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Evaluation of Critical Protection Area

Delineation Technique 21 pp

Horsley Witten Hegemann, Inc

Narragansett Bay Estuary Program

EVALUATION OF CRITICAL PROTECTION AREA DELINEATION TECHNIQUE

NARRAGANSETT BAY

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FOREWORD

The United States Congress created the National Estuary Program in 1984, citing its concern for the "health and ecological integrity" of the nation's estuaries and estuarine resources. Narragansett Bay was selected for inclusion in the National Estuary Program in 1984 and designated an "estuary of national significance" in 1988. The Narragansett Bay Project (NBP) was established in 1985. Under the joint sponsorship of the U.S. Environmental Protection Agency and the Rhode Island Department of Environmental Management, the NBP's mandate is to direct a five-year program of research and planning focussed on managing Narragansett Bay and its resources for future generations. The NBP will develop a comprehensive management plan by December, 1991, which will recommend actions to improve and protect the Bay and its natural resources.

The NBP has established the following seven priority issues for Narragansett Bay:

* management of fisheries
* nutrients and potential for eutrophication
* impacts of toxic contaminants
* health and abundance of living resources
* health risk to consumers of contaminated seafood
* land-based impacts on water quality
* recreational uses

The NBP is taking an ecosystem/watershed approach to address these problems and has funded research that will help to improve our understanding of various aspects of these priority problems. The Project is also working to expand and coordinate existing programs among state agencies, governmental institutions, and academic researchers in order to apply research findings to the practical needs of managing the Bay and improving the environmental quality of its watershed.

This report represents the technical results of an investigation performed for the Narragansett Bay Project. The information in this document has been funded wholly or in part by the United States Environmental Protection Agency through Cooperative Agreement #CE001509 to the Rhode Island Department of Environmental Management. It has been subject to the Agency's and the Narragansett Bay Project's peer and administrative review and has been accepted for publication as a technical report by the Management Committee of the Narragansett Bay Project. The results and conclusions contained herein are those of the author(s), and do not necessarily represent the views or recommendations of the NBP. Final recommendations for management actions will be based upon the results of this and other investigations.

Abstract

EVALUATION OF CRITICAL PROTECTION AREA DELINEATION TECHNIQUES

Report and accompanying maps prepared by
Horsley Witten Hegemann, Inc.

Horsley Witten Hegemann, Inc., a water resources and land planning firm, was retained by the Narragansett Bay Project to develop an approach for delineation of protection areas for Narragansett Bay and its tributaries. This study involves an evaluation of techniques that could be used to delineate appropriate land areas surrounding sensitive resources. It includes conceptual mapping of the protection areas throughout the Narragansett Bay watershed and, on a case study basis, within the Hunt-Potowomut River watershed. Finally, it presents an analysis of affected acreages and land uses under each approach.

Alternative protection area delineation techniques reviewed include 1) existing Rhode Island environmental programs and regulatory standards, 2) surface and ground-water classification schemes, 3) approaches used in other states that delineate critical protection zones around sensitive water bodies (Maryland and Massachusetts), and 4) an environmental science-based approach, reflecting routes of transport for contaminants.

Based upon its assessment of the effectiveness of these approaches for habitat and water quality protection, HWH recommends utilization of the following combination of critical area delineation techniques: surface watersheds and sub-watersheds; ground water drainage basins and sub-basins; vegetated buffer strips/surface runoff attenuation zones; ground water attenuation zones; ecologically-significant habitat areas; and wetland reserve areas. After delineation of protection areas surrounding critical resources, HWH recommends considering different levels of protection in different watersheds based upon the water quality goals of the receiving waters.

INTRODUCTION

Horsley Witten Hegemann, Inc., a water resources and land planning firm, has been retained by the Narragansett Bay Project to develop an approach for delineation of protection areas for Narragansett Bay and its tributaries. The first task of this study has involved an evaluation of techniques that could be used to delineate appropriate protection areas. The second task will produce conceptual mapping of the protection areas throughout the Narragansett Bay watershed, using the delineation techniques discussed in Task One. During the second task, HWH will also delineate the protection areas on a more detailed basis for one case study area bordering Narragansett Bay.

The remainder of this report describes the results of the task one investigation; the evaluation of alternative critical area delineation techniques. The goals of the delineation process are discussed, followed by evaluations of four options requested by the Narragansett Bay Project. These include:

1) Existing Rhode Island critical areas programs and regulatory standards.

2) Surface and ground-water classification schemes.

3) Other State's Programs (Maryland and Massachusetts).

4) Environmental science-based approach.

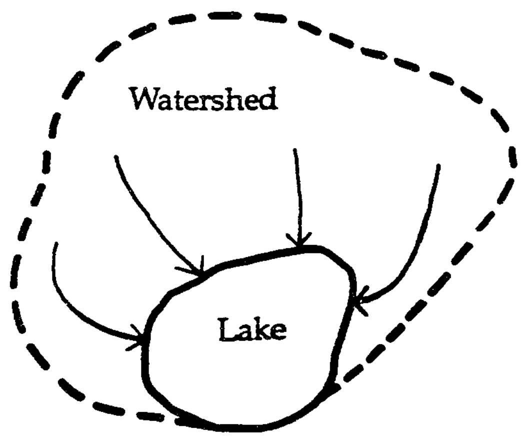
APPROACH

The goal for delineating protection areas is to develop a framework for the maintenance and/or restoration of high quality water and habitat in the Bay, its tributaries and associated upland areas.

A distinction must be drawn between "critical resource areas" and "critical protection areas." The critical resource areas are those natural features which have important values in need of protection. Examples include lakes, streams, wetlands, aquifers, wellhead protection areas, significant habitats and Narragansett Bay itself.

Critical protection areas are those land areas within which land use activities can impair their associated critical resource areas. For the purposes of this project they can be more clearly defined as areas which contribute water (and potentially pollutants) to the resource areas.

An illustration of the resource area/protection area distinction is a lake and its watershed (shown below). The lake is the critical resource area as it provides the values in need of protection. The watershed is the land area that contributes freshwater inputs and pollutants from adjacent lands; and therefore functions as a critical protection area.



Applying this principle throughout the Narragansett Bay basin, and to a broader range of critical resource areas (i.e. streams, wetlands and estuarine waters) requires a more detailed understanding about the linkages between resource areas and protection areas. These details are presented in the section of this report entitled, "Environmental Science-Based Approach."

EVALUATION OF DELINEATION TECHNIQUES

Four techniques, or options, for delineating protection areas to water resource areas are evaluated below. A summary of each technique, including the advantages and disadvantages of its implementation, and its effectiveness, is provided in Table 2, which is found in the Conclusions and Recommendations section of this report.

Rhode Island's Existing Critical Areas and Regulatory Program

The State of Rhode Island's existing "critical areas" program focuses on the identification of critical resource areas and primarily relies upon increased setback distances, depth to water table and percolation criteria for the siting of septic systems. The program dues not provide area-wide land use controls to address the cumulative impacts of development throughout the critical protection areas.

Critical (resource) areas identified by the state in the ISDS regulations include: 1) the South Shore Coastal Ponds of Charlestown, South Kingstown and Westerly, 2) the Scituate Reservoir and 3) the Narrow River. Ground water drainage areas to the coastal ponds and watersheds to the Scituate Reservoir and the Narrow River are recognized in the Critical Areas program. In the context of this report, we consider these areas as critical protection areas.

Rhode Island's critical areas programs are based primarily upon setback distances from designated "critical areas". The setback requirements are not based upon site-specific scientific principles. While the setbacks do provide for attenuation of many potential contaminants, they may be excessive in protecting some areas and be inadequate in protecting other areas.

The ISDS regulations provide for increased setbacks from septic systems to the Coastal Pond and the Narrow River (150 feet instead of 50 feet) and to surface water reservoirs and perennial tributaries (200 feet instead of 50 feet).

Setbacks for large septic systems (greater than 2,000 gallons/day) to water bodies designated as critical areas are required to be three times the normal setback requirements for the Narrow River and the South Shore Coastal Ponds (SD 19.02.1 (b) 3). For instance, large septics cannot be located closer than 450 feet to the Narrow River (the setback to the river for smaller systems is 150 feet).

These separation distances are adequate to filter out bacteria before they reach the surface water (Harvey, et al, 1989). Depending upon the ground-water transport velocity in a given area it may or may not be adequate to inactivate viruses. Viruses are capable of being transported in the ground water environment for a period of approximately 120 days (HWH, 1990 Nantucket Report). Ground water flow velocities range from several feet per year (in glacial till) to several feet per day (in glacial outwash). Where ground water flow rates are 3 feet/day, a 360-foot buffer zone would be required for virus inactivation.

The setback distances are unlikely to attenuate phosphorus loading from the septic system, as over time phosphorus will utilize all available binding sites between the system and the water body. It also will not allow for attenuation or dissolution of nitrogen loadings, which for the most part are conservative compounds in ground water. The setback distances therefore be excessive for bacterial contamination but inadequate for the protection from nutrient (and possibly viral) contamination.

The Coastal Resources Management Council (CRMC) has jurisdiction over land within a 200-foot buffer strip of the shoreline. It has discretionary authority to require undisturbed buffers between development and coastal resources. This jurisdiction and authority is not limited to designated critical areas but applies state-wide. The CRMC has also developed Special Area Management Plans for the Coastal Ponds, the Narrow River and Providence Harbor.

Rhode Island's Ground Water Protection Act (Chapter 13.1) recognizes "Special Protection Areas" as "recharge areas within a ground water reservoir which is particularly critical for the maintenance of large volumes of high quality ground water for long periods of time." The Rhode Island Wellhead Protection Program was published in February 1990. This program indicates that wellhead protection areas will be delineated by DEM utilizing a combination of analytical and hydrogeologic mapping techniques and recommends inventories of contamination sources within these areas. It classifies land uses into high, medium and low contamination risk categories. Recommended management approaches include both regulatory and non-regulatory options.

Regulatory programs do not protect against cumulative impacts from nutrient and volatile organic loadings, an important source of water quality degradation. Protection from these loadings can only be accomplished using a carrying capacity analysis involving density restrictions within the upland contributing areas (surface watersheds and ground-water drainage basins). This requires a delineation of surface watersheds and ground water contributing areas (or recharge areas) to the receiving water, which are not included in the setback distances of the existing regulations. The watershed delineation is for the Narrow River and the Scituate Reservoir and the Wellhead Protection Area delineations currently underway by DEM are excellent examples of the delineation of contributing areas.

Advantages of using the existing setbacks as protection areas include the fact that the setbacks and accompanying regulatory structure are currently in place. No additional regulations need to be adopted and there are no additional implementation or enforcement costs. Disadvantages include the inability to attenuate certain contaminants within specified distances and the inability to account for cumulative loading impacts.

Surface and Ground Water Classification Programs

The State of Rhode Island has classified surface waters, both fresh and salt, and ground waters according to their existing or potential uses (RIDEM, June 1989). Water quality standards have been determined for each classification level, with the highest being drinking water standards for Class A fresh surface waters, Class GAA ground waters, and Class GA ground waters which are potential water supplies.

The prioritization schemes for water resources do not in themselves constitute protection area delineations. However, they are valuable for planning regulatory strategies for protection areas determined using other methods. For example, regulations governing nutrient loadings to ground water may allow greater loadings (and therefore higher densities of development) in areas upgradient to Class B and Class C surface waters. Areas upgradient of Class A surface waters would be regulated more stringently to maintain drinking water quality in the receiving water.

HWH recommends that the delineation program should consider all water resources within the Narragansett Bay basin as critical, regardless of their present classification. The corresponding critical protection areas should be delineated to determine the relationship between potential contamination sources and the water resources.

Other State Programs

In 1984, the Maryland General Assembly passed the Chesapeake Bay Critical Area Law (Natural Resources Article Title 8-1801-1816). The law and its subsequent regulations is designed to help protect the Chesapeake Bay and its tributaries from resource degradation primarily resulting from human development activity. In 1986, the State promulgated regulations under the Code of Maryland Regulations Subtitle 15 COMAR 14.15.01 - 14.15.11. The program established a "Critical Area"as all lands and waters including:

"(a) all waters of and lands under the Chesapeake Bay and its tributaries to the head of tide as indicated on the State wetlands maps, and all state and private wetlands designated under Title 9 of the Natural Resources Article, Annotated Code of Maryland;

(b) all land and water areas within 1,000 feet beyond the landward boundaries of State or private wetlands and the heads of tides designated under Title 9 of the Natural Resources Article, Annotated Code of Maryland; and

(c) modification to these areas through inclusions or exclusions proposed by local jurisdictions and approved by the Commission...".

All land within the defined Critical Area have been classified into one of three categories based upon existing land use patterns: (1) Intensely Developed Areas; (2) Limited Development Areas; and (3) Resource Conservation Areas. The general policy is that intense development should be directed outside the Critical Area and that future intense development activities, when proposed in the Critical Area shall be directed towards the

Intensely Developed Areas. Additional low intensity development may be permitted in the LDA's but it shall be subject to strict regulation to prevent adverse impacts on habitat and water quality. Development in the RCA's is designated primarily for agriculture, forestry; fisheries activities, other resource utilization activities and for habitat protection. Specifically excluded for the Critical Area are solid or hazardous waste collection or disposal facilities and sanitary landfills.

The State has developed specific criteria for the characterization of each of the classified areas to assist the counties in the preparation of their Critical Area Programs. All of the counties in Maryland affected by the act have accepted the 1,000-foot buffer as the critical area boundary except Kent County which in certain areas have extended the boundary beyond the 1,000 feet minimum. In addition the counties have all established listing of which types of development are allowable in each of the development districts.

The 1986 Criteria established development limitations for each classification. For example, in IDA's residential density is limited to no greater than four dwelling units per acre. In the LDA, housing density ranges from one dwelling unit per 5 acres up to four dwelling units per acre. The RCA is the most restrictive with residential densities not to exceed one dwelling unit per 20 acres.

The program has been very successful to date in limiting development within the Critical Area and redirecting future development outside of the buffer. The program has been successful from an implementation point of view because of the groundwork in natural resource mapping that the state had in existence when the Act was passed. The mean high water and tidal limits and wetland boundaries were already established, mapped and accepted by all state agencies and the courts. Since that natural resource base was available, it was very easy for the State to adopt an arbitrary fixed distance of 1,000 feet. As a result, the Commission staff have not had to settle boundary disputes with developers and local governments.

In addition to the 1,000-foot buffer for tidal areas, the law and the regulations also established a more restrictive 100-foot buffer for habitat protection in the Critical Area. Certain activities are prohibited in this zone such as surface mining and the cutting and clearing of trees except under certain conditions. Also, non-tidal wetlands in the Critical Area are required to maintain a 25-foot buffer from development unless it can be shown that the proposed activities (excluding grazing) will not adversely affect the wetland.

The Chesapeake Bay Critical Area Protection Program has used several fixed distances from known natural resource boundaries to establish areas within which land use will be regulated. The stringency of land use controls is based on the existing land use at the time the boundaries were established. Land use activities continue to be reviewed and regulated at the local level where zoning controls and performance standards are traditionally employed. The State serves in an oversight role to assist counties in the implementation of the Program. Disputes are referred to the Commission for administrative review and decisions can be appealed to the Circuit Courts.

The Commonwealth of Massachusetts is currently considering legislation to protect watershed areas (commonly known as the "Cohen Bill"). This legislation proposes to regulate land within the surface watersheds of reservoirs and their tributaries. No septic systems would be allowed within 400 feet of the reservoirs and their tributaries. A maximum density of one unit per acre would be applied to development within the watershed areas.

Both of these approaches make use of a combination of setback distances and density controls within the designated critical protection areas (1000-foot buffer in Maryland and watersheds in Massachusetts). They address the issue of cumulative effects by utilizing density controls. However, the density controls are not linked to the carrying capacity of the receiving waters. The Maryland density controls are designed to preserve existing land use patterns within the three distinct classifications. The proposed Massachusetts density restriction of one acre minimum lot size within the watersheds is based upon a generalized nitrogen loading calculation and does not take into account the flushing rate of the receiving waters or the local hydrogeologic conditions.

It is impossible to say whether these controls adequately protect the resources without a more detailed analysis of flushing rates and hydrogeologic conditions. However, both approaches have merit and are applicable to the Narragansett Bay Project. The concept of density controls throughout a watershed area (Massachusetts) is a scientifically defensible approach and the recognition of a need to maintain existing land use patterns (Maryland) is practical.

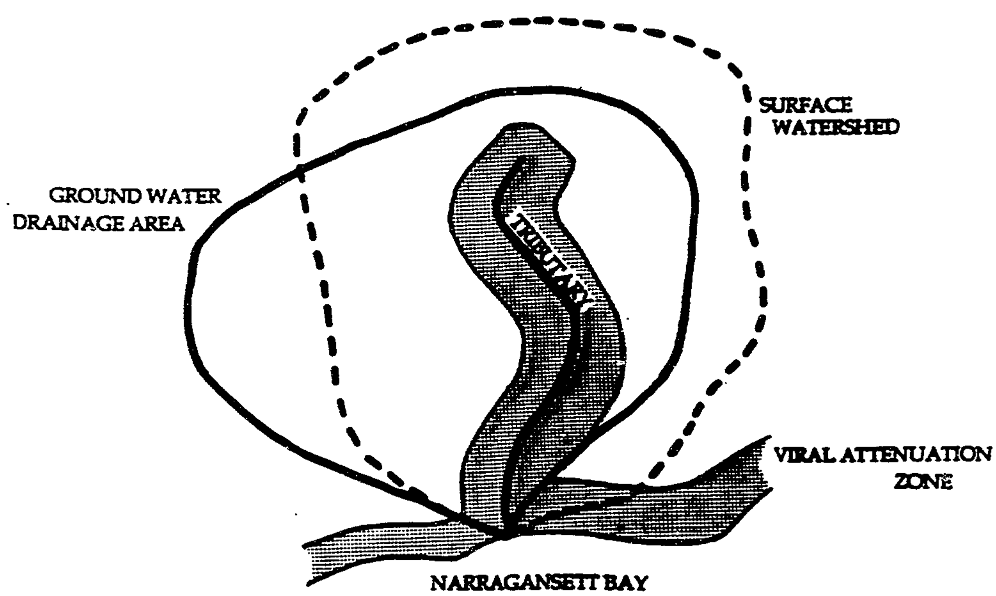
Environmental Science-Based Approach

A wealth of environmental science data is available for the Narragansett Bay basin. This data can be utilized to predict the movement of water and anthropogenically-derived contaminants from upland areas to the receiving waters comprising the estuarine system. In this sense it may serve as a workable and defensible basis for the delineation of critical protection areas and the development of land use regulations.

Numerous critical resource areas exist within the Narragansett Bay basin. Those include: lakes, streams, wetlands, aquifers, wellhead protection areas, significant habitats and Narragansett Bay itself. The environmental science-based approach identifies each of these resource areas and recognizes that each has different carrying capacities for pollutant loadings. For example, lakes are sensitive to phosphorus concentrations in excess of 0.05 mg/liter, whereas aquifers and wellhead protection areas are not sensitive to phosphorus (there is no proposed or existing drinking water standard).

The following figure illustrates the interaction of various water resource areas which may exist within a watershed basin. A wellhead protection area and a lake protection area may be subsets of a larger tributary protection area. Land uses within the lake protection area will affect lake water quality and may also impact water quality in the downstream tributary.

The second step in the environmental science-based approach is to map critical <u>protection</u> areas to the critical <u>resource</u> areas. The routes of transport for contaminants to each resource area include surface and ground water

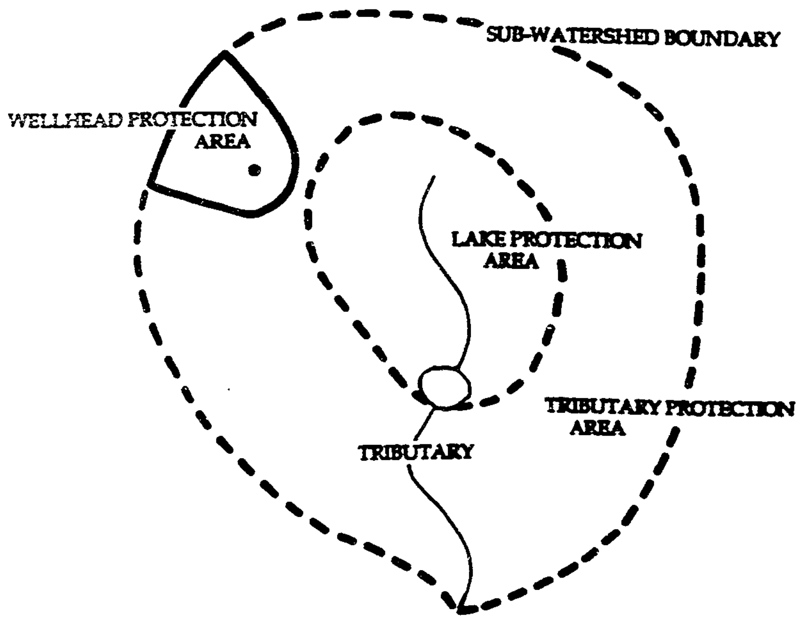


flow. Both are significant sources of water and contaminants and should be considered in the delineation of critical protection areas.

Surface water flow includes overland flow (runoff) and stream discharge. The land areas which contribute surface runoff are defined topographically by surface watershed maps. Precipitation occurring within these watershed areas can carry contaminants found at the land's surface such as fertilizers and road drainage into the downstream receiving waters.

Ground water flows through upland soils and discharges directly to Narragansett Bay and to its tributaries. The land areas which contribute ground water to the Bay and its tributaries are defined hydrogeologically according to ground water drainage patterns best determined by water table maps. Water table maps are available for many of the drainage basins and show elevations of the water table (top of the saturated soils). Due to the geologic conditions present within the Narragansett Bay basin (glacial-fill buried river valleys), the ground water drainage basins will commonly be synonymous with the surface watersheds. However, in certain instances they may differ (see figure on following page).

Table 1 describes the concerns associated with selected contaminants, their mobility in the environment, and the implications of each with respect to appropriate protection areas. Many of the contaminants can be attenuated within a properly maintained vegetated buffer strip or a properly designed detention basin if they are transported via surface runoff. However, where the contaminants occur in ground water these measures will be of little value.



Certain contaminants (such as bacteria, viruses, metals and petroleum hydrocarbons and to a lesser extent pesticides and phosphorus) can be attenuated within the ground water environment if adequate separation distances between sources and receiving waters are maintained. Other contaminants (such as nitrogen and volatile organic compounds) are considered more conservative in ground water and may travel greater distances. In these instances a better method of control is to limit the total loading of sources throughout the ground water drainage areas.

Ground water transport velocities are considerably slower than surface water. They vary from several feet per day in sandy outwash soils to several feet per year in till. However, ground water is a significant source of both water and contaminants because it serves a constant source to Narragansett Bay and its

TABLE 1 PROTECTION AREA NEEDS FOR SELECTED CONTAMINANTS

Contaminant	Impact Concerns	Attenuation Potential in Soils/Sediments	Protection Area; Surface Water	Protection Area; Ground Water
Nitrogen	Eutrophication of coastal water	Low (some denitrification under anaerobic conditions)	VBS*/Surface Watershed	Ground water drainage area
Phosphorus	Eutrophication of fresh water tributaries	High (precipitation/ adsorption)	VBS/Surface Watershed	Setback based on loading and hydrogeology (short term) Ground water drainage area (long term)
Bacteria/Virus	Public Health (shellfish/swimming)	High (filtration, inactivation)	VBS	Setback based on hydrogeology
Volatile Organic Compounds	Toxic effects and carcinogens to humans and wildlife. Bio-accumulation	Varies based on compound and env in GW. Volatilize in SW.	VBS/Artificial Wetlands	Ground water drainage area
Petroleum Hydrocarbons	Toxic effects and carcinogens to humans and wildlife. Bio-accumulation	Varies based on compound and env in GW.	VBS	Ground water drainage area
Metals	Toxic and carcinogenic impact to humans and wildlife. Bio-accumulation	High (precip/adsorp/ ion exchange)	VBS/Surface Watershed	Setback based on hydrogeology and retardation coefficient
Pesticides	Toxic impact to humans and wildlife. Bio-accumulation.	Varies based on compound and environment	VBS/Surface Watershed	Ground water drainage area

*VBS = Vegetated Buffer Strip

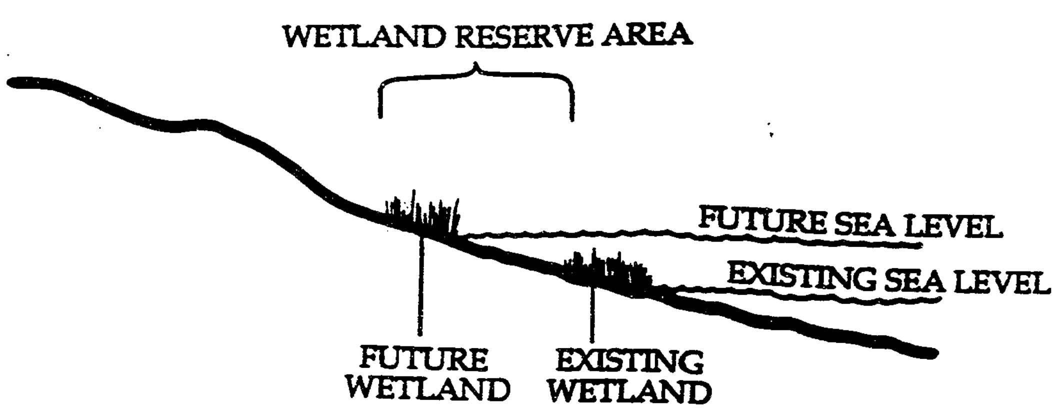
tributaries. Base flow in streams is maintained by ground water discharge from adjacent upland areas.

In addition to hydrologic considerations, ecologically significant habitat areas within the watershed areas can be delineated. This information can then be utilized during Task Three in the development of specific regulatory provisions to protect mapped habitat areas.

In summary, this option calls for the mapping of Protection Areas based upon hydrogeological and ecological principles. Surface watersheds are to be mapped based upon land topography. Ground Water Drainage Areas are to be mapped based upon water table and geologic maps.

Sub-areas are also to be mapped based upon contaminant attenuation and ecologically-significant habitats. Contaminant attenuation will include transport time (i.e. viral inactivation period of 120 days - Yates, 1989) and nutrient uptake capacities of wetland systems within the watershed. In this sense the Protection Areas will be sub-classified into those land areas which contribute water (and potentially contaminants) directly to Narragansett Bay estuarine waters and those that contribute indirectly (such as land areas upstream of extensive vegetated wetlands where significant denitrification is anticipated (i.e. the wetlands are functioning as a natural buffer or nutrient sink).

An additional critical protection area involves the expected sea level rise projected over the century (Massachusetts Coastal Zone Management Newsletter, December 1989). In some applicable geologic environments, this will result in the landward migration of coastal wetlands. If structures are placed in the way of this migration, wetlands will be lost. Therefore, these land areas will be mapped as "wetland reserve areas" (see figure below).



CONCLUSIONS AND RECOMMENDATIONS

Table 2 summarizes the advantages and disadvantages of each of the delineation and classification approaches discussed above. Each of the strategies offers certain attributes which can be integrated into a comprehensive delineation approach. Based upon this analysis, HWH recommends that the Narragansett Bay Project utilize the following combination of critical area delineation techniques:

1. Surface watersheds and sub-watersheds
   (to be determined topographically from existing GIS watershed maps),

2. Ground water drainage basins and sub-basins
   (to be determined from regional water table maps and surficial geologic maps, or when not available, from GIS watershed maps),

3. Vegetated buffer strips - surface runoff attenuation zones
   (to be determined based upon NBP buffer zone model: this model should be tested and calibrated based upon available field data before it is applied as a regulatory tool),

4. Ground water attenuation zones
   (to be based upon a standardized worst-case setback calculated from viral-inactivation rates and ground water flow velocities determined within the study area. A variance process will allow for site-specific determinations),

5. Ecologically-significant habitat areas
   (to be based upon existing habitat information available in the Rhode Island GIS).

6. Wetland reserve areas
   (to be mapped based upon available topographic maps).

Existing ground and surface water classifications will be further reviewed in relation to the proposed delineation criteria for the purpose of determining if different levels of control might be warranted in different watersheds and ground-water drainage basins based upon the water quality goals of the receiving waters. The implications of ground water classifications, (particularly GC areas in which waste disposal is allowed) will be evaluated with respect to any potential inconsistencies with downstream surface water quality goals.

TABLE 2 SUMMARY OF PROTECTION AREA DELINEATION STRATEGIES

	PROTECTION AREAS IDENTIFIED BY PROGRAM	ADVANTAGES	DISADVANTAGES	OVERALL EFFECTIVENESS
Existing Critical Area Programs	600 foot buffer-septics/ reservoir,150 foot buffer-septics/watercourses.	No further implementation needed. Regulatory structure in place.	Complex system of setbacks. Does not consider cumulative impacts.	Moderate
Water Classification	N/A	Allows varying levels of protection based on water quality goals.	Not a protection area. Misconceptions about the need to protecting clean waters.	To be used in conjunction with another strategy.
Chesapeake Bay and Massachusetts Programs	Chesapeake - 1,000 buffer. Massachusetts - Surface watershed and 400 foot buffer-septics/reservoir.	Simple, easy to implement. Effective for pathogen ground water transport, surface water runoff.	Ineffective for cumulative nutrient inputs. Will over/ under-protect land areas.	Low-Moderate
Environmental Science Based Approach	Surface watershed ground water drainage areas pollutant attenuation buffer zones.	Only protect appropriate areas. Most defensible.	Expense of delineating protection areas, implementation of regulations.	High

MAPPING AND LAND USE ANALYSIS

The land areas that would be regulated under the three different protection area strategies have been mapped and compared The total area that would be affected under each strategy has been calculated and land use information has been determined or projected for the Hunt-Potowomut watershed to date for which information was available. The total areas that would be affected by each protection program are shown in Table 3. Known and projected land use data for the Hunt-Potowomut watershed are provided in Table 4.

The land use information for the Hunt-Potowomut watershed is taken from 1988 data compiled by a previous study for the Narragansett Bay Project using aerial photographic interpretation. The percentage of each land use type within the Hunt-Potowomut watershed was extrapolated to estimate land use areas affected by the existing regulatory programs. In this manner the most updated land use information was utilized across the entire watershed.

Methods for Calculations

Specific discussions on land area calculations for each protection area option are provided below. Given the scale at which the protection areas have been mapped, simplifying assumptions had to be made to obtain some of the land area information. These assumptions have been noted in the discussions below, along with estimates of their effects on the calculations. Details of the mapping conducted for each option are described as well. The accuracy of the mapping and land area calculations is a function of the scale of the base map that was used. The error in the calculations is not known, but is estimated at five to ten percent.

Existing Regulatory Program

The protection areas determined for this option are based on the setbacks required under existing Rhode Island regulatory programs. The land areas were calculated using the most stringent setbacks in the regulations. including the setbacks for individual sewage disposal systems (ISDS) and the Coastal Resources Management Council (CRMC) jurisdiction area of 200 feet inland from coastal waters. At the scale of the entire watershed, land use and land area data for the existing protection area program was calculated only for the state of Rhode Island. The existing regulatory programs for Massachusetts are different than those in Rhode Island and were not analyzed.

TABLE 3: LAND AREAS REGULATED BY PROTECTION AREA STRATEGIES

	Area in RI (acres)	Area in MA (acres)	Total Area (acres)
Protection Areas at Narragansett Bay Watershed Scale			
Existing Reg. Program (1)	14000	ND*	330000
1,000 ft. Setback (1)	91000	240000	330000
Env. Science Approach (1)	420000	640000	1100000
Protection Areas at Scale of Hunt-Potowomut Case Study			
Existing Reg. Program (1)	610	*NA	610
1,000 ft. Setback (2)	9900	NA	9900
Env. Science Approach (1)	16000	NA	16000

ND = Not Determined
NA = Not Applicable

(1) Measured by HWH
(2) From 1988 Land Use (IEP, Inc.)

TABLE 4: LAND USES WITHIN CRITICAL PROTECTION AREAS (ACRES) FOR HUNT-POTOWOMUT WATERSHED

	Total Area	Projected Land Use					
		Residential	Urban	Agriculture	Brush/Forest	Wetland/Water	Barren Land
Hunt-Potowomut Case Study							
Existing Reg. Program (1)	600	120	75	35	250	100	10
1,000 ft Setback (2)	9000	1200	1100	150	5800	760	140
Env. Science Approach (3)	15200	3000	1800	830	6100	2500	310

Notes:

(1) - Projected from Actual 1988 Land Use
(2) - Actual 1988 Land Use
(3) - Actual 1988 Land Use. Does not include coastal watershed.

The Rhode Island ISDS regulations require septic systems to be set a minimum of 50 feet from a watercourse, 200 feet from a surface drinking water supply or tributary, and 400 feet from a public drinking water supply well. For this study, a watercourse was defined as a tributary that drains into Narragansett Bay. The definition of watercourse in the ISDS regulations also includes vegetated wetland areas. Setbacks for wetlands were not included in the calculations because of the difficulties in calculating the length of upland/wetland interface at the scales in which the areas were determined. It is estimated that the inclusion of setbacks from wetlands would increase the areas calculated for this option by at least twice that which was calculated by only considering the tributaries.

The setback for large septic systems (those with greater than 2000 gals. per day of discharge) within the Scituate Reservoir critical area are three times the normal distance, or 600 feet. Because the watershed to the reservoir is not heavily developed, it was assumed that large systems would only be used infrequently. Therefore the 600-foot setback was not included in the calculations.

The 400-foot setback was calculated for 67 public supply wells throughout the Narragansett Bay watershed that have been mapped in the Rhode Island GIS system. The CRMC 200-foot buffer was used for coastal areas, as it is the area under the jurisdiction of the CRMC. Under the CRMC regulations it is possible to site septic systems closer than 200 feet to the shoreline. However the CRMC has discretionary authority to increase setbacks by requiring undisturbed buffer zones. Because the size of these buffer zones can vary, the 200-foot setback was used.

To calculate the areas for each of the setbacks, measurements were made of the lengths of the coastline and the tributaries and multiplied by the appropriate setback distance. The breakdown of land areas for this protection option is provided in Table 5

Table 5. Land Areas Protected by Existing Regulatory Programs (Acres)

	Narragansett Bay Watershed	Hunt Potowomut Watershed
200' ISDS Setback from Surface Water Supplies	4,400	NA
50' ISDS Setback from Tributaries	2,000	420
400' Setback from Public Supply Wells	770	69
200' CRMC Jurisdiction	6,300	120

Maps of the protection areas provided by the existing regulatory program were not developed for either the Narragansett Bay watershed or the Hunt-Potowomut sub-watershed. This was because the areas were too small to be seen at either map scale. Even at the scale of the Hunt-Potowomut sub-watershed, the width of the 50-foot setback is less than one tenth of an inch.

One Thousand Foot Setback

Land areas located within a 1,000-foot setback from coastal waters and tributaries draining into Narragansett Bay were also calculated. Although the Maryland 1,000-foot critical protection area program only applies to coastal waters, calculations for land areas along freshwater tributaries were included as well, at the request of the Narragansett Bay Project. For the entire Narragansett Bay watershed, land areas were calculated by measuring the lengths of the coastal shoreline tributaries using a map wheel. For the Hunt-Potowomut sub-watershed, land areas were provided by the Narragansett Bay project from GIS calculations.

Mapping of the 1000-foot setback at the Narragansett Bay watershed scale was accomplished by highlighting the buffer to all the tributaries using a GIS base map provided by the Narragansett Bay Project. The mapping of the Hunt-Potowomut sub-watershed was conducted by the Environmental Data Center of the University of Rhode Island with the use of the GIS system. At this scale the 1000 foot buffer often extended beyond the boundary of the watershed, meaning some areas within 1000 feet of a tributary may not be hydrologically connected to the tributary and are not a source of water or contaminants to Narragansett Bay.

Environmental Science Based Approach

The land area considered for this protection option constitutes the entire watershed, both for the Narragansett Bay watershed and the Hunt-Potowomut sub-watershed. The proposed approach is to use different water quality protection strategies for different sub-regions of the watershed. These regions were identified based on their geologic makeup and setbacks from tributaries or coastlines. Specifically, the watershed was subdivided into two geologic regions, those with sand and gravel deposits, and those with bedrock or till. In addition a viral buffer zone is proposed requiring a 600-foot setback from the coast and from tributaries, with variances allowed with site specific tests. The land areas within each of these sub-protection areas is shown in Table 6.

The total area of the Narragansett Bay watershed and the Hunt-Potowomut sub-watershed area was determined using a digital planimeter. The area of the Hunt-Potowomut sub-watershed calculated by HWH is greater than that used in the 1988 land use calculations because it included the watershed to the estuarine portion of the Potowomut River.

Table 6. Land Areas Protected by Environmental Science Approach (Acres)

Watershed	Narragansett Bay Watershed	Hunt Potowomut
Aquifer Deposits	151,000*	6,000
Till/Bedrock	271,000*	9,900
600' Viral Buffer	198,000	5,400

* Rhode Island only

Comparison of land areas

The protection area strategy that incorporates the most land area is the environmental science based approach, as it includes the entire watershed. The land areas within the watershed would not all be regulated the in same way. Subsets of the whole watershed for which stricter regulations may apply are the areas of aquifer deposits and the viral buffer zones. The protection strategies would be most stringent in the viral buffer zones as septic systems would not be permitted within 600 feet of a tributary unless a variance was issued.

The land currently protected under existing regulations is small relative to the other protection area options. For example, existing protected land areas constitute only 1.3 percent of the land protected under the environmental science based approach, at the scale of the entire Narragansett Bay watershed. These protection areas are small because they are based only on setbacks to watercourses. The environmental science approach involves controlling cumulative impacts to water quality through density controls and therefore all land area within the watershed must be considered.

In the Hunt Potowomut sub-watershed, the area encompassed within the 1000-foot setback to the tributaries is 57 percent of the entire watershed. This large percentage is a result of the small size of the watershed and the relatively large numbers of tributaries. At the scale of the Narragansett Bay watershed the 1000-foot setback area is 31 percent of the total watershed land area.

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