. For example, on Sanibel Island, Florida a carrying capacity study was instituted to protect the unique ecology of this island from rampart development. Performance standards were designed to permit only those uses deemed to be compatible with identified ecological zones. The Bay Beach zone was designated as fit only for recreation and conservation and boat dock & marinas. The Mid Island Ridge, on the other hand was seen as fit for a variety of uses including agricultural, commerical and residential activities.[16]

A refined version of this approach might be appropriate in the Foster's Cove example, whereby specific methods of sub-surface sewage disposal may be required if they are shown to be compatible with the goals and policies adopted for the area. While no such system of regulation exists this time, the alternative selected by the Council was to specifically mandate that all sewage disposal systems be equipped with denitrifying units in order to eliminate this threat to the pond environment all together. A denitrifying unit is one which reverses the process of nitrification converting nitrate nitrogen (NO_3-) back into organic nitrogen and ammonia gas. The use of vegetative buffer zones was also required to assure maximum protection that nutrient rich surface water runoff will not not enter directly into the ponds. It should be stressed that the Council's study of the south shore was not undertaken as a carrying capacity analysis per se, however much of the research generated by this effort focuses on the areas current "condition" and its ability to absorb additional stresses associated with continued development.

Summary and Conclusions

The use of ISDS site suitability criteria has been examined within the framework of a carrying capacity analysis. This review has attempted to show how the selected state programs "measure up" to the unique requirements uncovered by researchers in their study of a portion of Rhode Island's coastal pond complex. The subdivision analysis is included in order to focus on the potential inadequacies of the New

Hampshire minimum lot size in this area as well as on the short-comings of this approach to land management in general. The analysis of the Foster Cove plat revealed that while some areas may present problems for conventional sewage disposal systems (seasonal high water table), the regulations in both programs are generally flexible enough to permit designing around this constraint. Indeed, where soil conditions account for very rapid percolation rates, signaling caution in the use of subsurface sewage disposal, the New Hampshire regulations allow for the smallest (30,000 sq. ft.) lot size. Furthermore, this lot size is 50 percent smaller than the minimum recommended lot size for areas relying solely upon ISDS and private wells without any site constraints![17] Clearly, the implication here is that ISDS regulations alone cannot provide adequate protection for such an area in the absence of a comprehensive, land management system. In fact, recent innovations in sewage disposal design are beginning to make this type of regulation even less dependent upon the constraints of the land, thus forcing the implementation of broad based, comprehnesive land use management as opposed to the "de facto" ISDS approach.

Growth management systems like carrying capacity analysis may be essential elements of a communities efforts to deal with development in those areas where environmental protection is of prime importance. The federal Coastal Zone Management Act of 1972 has identified critical environmental areas as "areas of particular concern", deserving of special consideration in the implementation of state coastal zone management programs. Within this context, carrying capacity analysis is a valuable tool for assessing both natural and man-made system's ability to accommodate growth. Through the use of performance standards, specific uses can be identified as "fit for" or compatible with the social values attributable to an area or specific natural system.

The role of individual sewage disposal system regulation should not be viewed as independent of this framework, but must be evaluated as an integral part of the overall system. As the limiting factors of both natural and man-made systems are identified, various methods of sewage disposal may be evaluated to determine which alternatives will result in acceptable levels of effluent discharge. This study must give consideration to the geologic, hydrolic and soil characteristics as well as the indirect impacts of sewer policy including improvement costs, impact or housing abailability and desired patterns of growth.

In conclusion it appears that current efforts to regulate on-site sewage disposal may be considered adequate where the receiving environment is not limited by advanced effluent quality standards (nutrient removal). However where effluent quality is critical, ISDS suitability criteria may be insufficient to provide the needed level of protection. As innovative and alternative approaches to ISDS design become more acceptable, this type of regulation may gradually become less site dependent. For this reason ISDS regulations should not be relied upon to discourage development in areas currently designated as "unsuitable". Long range comprehensive planning is needed to adequately guide growth in a fashion consistent with legitimate public purposes. Carrying capacity analysis can provide the needed framework for this type of evaluation and help to define suitable patterns of growth.

CHAPTER 5

FOOTNOTES

1. Donald G. Hagman, Public Planning and Control of Urban and Land Development. (St. Paul, Minn., 1973) p. 292-300.

2. Eugene P. Odum, Fundamentals of Ecology, 3rd ed. (Philadelphia, 1971). p. 195.

3. Devon M. Schneider, et. al., The Carrying Capacity Concept as a Planning Tool. (APA, Report No. 338) P. 1.

4. Schneider, p. 1.

5. Ian L. McHarg, Design with Nature. (Washington, DC, 1971) pp. 197.

6. Narendra Juneja, Medford Performance Requirements for the Maintenance of Social Values Represented by the Natural Environment of Medford Township, N.J. (Philadelphia, 1974) p. 7.

7. Nassau-Suffolk Regional Planning Board, Integration of Regional Land Use Planning and Coastal Zone Science (Washington, DC, 1976) p. 5.

8. Nassau. p. E-5

9. Fred Bosselman and David Callies, The Quiet Revolution in Land Use Control, 1971.

10. Bosselman and Callies, 1971.

11. ibid.

12. David R. Godschalk, et al. Carrying Capacity: A Basis for Coastal Planning? 1974.

13. David R. Godschalk, et al., Constitutional Issues of Growth Management, 1979, p 147.

14. ibid., p. 161.

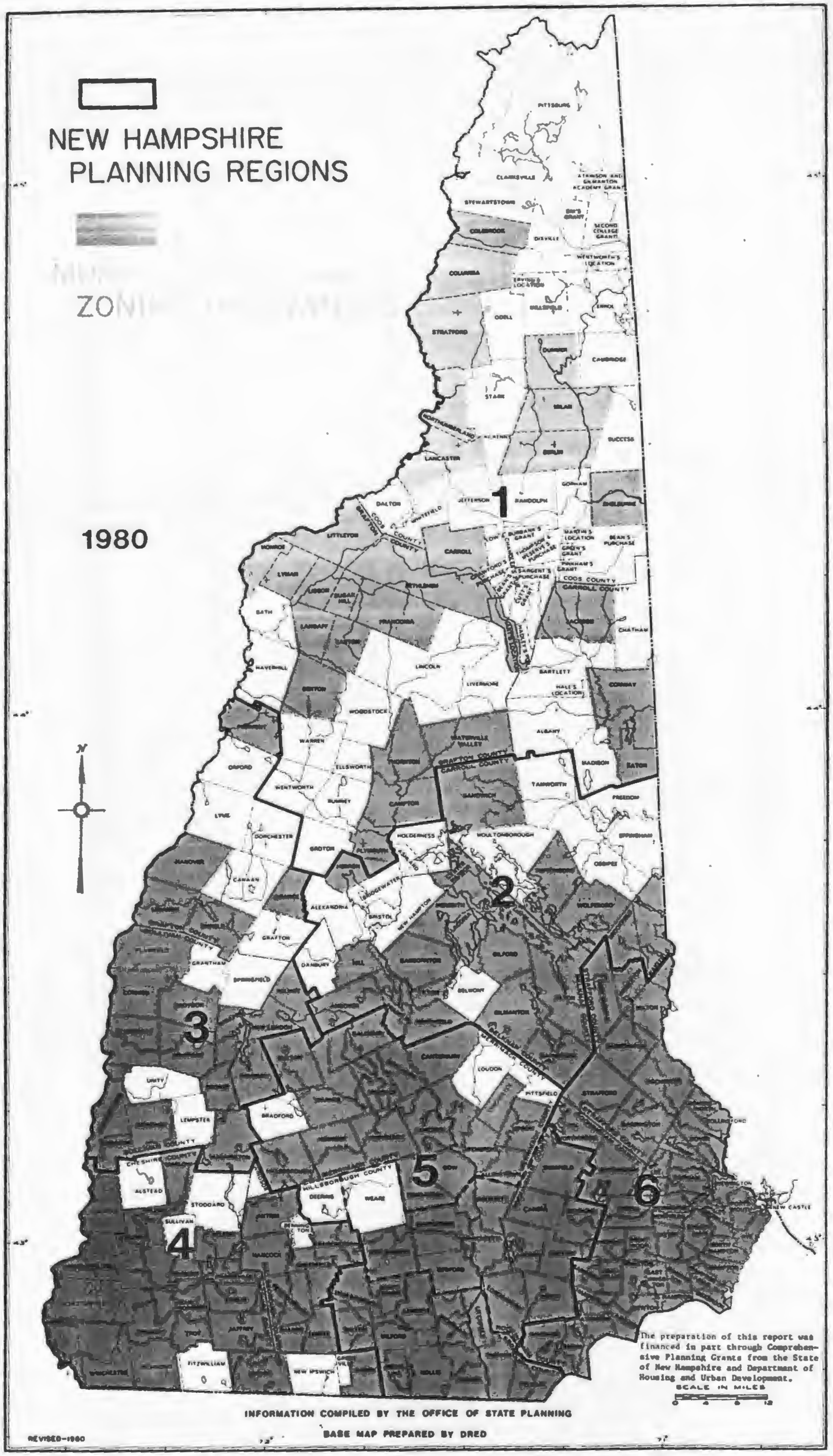
15. Rhode Island Coastal Resources Management Council, State of Rhode Island Coastal Resources Management Program, 1978, p. 304.

16. David R. Godschalk, et al., 1979, pg. 285.

17 Rhdde Island Statewide Planning Program, 208 Areawide Water Quality Management Plan, 1980.

18. Nina McClelland, ed., Individual Onsite Wastewater Systems, Proceedings of the Sixth Annual Conference, 1979, p. 522.

Appendix A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The preparation of this report was financed in part through Comprehensive Planning Grants from the State of New Hampshire and Department of Housing and Urban Development.
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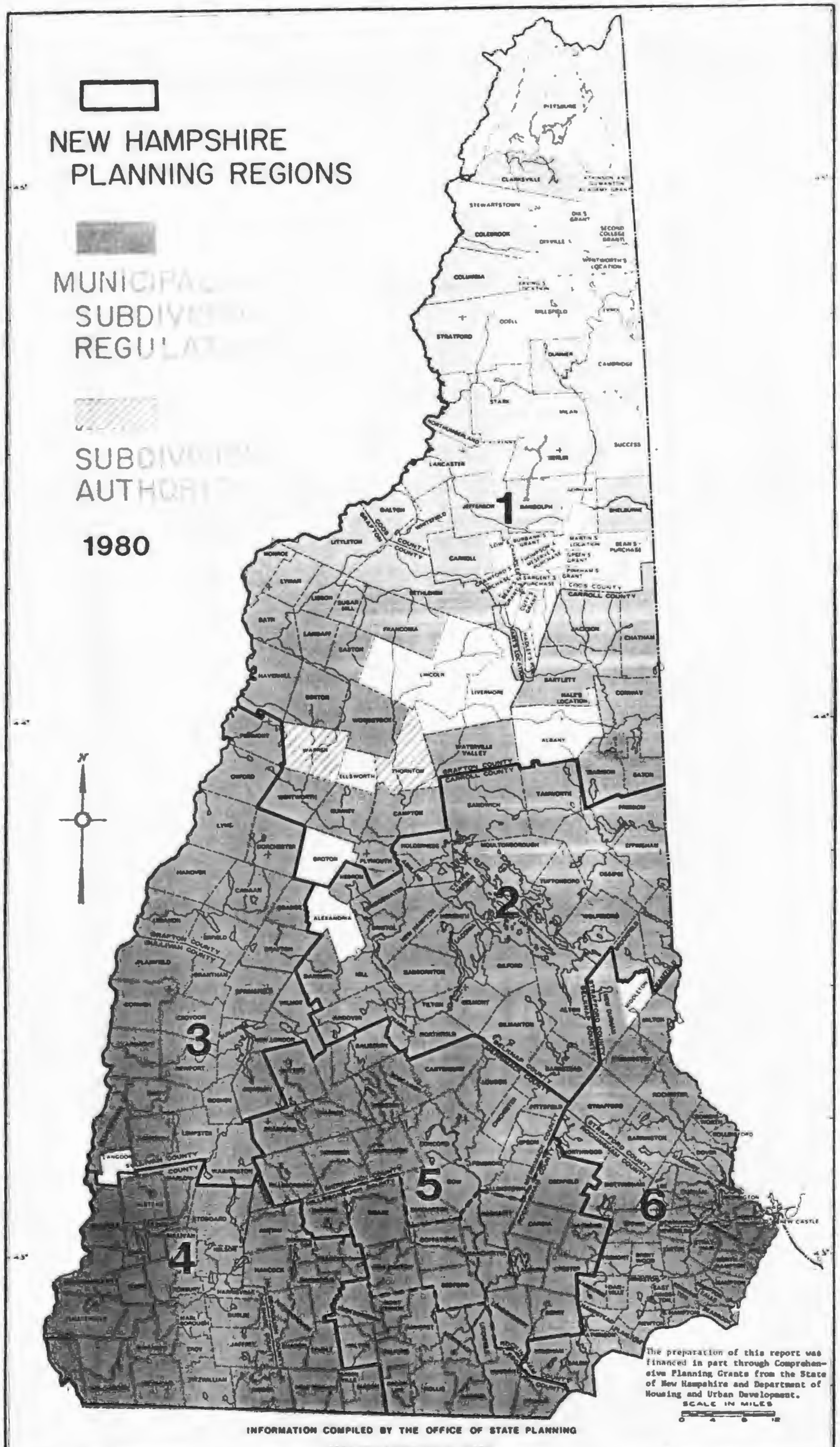
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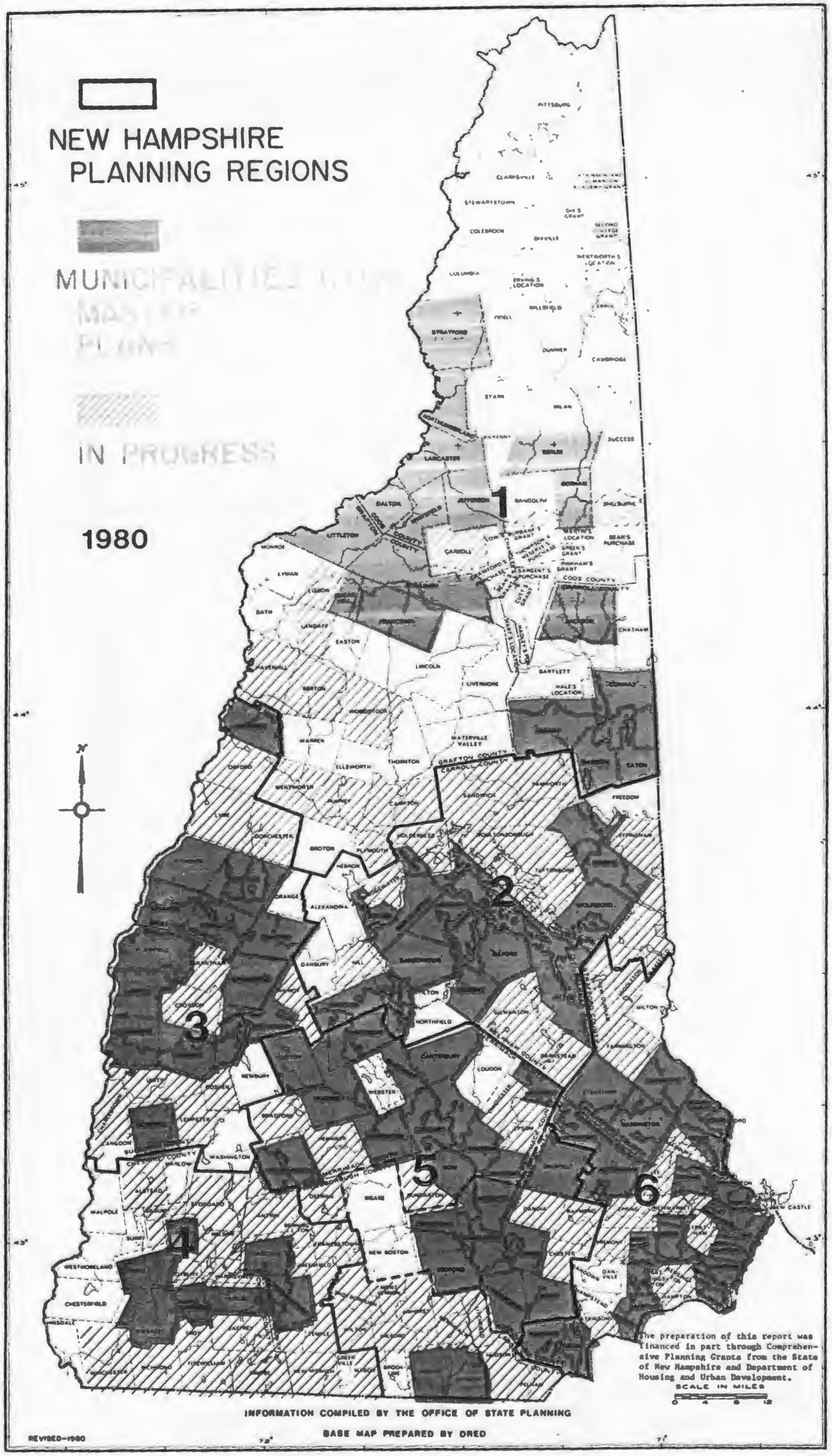

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Appendix B

State of Rhode Island and Providence Plantations
COASTAL RESOURCES MANAGEMENT COUNCIL
60 DAVIS STREET
PROVIDENCE, R.I. 02908

DATE: 29 October 1982
FILE NO: 79-9-12

To Whom It May Concern:

Attention is invited to the provisions of Section 42-35-15 of the Administrative Procedures Act whereby a final decision in a contested case may be subject to judicial review provided a complaint is filed in the Superior Court of Providence County within thirty (30) days after the mailing of the decision. This thirty (30) day period for the [redacted] cas expires on November 29, 1982.

John A. Lyons

CHAIRMAN
COASTAL RESOURCES MANAGEMENT COUNCIL

STATE OF RHODE ISLAND
PROVIDENCE, SC

COASTAL RESOURCES MANAGEMENT COUNCIL
60 Davis St., Providence, RI 02908

DECISION

Petition of: [redacted]
File No.: 79-9-12

[redacted] applied for an assent from the Coastal Resources Management Council to construct and maintain a dwelling and individual sewage disposal system on property located in the Town of Charlestown, State of Rhode Island, on a plat of land know as "Foster Cove Plat". The proposed activity is in an area adjacent to or associated with proposed activities of ten (10) other applicants who have also applied for assents from the Coastal Resources Management Council to construct and maintain dwellings and individual sewage disposal systems on the aforementioned plat. Because of the proximity of this application to the other ten applications, the Coastal Resources Management Council consolidated these applications for hearing purposes under the Rules of Procedure 4.5.

Most of the applications were filed on or about August 31, 1979. The record shows the Rhode Island Department of Environmental Management asked the Coastal Resources Management Council to delay action on these applications until it could review its own actions on these applications. The record further shows that the applicant and the Department of Environmental Management met to discuss alternative sewage disposal systems to those already approved by DEM. This application was scheduleld for public hearing after these discussions concluded without a consensus and the Department of Environmental Management had completed its internal review. A duly appointed subcommittee then held extensive public hearings on the consolidated applications on July 15, August 4, September 8, September 15, October 9, October 20, December 1, and December 8, 1980; and January 12, February 9, February 28, March 23, and April 13, 1981. Evidence was submitted by the Applicant and other interested parties at the subcommittee hearings. Additional evidence was submitted by Coastal Resources Management Council staff members and other state agencies, all of which was incorporated into the record and subject to cross examination. All evidence submitted to the Council pursuant to this application is available to all interested parties at the offices of the Coastal Resources Management Council, 60 Davis Street, Providence, Rhode Island, during normal business hours. The subcommittee requested and received post-hearing memoranda submitted by the applicants and the Department of Environmental Management.

After deliberating upon all the evidence, testimony and the entire record pending before it, the subcommittee recommended to the entire Council that the applications be approved with modifications.

Thereafter, the entire Council took under consideration the record, the evidence therein, and the recommendations of the subcommittee, and after careful deliberation upon same and after a roll call vote that all the evidence, record and recommendations of the subcommittee so submitted were read by members of the Council, the entire Council hereby finds:

FINDINGS OF FACT:

1. The proposed site is located on the western shore of Foster Cove. The site is essentially undeveloped, supporting open field vegetation. Two residential dwellings are presently located on the western shore of Foster Cove. A commercial structure is situated on the northern boundary of the proposed site along US Route 1.

2. The State Historic Preservation Commission indicated the proposed activity might raise the possibility of "potentially adverse impact on prehistoric sites next to the Cove." However, the record does not indicate that the proposed activity will adversely affect significant archaeological resources eligible for inclusion in the National Register of Historic Places.

3. The individual sewage disposal system of this applicant has been approved by the Department of Environmental Management. This approval is for the design and location of the proposed ISDS for the lot in question and is dated July 3, 1979.

4. The closest point of the proposed dwelling to the nearest bodies of water, Foster Cove and Ninigret Pond, is 118 feet to Foster Cove and 78 Feet to Ninigret Pond; and the nearest point of the proposed ISDS to Foster Cove is 150 feet and to Ninigret Pond is 126 feet.

5. The applicant has demonstrated to the subcommittee that all state and local approvals have been met for the proposed activity.

6. The waters in the area are classified SA. The Ninigret Pond/Foster Cove Complex has been classified a Type II Pond, "Multiple Use Recreation Tidal Waters and Coastal Ponds", by the Coastal Resources Management Plan. This area has also been designated as a Geographic Area of Particular Concern to be Preserved or Restored by the Coastal Resources Management Council. The Coastal Resources Management Council has made its preservation and protection high priorities, as evidenced by an extensive three-year study undertaken by the Coastal Resources management Council and other agencies to determine what the effects of past developments have been on Rhode Island's coastal ponds' water quality and adjacent environment and how best to preserve them in the future.

7. The Foster Cove/Ninigret Pond waters are important fishing grounds. Foster Cove, a shallow, poorly flushed embayment is one of the last remaining oyster producing areas in Rhode Island.

8. The record indicates that the proposed activity increases the probability of nutrients and other pollutants entering the waters of Foster Cove/Ninigret Pond as a result of uninhibited surface water runoff and ground water flow.

9. A minimum buffer zone of one hundred feet landward of the tidal area would alleviate the effect of surface water runoff provided the buffer zone remains inviolate with no activities or alterations allowed. The subcommittee finds that there will be no significant impact on the coastal resources as a result of surface water runoff provided the 100-foot buffer zone is maintained and the applicant is required to follow the recommendations of the Coastal Resources Management Council staff biologist.

10. Volumes of evidence were submitted on the questions of ground water flow. A review of the evidence, conflicting testimony, and substantive scientific reports from both sides of the proceedings indicate that the introduction of any nutrients, phosphates or other detrimental materials into coastal waters as a result of the installation and use of an ISDS could affect tidal waters.

Because of the many concerns regarding water quality degradation if building is to be permitted on the Foster Cove Plat, the subcommittee requested additional information from the Coastal Resources Center about the relative importance of various sources of nutrients and the role that denitrifiction can play in reducing nitrate input into coastal waters such as Foster Cove. A review of the literature indicated that the installation of a denitrification unit in conjunction with and ISDS has been used to eliminate the introduction of nitrates into coastal waters. Such a system would alleviate any potentially adverse impact to Foster Cove and Ninigret Pond.

WHEREFORE, as a result of the above Findings of Fact, it appears that the proposed activity as approved with modifications, will not detrimentally impact the coastal resources of this State.

CONCLUSIONS OF LAW:

1. This Council has been granted jurisdiction over the above-mentioned project by reason of Title 46, Chapter 23, of the General Laws of the State of Rhode Island, as amended.

2. The proposed alteration will not conflict with the Management Plan approved and adopted by this Council and presently in effect, provided the modifications contained herein are followed.

3. The record reflects that the evidentiary burdens of proof as set forth in the Coastal Resources Management Program have in fact been met for the activities proposed herein.

As a result of these Findings of Fact and Conclusions of Law, the

Council hereby grants approval to the applicant to undertake the activities contained in the applications with the following modifications:

1. A buffer zone of 75 feet be established landward of the tidal area to be staked by the Coastal Resources Management Council staff to alleviate effects of surface runoff.

2. The buffer zone shall be inviolate, naturally vegetated, and any activities or alterations within the buffer zone shall be prohibited.

3. All roadways, driveways, sidewalks, patios, and other surfaces within the lot shall be constructed of permeable materials to maximize infiltration and reduce runoff.

4. The discharge of water runoff into Foster Cove, the inlet to Foster Cove, or Ninigret Pond is prohibited.

5. In the event pumping of ground water is necessary during the excavation for or installation of the ISDS, all discharges shall be directed into crushed stone and haybale sediment traps located landward of the buffer zone and away from any drainage channels leading to Foster Cove or Ninigret Pond.

6. Materials excavated from the disposal system should be removed from the site unless used as fill around the system. These materials shall be disposed of at a suitable offsite location.

7. All areas of the property that have been exposed or devegetated during construction shall be revegetated upon completion of construction.

8. Use of fertilizers is prohibited.

9. An ISDS denitrification system approved by the subcommittee of the CRMC be a condition of this assent. The system will be approved on the basis of:

1. simplicity of design;
2. low maintenance;
3. provision for monitoring at the owner's expense;
4. an acceptable alternative means of treatment be available if the system fails.

10. The Department of Environmental Management is hereby requested to evaluate the effectiveness of the denitrification system by monitoring the tidal waters adjacent to the applicants property. Reports of their findings should be forwarded to the Coastal Resources Manaement Council upon completion of the installation of the denitrification unit and then periodically as determined necessary by DEM and CRMC.

By the Council,

JOHN A. LYONS, CHAIRMAN

ALVARO W. FREDA, VICE CHAIRMAN

PAUL T. HICKS, SECRETARY

CAROLYN F. BRASSIL

DONALD C. BROWN
(Abstained)

REP. GEORGE D. CARUOLO

HAGOP BOGOSHIAN
(Vote to Deny)

BARBARA B. COLT

DR. WILLIAM MINER

CAPT. JOHN J. NEARY, JR.

SAMUEL SNOW

JOSEPH TURCO

REP. CHARLES TED WRIGHT

FRANK GEREMIA
(Abstained)

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