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A WELLHEAD PROTECTION PROGRAM
NORTH SMITHFIELD, RI

Mark C. Gardella
University of Rhode Island

Richard C. Ribb
University of Rhode Island

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A WELLHEAD PROTECTION PROGRAM
NORTH SMITHFIELD, RI

BY

MARK C. GARDELLA
RICHARD C. RIBB

A RESEARCH PROJECT SUBMITTED IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
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MASTER OF COMMUNITY PLANNING

RESEARCH PROJECT

OF

MARK C. GARDELLA

AND

RICHARD C. RIBB

Approved:

Major Professor: John J. Kuna

Acknowledged:

Director: Howard H. Foster Jr.
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Mark C. Gardella
Richard C. Ribb
Chapter I: Program Overview

1.1 Problem Statement
1.2 Groundwater Protection: North Smithfield, RI
1.3 Purpose of the Project
1.4 Relevant Current Literature
1.5 Elements of the Wellhead Protection Program
1.6 Procedures and Methods of Analysis
1.7 Specifications of Data

Chapter II: Geohydrology

2.1 Groundwater
2.2 The Hydrologic Cycle
2.3 Groundwater Resource Areas
2.4 Characteristics of Aquifers
2.5 Types of Aquifers
2.6 Groundwater Movement
2.7 Public Supply Wells
2.8 Groundwater Pollution

Chapter III: WHPA Delineation

3.1 WHPA Delineation
3.2 EPA Guidelines
3.3 RIDEM Delineation Methodology
3.4 The Delineation Process
3.5 Category 1 Method
3.6 Category 2 Method
3.7 Category 3 Method
3.8 Delineation Development

Chapter IV: Inventory of Contamination Sources

4.1 Overview of RI Groundwater Contamination
4.2 Existing Water System
4.3 Contaminant Description and Effects
4.4 Contaminant Sources in North Smithfield
4.5 Superfund/CERCLIS Sites

Chapter V: Current Protection/Management Strategies

5.1 Regulatory Protection
5.2 Federal Groundwater Protection
5.3 State Groundwater Protection
5.4 Local Groundwater Protection
5.5 Management Approach
5.6 Management Strategies - Regulatory
5.7 Management Strategies - Non-Regulatory

Chapter VI: Implementation

6.1 Framework for Implementation
6.2 Implementation of Strategies - Regulatory
6.3 Implementation of Strategies - Non-Regulatory

Conclusions: 

LIST OF REFERENCES

APPENDICES

BIBLIOGRAPHY
LIST OF TABLES

Table 1 Existing SWC Supply Wells/Community Systems 43
Table 2 North Smithfield Sites on USEPA's CERCLIS List 59
Table 3 SARA Title III Sites 60
Table 4 RCRA Facilities 61
Table 5 RIDEM Registered USTs 62
Table 6 Implementation Table 95
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>The Hydrologic Cycle</td>
<td>15</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Types of Aquifers</td>
<td>21</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Cross-Section of a Well</td>
<td>25</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Contaminant Plume</td>
<td>27</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Draft WHPA Delineations</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Slatersville Wells</td>
<td></td>
</tr>
<tr>
<td>Figure 6</td>
<td>Draft WHPA Delineations</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Woodland Convalescent Well</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER I: PROGRAM OVERVIEW

1.1 PROBLEM STATEMENT

Groundwater is an important drinking water resource in the United States, especially in rural areas, unconnected to larger public systems, where it provides 96% of the drinking water supply (Travis and Etnier, 1984). Approximately 50% of all U.S. residents rely on groundwater as their source of drinking water, using 88 billion gallons a day (Patrick et al. 1987). Within the State of Rhode Island, 24% of the population depends on groundwater and 8% utilize private drinking wells (USGS, 1988). Groundwater withdrawals in Rhode Island average 37 million gallons per day and uses include public and private water supply, livestock and irrigation, and industrial uses (USGS 1986).

A recent study of the Rhode Island water supply, conducted by the Arthur D. Little Company, has indicated that the state’s increasing reliance on the Scituate Reservoir system may cause future supply problems, forcing water suppliers to look to groundwater as a supplemental source. In most New England states, groundwater is a primary drinking water source.

Groundwater is generally available in good quality throughout the nation, although supplies are gradually becoming more threatened by human activity. The duration, type, and intensity of human activities will determine the
degree of risk that is posed to both ground water quality and quantity. As further development takes place, additional pollutants are introduced into the groundwater, significantly impacting water quality. Rhode Island's twenty-one major groundwater aquifers are extremely susceptible to contamination due to high aquifer permeability and minimal depth (usually less than 20 feet) to the water table (USGS, 1986). Since 1975, the water from 9 public supply wells and 250 private wells has become unsuitable for human use due to contamination by hazardous chemicals (USGS, 1986).

Groundwater contamination occurs as a result of three main mechanisms: by natural processes, by man’s waste disposal practices (sanitary, industrial, solid, and hazardous wastes), and by spill (and illegal dumping), leaks, and agricultural activities and other sources unrelated to disposal. Non-point sources of groundwater pollution include nutrient loading from septic systems, erosion and sedimentation from construction sites, stormwater runoff carrying nutrients, heavy metals and hydrocarbons, road de-icing practices with heavy salt concentrations, and the use of pesticides and fertilizers. Past land uses may yet cause groundwater contamination. Many of the known 16,000 hazardous waste sites nationwide that are now closed will eventually leach contaminants into the ground, as will the 2 million underground storage tanks
containing petroleum and chemical products (Page, 1987).

It is difficult to assess the overall threat to groundwater from a particular land use. The actual threat presented by a land use depends upon several factors including; (1) the type and quantity of chemicals used or wastes generated, (2) storage and disposal methods, (3) soils and aquifer characteristics of the site, (4) distance from the contamination source to the wellfield, and (5) the attenuation of the pollutant in the soils and ground water. These factors all contribute to the complexity of adequately protecting ground water quality.

1.2 GROUNDWATER PROTECTION: North Smithfield, RI

The Town of North Smithfield, Rhode Island, uses four separate water supply systems, which serve one-third of the Town’s residents (Weston and Sampson 1990). One of the systems, the Slatersville Water Company, consists of a series of five wells, three of which are tapped into a groundwater aquifer and two others that draw water from bedrock fractures. This system currently serves approximately 445 residences and 12 non-residential users (Weston and Sampson 1990). In addition to this system, most residents and many businesses depend on private wells for water supply. The RIDEM Division of Groundwater and Freshwater Wetlands, Groundwater Section has identified major aquifers capable of supporting public well systems
throughout the State. One of these large aquifers underlies a section of North Smithfield. Due to a projected increase in demand and the availability of an accessible aquifer source, it is possible that the Town will increase its dependence on groundwater reserves.

Local groundwater protection programs are still uncommon in rural communities like North Smithfield. Smaller communities often lack sufficient staff and economic resources to undertake the hydrogeological and management studies that underlie ground water protection planning. Like most rural communities, North Smithfield is experiencing increased development, leaving its groundwater supplies vulnerable to contamination from point source as well as non-point source pollution. Groundwater protection has long been a concern to water suppliers, public health officials and Town residents. It is also an issue of growing importance for planners because of the long-term problems associated with groundwater contamination. Consequently, the most effective groundwater protection measures are preventive, and prevention requires planning. In terms of policy issues, this program helps with the clarification of state, local, and water supplier responsibilities. Contingency planning, often neglected in local government, is given a new focus.
1.3 PURPOSE OF THE PROJECT

The primary purpose of this project is to fulfill the requirements for a Master's Degree from the Graduate Curriculum in Community Planning from the University of Rhode Island. A secondary purpose of this project is to assist the Town of North Smithfield in establishing a WellHead Protection (WHP) Program (as mandated by the 1986 amendments to the Safe Drinking Water Act (SDWA) to protect its wellhead areas from the threat of contamination. An effort to obtain available EPA WHPA pilot project funding, initiated by the authors, has been met with enthusiasm by the Town of North Smithfield and RIDEM. An application has been made to the EPA and it is currently under consideration. Throughout the project, the authors of the study will be working closely with the RIDEM, Town officials and residents. A document will be drafted that will incorporate the requirements of the WHP Program with local groundwater concerns and efforts. In addition, this project will benefit RIDEM by providing a pilot project that will allow the Department to critique existing WHP Program guidelines as applied in a practical planning exercise.

1.4 RELEVANT CURRENT LITERATURE

As the demand for water has increased, a great deal of research has been conducted that focuses on groundwater protection issues. This documentation takes the form of:
EPA documents relating to groundwater protection and management;
* State documents;
* Books and articles from planning literature;
* Scientific research studies;
* Computer generated maps and analysis;
* Symposium reports;
* Groundwater related periodicals;
* University Research;
* Water resource management studies.

These documents describe policy issues related to groundwater management, sources and chemical properties of contaminants, computer modeling techniques, mitigation measures, results of scientific studies of groundwater movement, local government responsibilities and limitations, financing of programs, legal tools and techniques for groundwater protection, soil properties, and data needs for groundwater protection programs. This literature is available through government and University sources.

The RIDEM Wellhead Protection Program

In 1986, amendments to the Federal SDWA established a WHP Program in order to enable states to "protect wellhead areas within their jurisdiction from contaminants which may have an adverse effect on the health of persons." Under the WHP amendments, section 1428 of the SDWA, each State must prepare a WHP Program and submit it to the Environmental
Protection Agency (EPA). The Rhode Island Department of Environmental Management (RIDEM) has undertaken the responsibility for developing and implementing the WHP Program for the State. The WHP Program is an attempt by federal and state officials to curtail or minimize the effects of development on groundwater quality. Groundwater protection planning encompasses several stages including the identification of contamination sources relative to wells and wellfields and the ranking of existing and potential threats. These steps will establish a framework for identifying problems facing the community and will aid in the development of the individual components of management plans. Once identified in the management plan, a series of Best Management Practices (BMPs) will be analyzed to determine which will be the most effective in minimizing the effects of development within the wellhead area identified by RIDEM.

RIDEM has developed a wellhead protection program in accordance with the EPA requirements. The agency given responsibility for this program is the Groundwater Section of the Division of Groundwater and Freshwater Wetlands. The WHP Program is part of an ongoing comprehensive effort by RIDEM to protect the state's groundwater supply. Elements of the WHP Program will be integrated into other agency programs. The program is focused on (1) placing a high priority on pollutant source control and remedial efforts in
the designated wellhead areas, and (2) providing local
governments and water suppliers with technical information
and administrative tools that are necessary to accomplish
protection objectives. Success of the program is dependent
on local initiative.

The WHP Program applies to all public water systems
that are dependent on groundwater. These systems consist of
community wells (supplying municipal systems, nursing homes
and trailer parks and serving at least 25 individuals at
least 60 days out of the year) and non-community wells
(which are seasonal systems, or those serving schools,
hotels, and restaurants). In Rhode Island there are seventy
community water systems using 170 community wells and 375
non-community wells (RIDEM, 1990).

Local governments have the responsibility to see that
the protection plans are completed and submitted to RIDEM
for review. This program was developed with an
understanding of the limited resources of local governments
and suppliers. By integrating the program elements with
other state and federal planning requirements, a minimal
additional burden will be placed on municipalities and
suppliers. In addition, RIDEM will provide technical
assistance for all aspects of the program.
1.5 ELEMENTS OF THE WHP PROGRAM

A. Delineation of the Wellhead Protection Areas (WHPA).

Preliminary delineation of the WHPA is the responsibility of the RIDEM. The delineation for community wells is based on existing information (RIDEM maps, USGS maps, supplier's information, RIGIS maps, private and public testing, and EPA/RIDEM groundwater computer modeling processes). For non-community wells, a WHPA consisting of all land within a circle with a radius of 1750 feet will be used.

B. Identification of Contamination Sources in WHPA's.

Many land activities have the potential to contaminate groundwater. The degree of threat varies depending on the nature of the activities at the site, the materials used, and the safety practices in use. Local governments or suppliers are responsible for the inventory of existing and abandoned/inactive sources. The RIDEM will provide guidance on inventory procedures, standards, and forms for data collection.

C. Development of Management Strategies.

Over the past several decades, engineers and planners have combined their expertise and have developed a number of BMPs to mitigate some of the adverse impacts on groundwater associated with human activity. Through trial
and error, it has been shown that each BMP option has both unique capabilities and limitations which must be balanced with the overall management objectives and the physical constraints within the WHPA.

Municipalities have many tools other than physical design standards at their disposal to protect local groundwater resources. These tools include both zoning and non-zoning measures, some traditional, some innovative. They range from land-use controls to public education programs. These can be tailored to fit the nature of the community’s water supply, the threats to surface and groundwater, the location of the wellheads, the degree of protection desired, and the structure of local government. Strategies developed for WHPA’s should be implementable and administrable by local authorities.

The RIDEM guidelines require that management plans include a discussion of:

1. Past efforts to protect groundwater;
2. An assessment of groundwater quality;
3. Selection of the most appropriate management strategies;
4. Implementation strategies for management options.

D. Preparation of Contingency Plans.

These plans will describe the steps to be taken by a supplier in the event of a well being contaminated or threatened with contamination. This process will augment
existing state emergency plans. It will define responsibilities, equipment inventories, and alternatives for short-term and long-term provision of water. Technical, logistical, and financial resources will be identified.

1.6 PROCEDURES AND METHODS OF ANALYSIS

A. Wellhead Delineation

As stated before, the preliminary delineations will be prepared by the Groundwater Section of the RIDEM Division of Groundwater and Freshwater Wetlands based on site information and hydrogeological computer modeling. A detailed description of this process is included in Chapter II.

B. Inventory Procedures

Once the WHPA’s are delineated, field surveys will be conducted in order to identify existing and potential contamination sources. On-site investigations, along with information from RIDEM files, local government files, directories of local industrial companies, and examination of aerial photographs, will be used in creating inventories of land use and contamination sources.

C. Management Strategies

A review of state and local protection measures including ordinances, regulations, policies, and existing
management plans will be conducted to assess current protection. A review of the current literature will provide a selection of innovative protection strategies which can be applied on a site-specific basis. Coordination and consultation with the Town, RIDEM, and water suppliers will assist in the identification of the preferred alternatives.

D. Implementation Plan

Once a range of appropriate management strategies have been determined, the strategies will be prioritized according to staffing capabilities, health risks, funding sources, and community support. An implementation plan will be developed that reflects these priorities and identifies possible initiating parties. This plan will effectively preserve groundwater quality within the WHPA.

1.7 SPECIFICATIONS OF DATA

Data collection tasks will include the compilation of existing information from state agencies, local officials, published materials, aerial photographs, and maps related to the Town and its water resources. The Department of Health (DOH) will provide water samples containing detailed information on water quality as the need is indicated. Attributes will be mapped at a scale suitable for analysis (1 inch equals 2,000 feet) as appropriated by the WHP Program.
A considerable amount of data concerning geology, topography, and soils is available through published reports and maps (e.g., USGS topographic maps, USDA Soil Survey). Information concerning land use, vegetative cover, wetlands, roads, drainage, and infrastructure will be obtained from federal, state, and municipal sources. This will be supplemented by aerial photograph interpretation. Point source wastewater generators will be inventoried using state discharge permits. Additional on-site investigation will verify and add to the data gathered, where necessary. This data will be combined with climatic information to determine rain runoff, flooding, and surface and groundwater relationships.
CHAPTER II: GEOHYDROLOGY

2.1 GROUNDWATER

Groundwater is water beneath the surface of the ground in the zone of saturation where every pore space between rock and soil particles is saturated with water (Dunne and Leopold 1978). Above the zone of saturation is an area where both air and moisture are found in the spaces between soil and rock particles. This is called the zone of aeration. Water percolates through this zone until it reaches the zone of saturation, the top of which is termed the water table.

2.2 THE HYDROLOGIC CYCLE

Before analyzing different methods and strategies to manage local groundwater resources, it is important to first describe groundwater characteristics in order to understand how groundwater pollution occurs. Basic concepts, principles, and hydrogeologic terminology will be briefly examined. Acquiring an understanding of groundwater dynamics will enable the water resource planner to adopt the proper design and regulatory guidelines on a site-specific basis which is crucial for the successful implementation of a WHP program.

The hydrologic cycle, as illustrated in Figure 1, involves the continual movement or exchange of water between the atmosphere, the oceans, and other surface water bodies
Figure 1: The Hydrological Cycle
Source: CT Department of Environmental Protection
and the land. During this endless circulation, the water is stored temporarily in streams, lakes, the soil, or groundwater and becomes available for use. In this cycle, when atmospheric conditions are favorable, a portion of the water is precipitated as rain or snow. There are several processes that water can undergo at this stage. The water will either evaporate or transpire through vegetation back into the atmosphere, be absorbed into the soil by the process of infiltration where it is held there as soil moisture by capillary forces, or remain on the surface and travel overland to streams or lakes. Water that is absorbed into the soil will gradually percolate down through the zone of aeration (or unsaturated zone), the upper layer of soil where all available pore spaces between rock and soil particles contain air as well as water. When the soil moisture content is raised, infiltrating water will percolate vertically to the zone of saturation where all available pore spaces are completely filled with water. From this zone water moves slowly into streams, swamps, or lakes, providing surface runoff during dry weather.

2.3 GROUNDWATER RESOURCE AREAS

Groundwater is always present at some depth below the land surface, which can be found in saturated rock and soil formations. These formations may be consolidated bedrock, or unconsolidated deposits of sand and gravel (stratified
drift). Water is stored in void spaces within the sand and gravel. The ability of a specific geologic material to hold groundwater is known as its porosity. Unconsolidated deposits generally contain a larger proportion of void space to total volume thus enabling them to hold larger amounts of water than consolidated deposits.

Permeability refers to the size and interconnectedness of the voids and describes the capacity of a material to transmit water or the availability of stored groundwater. There are three important characteristics of unconsolidated materials that influence permeability: (1) the size and shape of rock particles, (2) the degree of uniformity in the size and shape of the particles (sorting) and (3) the pattern in which the particles are packed (CCAMP 1988).

Permeability, or the ability of a material to transmit water, is an important parameter, since a geologic unit containing a large volume of groundwater will be of little value to a community if water flow in the formation is impeded and consequently trapped. In consolidated rock, such as granite bedrock, permeability depends on how well the fractures in the rock are interconnected. A detailed study on a site specific basis is needed to determine the yield of a well drilled into bedrock. Unconsolidated deposits such as sand and gravel on the other hand, are examples of highly porous, permeable aquifer materials.

Aquifers occur where such formations will yield usable
amounts of water to a well. An aquifer’s capacity to hold water is due to spaces and cracks between particles of rock and soil, which become saturated with water below the water table. The uppermost surface of the zone of saturation is known as the water table. The movement of water is a function of elevation and water along the water table surface will always move from higher to lower elevations. Therefore, the water table (in Rhode Island) generally follows the contours of the overlying terrain (S. Bobiak, pers comm. 1991).

2.4 CHARACTERISTICS OF AQUIFERS

Without going into specific detail regarding the types of aquifers, for the purposes of this introduction it can be generally stated that there exists two types of aquifers. Unconfined or surficial aquifers occur where only unsaturated porous material overlies the saturated formation (Jaffe and Dinovo 1987). The top of this aquifer is defined by the water table. Precipitation recharges the groundwater by soaking into the ground and percolating down to the water table. These aquifers contain little or no pressure and withdrawal of water from these formations requires pumping. Confined aquifers, also known as artesian aquifers, are bounded at the top and bottom by relatively impermeable formations called confining beds, typically of clay or rock. These artesian aquifers may be under greater than
atmospheric pressure thereby raising water levels in wells above the top of the aquifer or water table. The pressure of the groundwater determines the elevation to which the water will rise. This pressure causes the water to flow from wells without requiring pumping. Both the water table and the potentiometric surface, or height of water under pressure, determine the characteristics of the hydrologic system and the rate and direction of groundwater flow.

Each type of aquifer has unique characteristics that determines its susceptibility to contamination. Groundwater management programs must take into account these variable characteristics in order to develop an effective local groundwater protection plan.

2.5 TYPES OF AQUIFERS

Aquifers are generally divided into two classes, characterized by different water-storage properties. The first class is surficial deposits. These unconsolidated aquifers appear as formations of sand and gravel deposited by glacial ice, water, or sometimes wind. Unconsolidated aquifers often occupy the buried valleys of preglacial streams to form highly productive groundwater sources that may be hundreds of feet deep. The surficial sediments overlying bedrock were deposited as the last glacier melted over 10,000 to 15,000 years ago (CCAMP 1988). Permeabilities vary among these deposits depending on the
characteristics of the particles as well the heterogeneity and the degree to which it has been sorted. Sediment deposited by glaciers is called drift and can be classified into two categories, till and stratified drift (See Figure 2).

Till is an unsorted mixture of debris that was deposited directly by glacial ice either frozen within or pushed beneath the ice sheet. As the glacier melted, it compacted the till directly onto the surface of the bedrock creating a dense layer called hardpan. Till deposits generally provide small amounts of water normally yielding only a few hundred gallons of water a day. Till is usually of low porosity and are relatively impermeable. Predicting the result of contamination within these formations is difficult because contaminants can rapidly enter underlying bedrock fractures.

Stratified drift is glacial debris that was carried away by torrents of water that flowed off the melting ice in meltwater streams. These materials dropped out of the meltwater into layered deposits with the larger stones and boulders being deposited closest to the glacier and the smaller lighter materials carried further away. Thus, as they moved away from the glacier, the meltwater streams sorted the rock fragments they carried into separate layers of gravel, sand, and fine sand. Coarse-grained stratified drift contains space between the gravel and sand particles
Figure 2: Types of Aquifers

BEDROCK:
- High Yield if large spaces or cracks
- Low Yield if few interconnected cracks

GLACIAL TILL:
- Low Yield due to insufficient pore spaces

STRATIFIED DRIFT:
- High Yield if coarse grained sand & gravel
- Low Yield if fine sand, silt or clay

Source: CT Department of Environmental Protection
which can hold large amounts of water without restricting its flow. The thicker the deposit the more likely the chance of yielding large quantities of water.

The second class of aquifer is known as a bedrock aquifer. This consolidated material can only store water in cracks, fractures, or in channels created when water enlarges the fractures in certain carbonate rocks. If there is an abundance of fractures and cracks that are interconnected, then bedrock may provide significant quantities of groundwater as much as 200,000 to 400,000 gallons per day (CCAMP 1988). Although the yield of groundwater from bedrock aquifers is reliable, the path of groundwater as it moves through the bedrock is very difficult to predict. Large fractures serve as conduits transmitting contaminants over large distances, with no attenuation or filtration. Due to the difficulty in predicting groundwater flow through bedrock, a larger wellhead protection area is needed to effectively protect the groundwater resources within this type of aquifer.

2.6 GROUNDWATER MOVEMENT

Groundwater is always moving from the higher recharge areas to the lower discharge areas. The speed at which groundwater moves is determined by the types of material through which it flows and the steepness of the gradient from recharge area to discharge area. The larger the pores
between soil particles, the more easily the water will move through the soil. Groundwater movement is measured in feet per day, or in feet per year. Examples of recharge areas are land surfaces that allow a significant amount of precipitation to infiltrate the soil. Examples of discharge areas are streams, lakes, rivers, springs, wetlands and the oceans.

Once water infiltrates the ground and forms an aquifer, it is not simply stored there but moves by gravity toward areas where it discharges to a surface water body. The water table generally follows the shape of the topography or surface elevation of the ground. The water table is at the top of the zone of saturation but does not remain at one level all year long. The level rises and falls seasonally as a result of natural processes. Melting snow, evaporation, transpiration, and rainfall all contribute to a fluctuating water table. The water level is generally higher during winter and spring and usually falls during the summer and fall months. The water table also responds to cyclical periods of drought and heavy rain.

2.7 PUBLIC SUPPLY WELLS

When a public supply well is pumping, the well creates an artificial discharge area by changing the direction of groundwater flow within the influence of the well. Instead of moving toward the natural discharge area, the groundwater
within the influence of the pump flows toward the well from every direction. Pumping depresses the water table in the vicinity of the well and causes water to flow towards the well, creating a cone of depression which outlines the area of drawdown. Figure 3 illustrates a typical cross-section of a well. The cone of depression varies in size depending on the duration and rate of pumping, the aquifer characteristics, and the availability of recharge. This cone of depression is termed the area of influence. Wellhead delineations are based on these areas.

Land use within the area of influence can change the size and shape of the cone. Impermeable surfaces redirect the flow of water that normally recharges the groundwater by creating runoff that flows to streams instead of recharging the groundwater. The cone of depression will then expand to compensate for the loss of water. This creates a larger area of influence that will have to be protected, placing an additional burden on municipalities. Corrective measures should be implemented to ensure that land uses do not degrade or impact the quality or quantity of groundwater resources in the vicinity of the well.

Induced recharge is a process where wells draw surface water from a stream or surface water body. This occurs when the cone of depression reaches as far as a stream and lowers the water table beneath it. Instead of discharging water into the stream, this cone reverses the direction of flow
Figure 3: Cross-Section of a Well
Source: CT Department of Environmental Protection
and draws water from the stream. The pump will then pull water from the stream down through the aquifer and into the well. Under these conditions, polluted surface water can enter the well and degrade the quality of water. Two of North Smithfield's stratified drift wells are in close proximity to the Slatersville Reservoir and may be subject to induced recharge.

There are four areas significant to groundwater supplies that must be identified and protected to prevent contamination. These four areas are (1) aquifers where groundwater can be found, (2) cone of depression or area of influence, (3) recharge areas by limiting development, and (4) surface water since groundwater and surface water are interconnected.

2.8 GROUNDWATER POLLUTION

There are many types and sources of groundwater contamination, both natural and man-made. Figure 4 illustrates the results of contamination in the ground and its effects on the groundwater. Man-made pollutants such as sanitary waste and landfills are the most serious sources. Contamination from hazardous waste spills and leaks as well as the application of pesticides and fertilizers and road salting procedures all contribute to the pollution of groundwater. Once groundwater is contaminated, its use as a drinking water supply may be ended because restoration is
Figure 4: Contaminant Plume
Source: CT Department of Environmental Protection
often either technologically impractical or prohibitively expensive.

Groundwater pollution usually results from some activity on or just below the land surface. As the water infiltrating the ground comes into contact with pollutants, some may be dissolved and move with the water down to the groundwater. Many of the harmful contaminants are removed as the water moves through the soil. Other contaminants such as synthetic organic chemicals, however, travel unaltered through the ground. Once pollutants enter groundwater, they flow according to the same hydrologic principle: from recharge areas toward discharge areas.

Contaminants in groundwater usually form a concentrated plume of pollution that moves with the groundwater as a contamination plume. The porosity, permeability, and chemical composition of the geologic formation as well as the chemical properties of the contaminants all affect the way contamination moves once it reaches the groundwater.
CHAPTER III: WHPA DELINEATIONS

3.1 WELLHEAD PROTECTION AREA DELINEATION

This chapter is based on information from the US EPA's publication, "Developing a State Wellhead Protection Program", Rhode Island Wellhead Protection Program documentation and from interviews with RIDEM hydrogeologist, Sofia Bobiak.

3.2 EPA GUIDELINES

EPA guidelines for wellhead protection require that delineation methods protect wells from three general categories of threats:

* direct introduction of contaminants in areas immediately contiguous to wells;
* microbial contaminants;
* chemical contaminants.

The EPA authorizes states to make initial delineations using simplified procedures to ensure early implementation and then to later refine these delineations. States are also instructed to prioritize the delineation of wellhead protection areas (targeting larger WHPA's initially) according to factors such as well yield, hydrogeologic setting, vulnerability, or contamination risk so that phased protective measures can be developed. Also required of the states was a comparison of alternative delineation criteria, thresholds, and methodologies to ensure cost-effectiveness.
and a statement of rationale for the methods chosen. Delineation criteria considerations include: protectiveness, ease of understanding, economy of development, economy of application, defensibility, application for phasing, and relevance to goals.

3.3 RIDEM DELINEATION METHODOLOGY

For the purposes of this report, the delineation methods developed by geohydrologists from the Groundwater Section of the Division of Groundwater and Freshwater Wetlands, RI Department of Environmental Management, were used. It should be noted that, in order to provide a measure of wellhead protection at the earliest date possible, a two-stage process was used. Delineations used in this report are considered draft initial delineations; final delineations derived from further refinements in the methods will be forthcoming (see Figures 5 and 6 for mapped delineations). Local wellhead protection programs developed at this time will be updated using the refined delineations as those refinements become available. The EPA’s framework for selecting criteria and criteria thresholds was utilized in the RI DEM delineations. The delineations produced for this project are some of the first examples of delineations that will be part of the RI Department of Environmental Management’s Wellhead Protection Program.

In order to develop effective wellhead delineations,
DRAFT

Wellhead Protection Areas for Slatersville Wells

- Bedrock Wells
- Stratified Drift Wells
- Wellhead Protection Areas for Wells in Bedrock
- Wellhead Protection Areas for Wells in Stratified Drift
- Streams
- Lakes and Ponds
- Town Boundaries
- Roads

FIGURE 5.

Area Location

Scale 1: 18,000
DRAFT
Wellhead Protection Area for
Woodland Convalescent Home Well

+ Bedrock Well Location
☑ Wellhead Protection Area
☑ Streams
☑ Town Boundaries
☐ Lakes and Ponds
☑ Roads

Area Location

Scale 1 : 10,000

FIGURE 6.
the staff of the Groundwater Section worked with a wellhead protection delineation committee. Recommendations of the committee members were incorporated into the delineation program. Representatives of the following organizations participated in this process: the US Environmental Protection Agency, the US Geological Survey, the University of RI, the RI Water Resources Board, the RI Department of Health, the League of Women Voters, the RI Department of Environmental Management, and members of the private sector.

In order to prioritize wellheads in terms of needed protection, public wells were divided into three groups:

1. Community wells in stratified drift deposits, and non-community stratified drift wells with maximum yields known to be greater than 10 gallons per minute (gpm);

2. Community wells drilled into bedrock, and those non-community bedrock wells that are capable of yielding greater than 10 gpm;

3. Non-community wells with maximum yields of less than 10 gpm.

3.4 THE DELINEATION PROCESS

Data used in the initial WHPA delineation process included one or more of the following: published reports, well driller completion reports, pump test data, and RI Department of Health records. Information from the Rhode Island Geographic Information System (RIGIS) was used in processing information from the U.S. Geological Survey regarding average transmissivities (the ability of an
aquifer to transmit a fluid, i.e. water) and hydraulic gradients (the slope of water tables). USGS and RI Department of Health (DOH) records, as well as local municipalities and water suppliers, provided pump capacities and rates. Well locations are mapped by the use of aerial photographs and site visits and this information is entered into the RIGIS. Non-community wells have been mapped by the RI DOH.

Several options for delineation methods were examined and evaluated by the Groundwater Section. A basic method is to set an arbitrary fixed radius around a wellhead. This method was considered too simplistic given the available data. Another method, numerical modeling, was deemed too complex given the available data. A method combining analytical modeling and hydrogeological mapping was devised for use with the larger wells and a calculated fixed radius was used for smaller wells.

Delineation Techniques Recommended by the EPA (listed in order of increasing sophistication (US EPA, 1990)):

* Arbitrary fixed radii
* Calculated fixed radii
* Simplified variable shapes
* Analytical methods
* Hydrogeological mapping
* Numerical flow/transport models

3.5 Category 1 Method - Stratified Drift Community and Non-Community Wells.

For these wells, two methods were combined: the uniform flow equation model downgradient of the well, and
hydrogeological mapping upgradient of the well (delineation information can be seen in Appendix A). Although the decision to utilize hydrogeological mapping was straightforward, the choice of an analytical model was more complicated. The Theis, Theim, and uniform flow equations were considered and it was determined that the uniform flow equation’s ability to incorporate a gradient component made it the most appropriate model. The former equations would cause overprotective delineations (on the downgradient side of a wellhead) due to the fact that Theis and Theim equations assume a flat water table; the latter would require more specific site information but would provide a more accurate delineation of the surface and subsurface area.

When using the uniform flow equation (an EPA groundwater modular flow mode, WHPA - module MWCAP, was used) there is a point downgradient of a stratified drift well at which groundwater no longer flows toward the well (the null point) and this constitutes the downgradient limit of a WHPA. This location of this point is determined by aquifer transmissivity, well pumping rate, and water table gradient. Some values for these parameters may be estimated from available data. The drainage basin upgradient of the wellhead is considered the upgradient limit of the WHPA. However, if the well is located in a major stream valley where the stream affects the configuration of the water
table, a distance of one mile from the well is the criterion and threshold (this is consistent with RIDEM’s GAA groundwater classification delineation method). In valleys where no stream exists to affect water table configuration, the criterion is time of travel and a threshold of 10 years was selected.

3.6 CATEGORY 2 METHOD - Bedrock Community and Large Non-Community Wells.

WHPA delineation for these wells was achieved by using the Theis equation in conjunction with a drainage basin (or portion thereof) that is situated in the uphill glacial drift. Other equations considered for this delineation method (uniform flow equation, volumetric flow equations for cylinder and cone shaped zones of influence) were considered but rejected because necessary information regarding groundwater flow direction in major bedrock fractures is not readily available (extensive mapping of fractures and a pump test to determine the location of water-bearing fractures would be required). It was determined that the safest method for delineation of a bedrock well would create a WHPA in the shape of a circle. This shape would best protect the unknown extent of the drawdown area contributing water to the well. As mentioned above, this circular shape was modified by the addition of the uphill glacial drift area from which water seeps into bedrock areas in the vicinity of the well. These delineations are subject to a threshold
value of a one-foot drawdown for the Theis-equation generated circle.

3.7 CATEGORY 3 METHOD - Non-Community Wells with Maximum Yields of Less Than 10 gpm or Unknown.

Through the use of the Theis equation, a WHPA consisting of a circle with a radius of 1750 feet was determined for these wells. The choice of this simpler method was due to lack of site-specific information about these wells and the time and staff limitations of RIDEM. This lack of data has caused conservative delineations which may possibly be overprotective on the downgradient sides and underprotective on the upgradient sides.

3.8 DELINEATION DEVELOPMENT

RIDEM provides initial delineations in order to accelerate the WHP Program and to ensure protection of groundwater supplies at the earliest date possible. It is intended that more refined delineations will be developed and that local WHP Programs will update their programs with this more detailed information. However, due to resource limitations at the state and local level, "no determination has been made with respect to responsibility for or scheduling of this refined delineation process" (RIDEM WHP Program, 1990). RIDEM will be providing guidance regarding methods for refining WHPA delineations which will likely require more sophisticated numerical modeling and the
gathering of new data. It is recognized, however, that the costs involved in this second stage may delay any refinement programs until the state or communities feel that they can afford to initiate such a program. Initial delineations provided by the RIDEM may be the basis for local WHP Programs for the foreseeable future. However, in response to comments presented at a WHP Program public hearing in February 1990 that inquired about the accuracy of the delineations and their legal defensibility, RIDEM expressed confidence that these delineations are suitable for local planning purposes.
CHAPTER IV: INVENTORY OF CONTAMINATION SOURCES

4.1 OVERVIEW OF RI GROUNDWATER CONTAMINATION

Contamination has forced the closure of 17 community wells (those wells serving 25 people or more) since 1979 (RIDEM 305 (b) report). In over half the cases, volatile organic compounds (VOCs), specifically TCE and tetrachlorethylene, were identified as the contaminants. Two of the closed wells were in North Smithfield (Forestdale Water Association and N.S. Air National Guard). Other contaminants forcing closures were bacteria, metals, pesticides, hydrocarbons, and radionuclides. Of these 17 wells, only one has been returned to service. Over the last four years, eight non-transient non-community wells (those serving at least 25 people for more than six months of the year) have been closed to contamination by VOCs. Remediation efforts have allowed four of the NTNC wells to be operated again.

DOH Private Well Testing Data—Public Water Supply Wells

Testing of public water supply wells conducted by the DOH over the last four years showed that VOCs were detected in low concentrations in approximately 15-20% of the wells tested (a complete listing of contaminants detected in RI groundwater can be found in Appendix B). Of the twelve VOCs detected, the most commonly occurring compounds were 1,1,1-
trichloroethane and chloroform, found in 15 wells in 1987 (RIDEM 305 (b) report). The levels found were below the EPA MCL (maximum contaminant levels) standards, where such standards were available. The only instance of an exceedance of an MCL standard was at the North Smithfield Air National Guard facility, where TCE (MCL of 5 ppb) was detected at a level of 6 parts per billion (ppb). This site is within one of the North Smithfield WHPAs.

Up until January of 1988, the EPA had produced standards for only eight VOCs. At this point, the DOH began testing for an additional 51 VOCs, as required by the SWDA amendments of 1986 (Swallow, pers. comm. 1991) Up until mid-1989, although VOC contamination had been detected, MCLs for these substances had not been exceeded. The greatest incidence of VOC contamination occurred in systems serving over 10,000 people (RIDEM 305 (b) Report). The DOH remains very concerned over the management of VOCs due to the relative ease with which they travel in groundwater, their persistence in the environment, and the serious threat these substances present to public health.

The US EPA, in January 1991, added 14 other inorganic and organic compounds to the list of regulated substances. Inorganic chemicals are metals, salts, and other compounds that do not contain carbon and organic chemicals are natural or synthetic compounds that do contain carbon (US EPA 1991). Initially, the EPA was required to develop standards for a
total of 83 contaminants by 1989 (US EPA, 1991). However, that deadline has not been met and has been the subject of recent lawsuits. 25 other contaminants are slated to become regulated after standards for the initial 83 are determined.

Elevated levels of other pollutants have been detected in public water supply wells. DOH sampling (over a seven-year period, 1981-88) revealed elevated levels of sodium and nitrates as well as iron and manganese. Contamination by nitrates is the result of multiple non-point source inputs from land use activities. The highest level of nitrates detected was 7.6 mg/l which is still below the EPA standard of 10 mg/l. Road salting practices have resulted in increased levels of sodium and chloride. 21% of the public wells had sodium levels that exceeded 20 mg/l which is the DOH Alert Level, designed to protect citizens who are on salt-sensitive diets and two wells showed levels over 100 mg/l (RIDEM 305 (b) Report, 1990). Iron and manganese are metals that naturally occur in groundwater and the EPA has established secondary drinking water standards for them based on aesthetic considerations rather than health reasons.

Private Well Testing

The DOH has monitored a total of 3,060 private wells, usually those in close proximity to hazardous waste landfills, industrial sites, and leaking underground storage
tanks. This monitoring indicates that VOCs are the most frequently detected contaminants (usually in low concentrations), occurring in 27% of the wells tested. Other detected contaminants include: gasoline, MBTE (a gasoline additive), fuel oil, arsenic, cadmium, chromium, lead, pesticides (aldicarb and carbofuran), salt, and nitrates (RIDEM 305 (b) Report, 1990).

4.2 EXISTING WATER SYSTEM WITHIN THE WHPAS

This section will describe the existing wells that fall within the initial draft WHPA delineations supplied by RIDEM for the Town of North Smithfield. Information in this section was derived from the Weston and Sampson Water System Master Plan and from records on file at the DOH. This study has focused on these delineations as being the primary wells of concern. There are a total of five bedrock and three stratified drift public wells. These comprise the public wells both community and non-community as described in the first section of this report.

The Slatersville Water Company (SWC) operates the original Slatersville water system which was constructed to supply the Slater’s Mills. The SWC currently serves about 445 residences and 12 non-residential users. Available records from the town and the DOH indicate that water is supplied from five well sites within the system. The SWC operates five of the eight wells that this study addresses.
Table 1 illustrates a summary of the eight well sites that are addressed in this study.

<table>
<thead>
<tr>
<th>Well</th>
<th>Type</th>
<th>Pumping (gpm)</th>
<th>Depth (Feet)</th>
<th>Year Built</th>
<th>Well House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main St. Pump House No. 1</td>
<td>Dug</td>
<td>90</td>
<td>28</td>
<td>1800's</td>
<td>8&quot; x 8' Brick</td>
</tr>
<tr>
<td>Main St. Pump House No. 2</td>
<td>6 Well Points</td>
<td>100</td>
<td>16-21</td>
<td>—</td>
<td>8&quot; x 8' Brick</td>
</tr>
<tr>
<td>Pacheco Park Well</td>
<td>Drilled Bedrock</td>
<td>40</td>
<td>&gt;300</td>
<td>1979</td>
<td>None</td>
</tr>
<tr>
<td>Halliwell School No. 5</td>
<td>Drilled Bedrock</td>
<td>10</td>
<td>580</td>
<td>1959</td>
<td>None</td>
</tr>
<tr>
<td>Halliwell School No. 6</td>
<td>Gravel Packed</td>
<td>100</td>
<td>43</td>
<td>1986</td>
<td>None</td>
</tr>
<tr>
<td>Slater Village Condominium Well</td>
<td>Drilled Bedrock</td>
<td>40</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Coast Guard Housing Well</td>
<td>Drilled Bedrock</td>
<td>30</td>
<td>300</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Woodland Convalescent Center</td>
<td>Drilled Bedrock</td>
<td>3</td>
<td>860</td>
<td>1968</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Source: RIDEM/DOH/SWC

Table 1

There are two well pumping stations located on Main Street in Slatersville. Pump House No. 1 houses a 28 foot deep dug well that was installed in the late 1800’s. The well is located adjacent to the Slatersville Reservoir approximately 300 feet north. Figure 5 illustrates the wells and the delineations supplied by the RIDEM. Studies have shown that induced recharge occurs along the southwest corner of the well. Due to excessive drawdown as a result of the pumping operation, the well is intermittently shut down to allow the well to recover. This gravel packed well
under optimum conditions has a pumping rate of 90 gallons per minute (gpm).

Main Street Pump House No. 2 houses a manifold and vacuum system which joins two sets of three well points, the combined total of which can be safely pumped at 100 gpm. The maximum depth of these well points is 16-21 feet.

The Pacheco Park Well is a 300 foot deep, drilled bedrock well with no well housing structure and has a 1 horsepower pump with a pumping capacity of 9 gpm.

Halliwell School Well No. 5 is a drilled bedrock well that was originally installed to supply the Halliwell school with water. The well began operation in 1959 and pumps at a rate of 10 gpm.

Halliwell School Well No. 6 is a gravel packed, 43 foot well with a pumping capacity of 100 gpm. Past pumping rates achieved a rate of 135 gpm but this rate was reduced to prevent excessive drawdown of the water table.

The Slater Village Condominium Well is a drilled bedrock well with a pumping capacity of 40 gpm. This system serves a condominium complex located off Victory highway. The WHPA extends westward across the town line into Burrillville. Adequate protection within this particular wellhead area will require a combined effort between the towns of North Smithfield and Burrillville.

The Coast Guard Housing Well is a 300 foot drilled bedrock well with a pumping capacity of 30 gpm. This well
serves approximately 85 persons located on the NIKE site. The RIDEM has documented contamination sources in the vicinity of this well. Pumping rates within this system should be carefully monitored to prevent excessive drawdown that might induce recharge in the direction of the contamination sources.

The Woodland Convalescent Well was installed in 1968 to provide drinking water for 60-80 residents of the center. This bedrock well has a pumping capacity of 3 gpm. Extensive drilling was required to a depth of 860 feet in order to provide the center and fulfill their water needs.

SWC Water Quality

Since 1989 the RIDOH has monitored RI water systems for a total of 59 solvents and organic chemicals as required under the SDWA Amendments of 1986. At present only 22 of these substances are regulated (J. Swallow pers. comm., 1991). Test results for the 22 regulated substances revealed that water from the Halliwell School Well No. 6 contained 1-2 parts per billion (ppb) of trichloroethene. This does not exceed EPA limits. None of the 58 other substances were detectable. The DOH advised the town (March 1990) that none of these chemicals are present in amounts that would pose a threat to the health of the consumer. Refer to Appendix C for the DOH sampling report.
4.3 CONTAMINANT DESCRIPTIONS AND EFFECTS

Information in the following section is derived from the following publications: CCAMP, 1988, Special Legislative Commission on Water Supply, 1986.

1. Acids and Bases

Acids and bases occur as a result of industrial wastes, wastewater from jewelry shops, machine shops, furniture stripping, leachate from landfills, junkyards and industrial pits/lagoons. The most common acids and bases found in the wastestream include hydrochloric acid, sulfuric acid, and ammonia. The harmful effects of acids occur when the positive charged ions remove heavy metals from soil particles. Consequently, the metals remain in solution and can move through the soil into the groundwater. High concentrations of acids and bases in wastewater will kill the bacteria that decompose the waste and reduce the effectiveness of a septic system.

2. Chloride

One of the major contributing sources of chloride in the soil stems from the road salt used to deice roads and parking lots. Road salt enters the groundwater as runoff from roads and uncovered salt piles. Septic systems and water softening agents also contribute chloride to groundwater. Elevated chloride levels in drinking water results in an aesthetically displeasing sample. The
presence of excessive chloride concentrations may be linked to the same elevated levels in sodium concentrations which can have adverse health effects on the general population (See Sodium).

3. Fluoride

Fluoride occurs naturally in the soil. Wastes generated from various manufacturing practices contain fluoride. It is also an additive to drinking water, toothpaste and other dentifrices. The ingestion of excess fluoride causes fluorosis, a disease which results in brittle and sensitive teeth and bones.

4. Heavy Metals

Heavy metals are not generally found in concentrated form in natural constituents. Metals are soluble in water and are more mobile in acidic, reduced conditions. The health threats associated with heavy metals are many depending on which one is of concern. Typical health threats associated with metals include: high blood pressure, kidney damage, toxicity, nervous disorders, and blue-gray discoloration of the skin, eyes and mucus membranes.

5. Iron and Manganese

Iron is one of the most abundant elements and can be found in high concentrations in natural constituents.
Industrial waste and drainage water contain an abundance of iron. Manganese is common in salts and minerals. Water with elevated iron concentrations will develop a brownish appearance which colors laundry and porcelain fixtures. High manganese levels have a similar aesthetic problem. Iron and manganese particles will collect in joints and valves and has a tendency to clog pipes and decrease their life expectancy.

6. Nitrates

The most commonly occurring source of contamination is excess nitrates. Sources of nitrate pollution include: leachate from septic systems, runoff, discharges from municipal sanitary waters, and runoff from agricultural lands, and landfills. At concentrations exceeding federal standards, nitrates can cause a disease called methemoglobinemia or "blue-baby disease" which can be fatal in infants under three months of age. This occurs as a result of too much nitrite in the blood which inhibits the blood's ability to transport oxygen.

7. Pathogens/Viruses

The presence of Escherichia coli (E. coli), more commonly known as coliform, results from contamination by human and animal wastes. Too much coliform indicates the presence of viruses and parthenogenetic bacteria. The harmful
effects of this type of contamination are generally gastrointestinal diseases. Bacteria, viruses, and parasites are all parthenogenic organisms. Diseases such as typhoid, dysentery, cholera, hepatitis and tuberculosis are common in contaminated conditions.

8. Pesticides

Pesticides refer to a wide range of chemicals including herbicides and insecticides. Application and storage of these products are process that can threaten groundwater quality. Farmers use pesticides to kill unwanted pests such as insects and weeds that threaten crops. Pesticides contaminate groundwater by percolation through the soil. A common pesticide used locally to control the Colorado potato beetle was aldicarb or more commonly called temik. The use and application of these chemicals must be closely monitored to insure the quality of the groundwater.

9. Petroleum Products

Petroleum products such as gasoline, diesel fuel, kerosene, heating oil, motor oil, and grease are commonly used everyday. The presence of these products in groundwater can be attributed to leaking UST and pipelines. Benzene is a component of fuels and is often the only name constituent in cases of fuel contamination. Toluene xylene, and butyl ether are also found. These products will degrade
in the presence of nutrients and oxygen. Concentrated plumes of these products will cause problems in drinking water that are costly and timely to rectify. Low level exposure produces dizziness, weakness, euphoria, headaches, nausea, tightness in the chest, and staggering. At high concentrations benzene blurs the vision, tremors paralysis and unconsciousness. Excessive exposure has resulted in death due to leukemia and aplastic anemia.

10. Sodium

Salt is a naturally occurring constituent of water. Elevated levels of sodium is commonly a result of runoff from de-icing operations. High sodium concentrations pose dangerous health threats to certain segments of the population. It is believed to be related to the development of hypertension and has also been connected as a factor in Sudden Infant Death Syndrome.

11. Solvents

Typically, solvents are used as a cleaning agent (degreasing) in automobile repair shops. Dry cleaning and furniture stripping businesses rely on solvents for cleaning purposes. Common household products contain solvents including, nail polish remover, drain openers, detergents, thinners and septic tank cleaners. The cumulative impact of toxic organic solvents by households into domestic septic
systems may have a significant effect on groundwater quality. Common solvents used in industrial manufacturing include toluene, naphthalene, benzene and trichloroethylene (TCE) which has been detected at the Stamina Mills Site in North Smithfield. The health threats are similar to those of petroleum products and should be carefully monitored to ensure the protection of drinking water supplies.

Non-point Sources of Groundwater Contamination in Rhode Island (See Appendix D for Land Use Impacts)

1. Pesticides

Instances of pesticide contamination in groundwater have been on the rise. Most pesticides are very soluble in water and therefore have the ability to be transported long distances in groundwater. In the RIDEM’s Private Well Survey, 28 or the 256 wells tested had detectable levels of pesticides (all were below drinking water standards). The most frequently detected pesticide was Aldicarb (also known as Temik), a compound designed to kill soil insects. It is often applied to potato fields.

2. Fertilizers

The most serious contamination problem resulting from agricultural and homeowner use of fertilizer is the introduction of nitrogen into groundwater. Nitrogen, in the form of nitrate, is very soluble in water and can become concentrated in the earth. It then can leach into and
travel quickly through groundwater. Homeowners have a tendency to overfertilize lawns thus allowing excess nitrate to contaminate groundwater.

3. Septic Systems

One of the most serious threats to groundwater is nitrates and contaminants that leach from septic systems. There are currently about 144,000 individual septic disposal systems (ISDS) in operation in Rhode Island today (RIDEM 305 (b) Report, 1990). Existing regulatory setbacks and separation distances cannot prevent effluent from properly designed ISDS from reaching groundwater (Myers, 1988, Horsley, 1990). This is problem is compounded by leachate from systems that have failed due to poor design or old age.

Bacteria, viruses, nitrates, and volatile organic compounds (VOC) are the main contaminants that leach from septic systems. It has been shown that although bacteria can be attenuated within the soil within a short distance of a septic system, viruses can survive as long as 120 days and can travel as far as 218 feet (Myers, 1988) in groundwater. High nitrate concentrations in groundwater drinking supplies are considered a health hazard. Nitrates can be converted to nitrites in the human body which can cause infant cyanosis (blue baby), a condition in which nitrogen rather than oxygen is transported by the blood and produces oxygen starvation (US EPA, 1976,). Groundwater nitrate levels
above 10 mg/l are considered a health hazard. Elevated concentrations of nitrates have been found as far as 330 feet from a septic system leachfield (State of State’s Waters 305 (b) Report). Many organic chemical pollutants are commonly found in septic systems. Household cleaners, paint thinner, drain and oven cleaners, and solvents are often flushed into septic systems. Many of these substances are very mobile in groundwater and are persistent in the environment. Septic system cleaners contain organic chemicals which present a serious threat to groundwater quality. The most common of these chemicals are methylene chloride and 1,1,1-trichloroethane. The State has banned the use of cleaners containing these chemicals but enforcement of this ban is difficult. Little research has been conducted on the impacts of these compounds and the EPA has yet to determine acceptable levels for many organic chemicals.

4. Road Salt

In an effort to provide safe winter road conditions, RI communities apply a mixture of sand and salt as a deicing measure. Salt is applied at a rate of up to 300 pounds per lane mile of road (RIDEEM 305 (b) report). Municipal and private wells are often located near major roads and some wells have been contaminated by road salt. High sodium concentrations in drinking water are considered a public
health threat, particularly to those on salt-restricted diets. Alternative deicing materials have been tried (calcium chloride mixed with sodium chloride) but high costs and complaints regarding road conditions have meant a return to the standard salt/sand mixtures.

5. Radon

Radon is a colorless, odorless radioactive gas which occurs naturally in bedrock in Rhode Island. The federal government has stated that an estimated 5,000 to 20,000 people may die each year from radon-induced lung cancer (Lowry, 1987). Because radon is 60 times more soluble in water than is oxygen, it accumulates in greater concentrations in water than in air (Lowry, 1987). The EPA recommended mitigation level for airborne radon is 4 picocuries per liter (pCi/l) and as low as 20 pCi/l for waterborne radon. The EPA is considering setting an MCL for radon at about 500 pCi/l (RIDEM 305 (b) Report). However, the magnitude of the problem is evidenced by the fact that national average radon concentrations in groundwater are about 500 pCi/l (Lowry, 1987). Radon in groundwater used for domestic water supply can be released into the air through dishwashing, showers, and other water-using activities. It is known that breathing radon is more dangerous than drinking it, although it has been concluded that drinking radon-contaminated water will increase the
risk of contracting stomach cancer (Univ. of ME, 1986).
Water supplies that are drawn from sand and gravel aquifers have lower radon levels than water drawn from bedrock wells. Some radon decay takes place when water stands while in storage before distribution (Univ. of ME, 1986).

The RIDEM Private Well Survey tested 303 wells and included radon as one of the test parameters. Groundwater radon concentrations ranged from 140 to 49,080 pCi/l. 291 of the RI private wells tested registered radon levels exceeding 500 pCi/l. No state action is anticipated until EPA standards are set.

6. Petroleum Spills

RIDEM Emergency Response personnel respond to over 200 spills of petroleum products every year (RIDEM 305 (b) Report). Many unreported spills result in groundwater contamination that is later discovered. Other sources of petroleum contamination are parking and transfer areas (with above ground tanks) for oil trucks and sand and gravel operation vehicles.

4.4 CONTAMINATION SOURCES IN NORTH SMITHFIELD

This section describes the existing and potential sources of contamination based on on-site investigation, aerial photographs, land use surveys and file reviews at the RIDEM Groundwater Section. There are primarily two sources
of contamination, natural and man-made. It is the purpose of this project to identify the man-made sources of pollution which will be broken into point and non-point pollution.

Point sources of contamination are attributed to a particular point of discharge such as end of pipe discharge, or any contaminant that can be traced back to its origin. Examples of point sources include but are not limited to: hazardous materials storage and disposal, leaking underground storage tanks, salt piles, oil and gas pipelines, and junkyards.

Non-point sources of pollution cannot be located at a particular point and are difficult to quantify. Examples of this type of pollution include: septic system failure, runoff from highways, pesticides and fertilizers, farms and animal waste just to name a few. Because of the difficulty in assessing the non-point sources of contamination, potential sources of contamination are included within this classification. The following section includes a brief discussion of various non-point sources of pollution.

4.5 SUPERFUND/CERCLIS SITES IN NORTH SMITHFIELD

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) established the Superfund - a funding source used to clean up existing or closed high priority toxic waste sites. There are three such sites in
the Town of North Smithfield. Toxins disposed of or stored at waste sites have been found to leach into groundwater. This act created a funding mechanism for clean-up actions. The broad powers this act grants of assigning liability for cleanup of such sites to hazardous waste transporters, generators, and landfill owners acts as a deterrent to continued toxic dumping practices. CERCLA sets forth a cost-sharing formula in which the states must contribute 10 to 50 percent of the cost of clean-up, depending on whether the site in question was publicly or privately owned. The high costs associated with toxic waste removal or remediation has hampered the effectiveness of this act as many states currently do not have the financial resources to allocate funds for CERCLA actions. Sites on the CERCLA Information List are potential contamination sources where it has been established that presently or in the past there occurred releases of hazardous substances. Locations deemed to represent an immediate threat to the public health and safety are elevated to the National Priority list called Superfund. When investigated and found not to be a potential hazard, it gets removed from the list.

Superfund Sites in North Smithfield

1. Stamina Mills, Main St., Forestdale section of N. Smithfield

   This five-acre site was in operation from 1969 to 1975 as a textile mill in which solvents were used in a scouring
system. In the early 1970s, an 800 gallon trichloroethylene spill occurred. The mill was closed in 1974 and storage tanks were abandoned still containing 600-700 gallons of solvents. The mill was destroyed by fire in 1979 and the tanks could not be found in the remains. Surface water (the Branch River), groundwater, and soil were contaminated. The RI Water Resources Board and the EPA provided funds for a new water supply. The EPA monitored the site until 1986 and remedial measures are still in the process of development. The contaminant plume is currently receding toward the site.

2. Landfill and Resource Recovery Site (L&RR)

This 28-acre site is located off of the Oxford Turnpike, northwest of Pound Hill Road. Industrial wastes were received at the site from 1927 until a court-ordered closure in 1985. The length of the time period in which hazardous wastes were received is not known. The site is located within the Slatersville Aquifer recharge area and on the perimeter of the groundwater reservoir. The EPA estimated the clean-up costs to be between 8 and 11 million dollars.

3. Western Sand and Gravel

Western Sand and Gravel, a gravel quarry operation, is located on the Burrillville, North Smithfield town line,
east of Douglas Turnpike. Disposal of septage and industrial wastewater occurred in the mid 1970’s on a portion of the site. This site was closed in 1980 and at present, there is little information available on the potential ability of this landfill to contaminate the Slatersville Reservoir or the aquifer. It is located between Douglas Pike (Rte. 7) and the reservoir. Approximately 4700,000 gallons of liquid hazardous wastes were disposed at the site between 1975 and 1977. Tarklin Brook, which eventually drains to the Slatersville Reservoir, passes within 300 feet of the site. Groundwater movement in the area of the site was determined to be in a northwest direction, closely following the Tarklin Brook channel. Remediation measures have included capping and a groundwater recycling system and further measures are still being developed.

The following table lists non-Superfund CERCLIS sites in North Smithfield.

<table>
<thead>
<tr>
<th>NORTH SMITHFIELD SITES ON USEPA'S CERCLIS LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE</td>
</tr>
<tr>
<td>Glas-Kraft/Halliwell Blvd.</td>
</tr>
<tr>
<td>Poly-Top Corp/Halliwell Blvd.</td>
</tr>
<tr>
<td>Halliwell Blvd. Property</td>
</tr>
<tr>
<td>DODF, Army, N. Smith Nike</td>
</tr>
<tr>
<td>DODF/Air-RI Air Nat. Guard</td>
</tr>
</tbody>
</table>

Source: USEPA CERCLIS List

Table 2
The Superfund Amendments and Re-authorization Act (SARA) Title III requires businesses to notify governments (Right-to-Know) of potentially hazardous substances stored or used on-site. SARA records for the State of Rhode Island are managed by the RI Department of Labor. Table 3 list the sites that fall within the WHPAs that have registered with the RI Department of Labor. Of these sites only 13 have submitted annual substance inventory lists (T. DiCicco, pers. comm.).

<table>
<thead>
<tr>
<th>COMPANY NAME</th>
<th>ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; J Well Co. Inc.</td>
<td>77 North Main Street</td>
</tr>
<tr>
<td>C &amp; C Service Inc.</td>
<td>Victory Highway</td>
</tr>
<tr>
<td>Dumais Plumbing &amp; Heating Inc.</td>
<td>905 Victory Highway</td>
</tr>
<tr>
<td>Farrell Construction Co. Inc.</td>
<td>468 Sayles Hill Road</td>
</tr>
<tr>
<td>G. Bouchard - Masonry</td>
<td>12 Willerval Avenue</td>
</tr>
<tr>
<td>Holliston Sand Co. Inc. *</td>
<td>Tiffi Road</td>
</tr>
<tr>
<td>L &amp; L Dozer Service Co. Inc.</td>
<td>115 Mount Pleasant Road</td>
</tr>
<tr>
<td>Marcantonio &amp; Sons *</td>
<td>31 Georgianna Avenue</td>
</tr>
<tr>
<td>Norman J. Langelier Co. Inc.</td>
<td>1435 Victory Highway</td>
</tr>
<tr>
<td>Northern RI Animal Hospital</td>
<td>152 School Street</td>
</tr>
<tr>
<td>Poly-Top Corp. *</td>
<td>Graham Drive</td>
</tr>
<tr>
<td>Precision Auto Repair Inc. *</td>
<td>550 Iron Mine Hill Road</td>
</tr>
<tr>
<td>The Homestead *</td>
<td>P.O. Box 543</td>
</tr>
<tr>
<td>The Pines</td>
<td>Poundhill Road</td>
</tr>
<tr>
<td>The Villa Capri Inc.</td>
<td>North Main Street</td>
</tr>
<tr>
<td>Village-Haven Restaurant Inc.</td>
<td>90 School Street</td>
</tr>
<tr>
<td>Woodland Convalescent Center *</td>
<td>70 Woodland Road</td>
</tr>
<tr>
<td>Yard King Inc.</td>
<td>1087 Eddy Dowling Highway</td>
</tr>
</tbody>
</table>

* Submits Substance List Annually

Source: RI Department of Labor

Table 3
**RCRA Facilities within the WHPAs**

This federal statute provides standards for treatment, storage, and disposal facilities for hazardous wastes (See Table 4) all aimed at preventing contamination of surface and groundwater and at public safety. Hazardous wastes are tracked from "cradle-to-grave" (point of generation to point of ultimate disposal). The Act was amended in 1984 to address groundwater contamination from leaking underground storage tanks which are subject to RCRA regulation if 10 percent of a tank's volume is beneath the ground surface and if the tank contains a material regulated under RCRA or CERCLA.

<table>
<thead>
<tr>
<th>REG. #</th>
<th>FACILITY NAME</th>
<th>ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>801192488</td>
<td>Glas-Kraft Inc.</td>
<td>Railroad Street</td>
</tr>
<tr>
<td>081889305</td>
<td>Menard Subaru</td>
<td>Eddy Dowling Highway</td>
</tr>
<tr>
<td>082766891</td>
<td>Menard Subaru</td>
<td>Eddy Dowling Highway</td>
</tr>
<tr>
<td>082192676</td>
<td>Precision Auto Repair</td>
<td>Greenville Road</td>
</tr>
<tr>
<td>910522105</td>
<td>RI Air National Guard</td>
<td>N.S. Air National S</td>
</tr>
<tr>
<td>000843735</td>
<td>Sunoco Service Station</td>
<td>1047 Eddy Dowling Hgwy</td>
</tr>
<tr>
<td>082755506</td>
<td>Yard King</td>
<td>1087 Eddy Dowling Hgwy</td>
</tr>
</tbody>
</table>

Source: RIDEM

**Table 4**

The US EPA has not added to the list of RCRA-regulated materials since 1980 although several states have requested that the list be expanded (Jaffe and DiNovo, 1987). Four
factors are used to classify hazardous wastes under RCRA: ignitability, corrosivity, reactivity, and toxicity. Substances not regulated under RCRA are those that are carcinogenic, infectious, and cause birth defects (teratogenic) although there are provisions in the 1986 amendments to add such substances.

**RIDEM Registered Underground Storage Tanks (UST)**

The State of Rhode Island regulates USTs that hold 1100 gallons or more. A majority of these tanks store petroleum products such as home heating oil and gasoline which comprise 39% and 35% of the total, respectively. Table 5 illustrates a list of USTs within the WHPAs.

<table>
<thead>
<tr>
<th>REG. #</th>
<th>FACILITY NAME</th>
<th>ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>02375</td>
<td>C &amp; C Service</td>
<td>Great Road</td>
</tr>
<tr>
<td>00883</td>
<td>Citgo/Slatersville Plaza</td>
<td>Victory Highway</td>
</tr>
<tr>
<td>00292</td>
<td>DB Mart</td>
<td>Eddy Dowling Highway</td>
</tr>
<tr>
<td>01599</td>
<td>Don Schmor Excavating Co.</td>
<td>Main Street</td>
</tr>
<tr>
<td>01557</td>
<td>Edgecomb Metals</td>
<td>Industrial Park</td>
</tr>
<tr>
<td>02725</td>
<td>Menard Subaru</td>
<td>1401 Eddy Dowling Hgwy</td>
</tr>
<tr>
<td>01473</td>
<td>North Smithfield Armory</td>
<td>Pound Hill Road</td>
</tr>
<tr>
<td>00580</td>
<td>Pike Mobil</td>
<td>1148 Eddy Dowling Hgwy</td>
</tr>
<tr>
<td>00401</td>
<td>Ryder Student Trans.</td>
<td>Old Providence Pike</td>
</tr>
<tr>
<td>00633</td>
<td>Sunoco #0002-4976</td>
<td>Eddy Dowling Hgwy</td>
</tr>
<tr>
<td>00367</td>
<td>Town Hall</td>
<td>Main Street</td>
</tr>
<tr>
<td>02229</td>
<td>U.S. Post Office</td>
<td>1 Main Street</td>
</tr>
</tbody>
</table>

Source: RIDEM

**Table 5**
There have been 125 incidents of UST leakage discovered in Rhode Island in the last few years (RIDEM 1989). 83% of the registered USTs are constructed of steel which deteriorates at a higher rate in humid climates.

Two incidents of groundwater contamination have occurred as a result of leaking underground storage tanks. The first leak occurred at the Sunoco station located at 1047 Eddie Dowling Highway when a neighbor complained of water quality problems in their well. After deliberation and careful studies, the Sun Refining and Marketing Company entered into agreement with the RIDEM to initiate a clean up program to restore the drinking water quality in a well located at 29 Woodland Road. Sun agreed to install a two-tiered recovery system to remove MTBE, a gas additive found in halos around the well. The first step in this procedure required aeration to volatize and release the additive into the air. Then to pass it through a charcoal filtration system, and finally discharge the water into a DOT storm drain. In the mean time the RIDEM would provide fresh drinking to the residents.

The second incident that resulted in groundwater contamination occurred in the same area as the first. The DB Mart located at 80 Eddie Dowling Highway owned by Deblois Oil Company was issued a permit for wastewater discharge following a clean up procedure of the contaminated groundwater. This problem began in 1989 after a complaint
by a local resident was filed with the RIDEM. High levels of MBTE and aromatics were found in a nearby well. The parties involved are in the process of working out an agreement to determine the responsibilities of each. Refer to Appendix E for Sun Oil/DB Mart documentation.

**Potential Threats**

Other potential sources of contamination that pose a threat to groundwater quality exist in North Smithfield. Of primary concern is an underground mobile pipeline bisecting Sayles Hill Road adjacent to the North Smithfield and Lincoln Town Line. This multi-product pipeline transports various petroleum products consisting of No. 2 and No. 6 bunker fuel. The 6 inch pipeline is buried at a depth of 37 feet. Although no record of leaks or contamination are on file at the RIDEM, the risk of contamination remains.

The final threat to groundwater quality found in this study occurs at the RI Air National Guard (NIKE) site located on Pound Hill road. The threat exists as an underground injection well which pumps wastes deep into the ground. This site is registered with the RIDEM.
5.1. REGULATORY PROTECTION

The development of surface water reservoirs has become politically difficult and extremely costly in recent times. Opposition from environmental groups (and sometimes the EPA as in the case of the proposed Big River project) combined with fiscal limitations has forced states and communities to take a closer look at groundwater sources of drinking water. Drought conditions in the Western United States have drawn attention to problems involving the allocation of water rights and withdrawal rates from groundwater aquifers (National Public Radio broadcast, May 1991). Because effective regulations aimed at the protection of groundwater did not exist until recent times, some reserves were contaminated and others are at risk. The RIDEM State of the State’s Waters 305 (b) Report estimates that 9% of the state’s groundwater has been impacted by contaminants and that 80% is threatened.

Federal, state, and local regulations address different aspects of the protection of groundwater reserves but existing regulations do not provide comprehensive protection. Rhode Island’s antiquated zoning enabling act did not provide the authority necessary for communities to adopt groundwater protection ordinances until recent amendments made that possible. The addition of aquifer
overlay districts to zoning ordinances has been beneficial but there are still gaps in protection.

Analysis of the existing regulatory groundwater protection measures prevents overlaps, duplications of effort, and conflicts with existing groundwater programs. Using these programs as a basis, communities can craft groundwater protection strategies that are specific to their circumstances. Gaps in existing authority can be identified and any needs for intergovernmental cooperation become apparent (as in the case of designing protection for aquifers that underlie several communities).

Federal and state efforts regarding groundwater protection are in a state of flux (Patrick et al. 1987). As the issue has recently become the focus of political concern and as communities realize the extent of the risk of contamination of groundwater drinking water supplies, there have been many legislative actions aimed at groundwater protection (primarily on the local level).

5.2 FEDERAL GROUNDWATER PROTECTION

There are no federal statutes that specifically target the protection of groundwater. When combined, different parts of existing programs provide a certain degree of groundwater protection (Refer to Appendix F for a descriptive listing of federal and state regulations that affect groundwater quality). These existing programs are
often amended to include aspects of groundwater protection (i.e. RCRA and SDWA) and are focused on activities or practices that are likely to threaten the environment with groundwater being one of the environmental factors warranting protection (Patrick et al. 1987).

It is likely that federal responsibility for groundwater protection will be legislatively expanded in the future (Jaffe and DiNovo, 1987). Comprehensive groundwater legislation was offered in both Houses of the Congress in 1986 and 1987; no acts were passed but support is growing as legislators and their constituents recognize the vulnerability of water supply systems in the United States.

One of the groundwater issues being debated in Congress is the question of whether the federal government or state governments should have primary control over groundwater protection. Also being discussed are legislative methods that will ensure that states develop and implement programs to address their own unique groundwater problems (Patrick et al. 1987).

In 1984, the EPA established the Office of Groundwater which was given the responsibility for developing an overall federal groundwater strategy. This effort is in competition with other environmental regulatory initiatives (i.e. air quality, surface water quality) that have been part of the regulatory scheme for more than a decade and that have established a certain momentum. Additionally, the process
is slowed by technical issues more complex than those encountered in other environmental protection efforts (Patrick et al. 1986).

The federal acts that are provide groundwater protection are:

- The Clean Water Act (CWA) as amended by the Water Quality Act of 1987
- The Safe Drinking Water Act (SWDA)
- Resource Conservation and Recovery Act (RCRA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Superfund Amendments and Reauthorization Act (SARA)
- Toxic Substances Control Act
- Federal Insecticide, Fungicide, and Rodenticide Act
- National Environmental Policy Act (NEPA)

These acts grant authority to governments to take action against threats to public health or the environment and so they can be applied to groundwater. State governments are given authority by Congress to administer and enforce these federal regulations. In some instances, states have developed programs that are more stringent than required by federal law.

5.3 STATE GROUNDWATER PROTECTION

RI Groundwater Strategy

In 1983, the State of Rhode Island's Water Pollution Control Act was amended to include groundwaters under the
definition of the State’s waters. In doing so, the RIDEM was given authority to regulate the prevention of groundwater contamination and to restore groundwater quality to acceptable levels. The State enacted the Groundwater Protection Act in 1985 which was designed to provide for the development of a comprehensive groundwater protection program. Policies established by the Act provided measures to restore, protect, and maintain the quality of the State’s groundwaters. These measures included aquifer, recharge area, and watershed protection. Degradation of groundwater was prohibited unless the state chose to allow "lower quality as a result of essential, desirable, and justifiable economic, commercial, industrial, or social development" (RI Groundwater Protection Strategy, RIDEM 1989). This act also directed the RIDEM to identify and classify groundwater aquifers and to establish standards for the four classes of groundwater. These classes are (from RIDEM’s RI Groundwater Protection Strategy, 1989):

GAA - groundwater sources suitable for public drinking water use without treatment;

GA - groundwater sources which may be suitable for public or private drinking water without treatment;

GB - groundwater sources which may not be suitable for public or private drinking water without treatment due to known or presumed degradation;

GC - groundwater sources which may be suitable for certain waste disposal practices because past or present conditions have rendered these sources more suitable for receiving permitted discharges than for development as a public or private
drinking water supply.

Analysis of State Regulatory Protection

State programs provide protection in terms of setbacks and separation distances (ISDS regulations) and control of substances and practices that pose a threat to groundwater quality (refer to Appendix F for a listing of State regulations). It has been scientifically documented that existing setbacks and separation distances may not be sufficient to attenuate certain contaminants (viruses, nitrates, VOCs) especially in the highly permeable outwash soils in which the state’s significant aquifers are located (RI State Plan Guide Overview - Element 010, 1984, Myers, 1988, Horsley, 1990).

Although regulations aimed at control of hazardous wastes are effective, hazardous materials, in raw form, are not regulated and pose a threat to groundwater quality due to spills or leaks that could occur as these materials are stored or transported. Another gap in groundwater protection from hazardous materials is the fact that federal and state statutes only regulate USTs with capacities of over 1100 gallons. Although a few communities have enacted more stringent UST regulations or bans (as encouraged by the RIDEM WHP Program), the majority of domestic and small commercial tanks are unregulated. Small volumes of contaminants can cause significant groundwater contamination.
The injection of waste products into the ground, while strictly regulated, creates a potential for future groundwater contamination problems due to the lack of knowledge of subsurface geological conditions. Contaminants can be transported great distances along bedrock fractures, threatening drinking water wells and aquifers (S. Bobiak, pers. comm. 1991).

There exist in RI many smaller, abandoned private landfills that could contain substances capable of contaminating water supplies. No state program exists that would identify and monitor such landfills that are located within watershed or aquifer recharge areas. Given current budgetary conditions, the establishment of new programs to address this problem would strain existing staff and funding capabilities.

Road salting practices are responsible for water quality degradation throughout the state. In an effort to provide safe winter road conditions, communities apply sand/salt mixtures that have been shown to contaminate water supplies (RIDEM 305(b) Report, 1990). Salt application practices are not currently regulated.

Some communities have identified watershed or aquifer recharge areas as areas targeted for public land acquisition programs, with funding from RIDEM or the federal government or through the surcharge created by the RI Public Drinking Water Protection Act. RIDEM programs such as Household...
Hazardous Waste Days and the Waste Oil Recycling Program remove potential sources of groundwater contamination. Towns can request that an Environmental Review Team (ERT) from the Resource Conservation and Development Area review specific site plans to determine the environmental impacts of projects, in particular those affecting groundwater quality.

5.4 LOCAL GROUNDWATER PROTECTION

Until recently, RI (and other state's) communities considered groundwater protection a function of state government but local municipalities are now starting to address this issue (Jaffe and DiNovo, 1987). Despite a shortage of staff and funding resources, local efforts are being made to protect groundwater. Several communities (Exeter, Richmond, North Kingstown, South Kingstown, Middletown, Jamestown, Tiverton, Smithfield, and Warwick) have passed groundwater protection measures which take the form of aquifer protection districts, nutrient loading provisions, hazardous material ordinances, underground storage tank registration programs (or even bans on USTs), and septic system repair funds. The establishment of Waste Water Management Districts (under 1987 State enabling legislation) is under consideration in several RI communities.

The Comprehensive Planning process provides an
opportunity for communities to address the protection of natural resources and provides a basis for changes in zoning ordinances that will effect such protection. The process requires that towns identify natural resource areas in need of protection.

**Regulatory Protection in North Smithfield**

1. **Zoning Ordinance**

   The development pattern of the Slatersville area consists of areas of relatively dense residential, and industrial development with some commercial areas. Most of these areas overlie the aquifer reservoir or recharge zone and fall into the delineated wellhead protection areas. It is impossible to rezone these areas for low-density uses (i.e. REA-120 3-acre zoning) that would afford aquifer protection. Many substandard lots are "grandfathered" and, due to the lack of sewers in most of the aquifer area, could be the sites of new septic systems and thus potential contamination sources.

2. **Subdivision Ordinance**

   North Smithfield’s Subdivision Ordinance has a also procedural focus that focuses on design specifications in terms of public safety and developer responsibility, not water quality or environmental protection issues. Groundwater is afforded some protection by the Ordinance’s requirements regarding the safe operation of ISDS. As
mentioned before, many communities have added a zero-net runoff provision to their subdivision ordinances as a water quality protection measure. There are no provisions for the use of vegetated buffers and other BMPs.

3. Groundwater Protection Overlay District

Section 6.16.1 of the North Smithfield Zoning Ordinance describes the Groundwater Protection Overlay District. This ordinance is designed to protect the public health and safety, to protect drinking water supplies, and to protect the integrity of natural systems within the Town. Permitted uses include all those allowed in the underlying zone with the exception of those activities that use hazardous material and those that could pollute the groundwater aquifer. Uses prohibited in the Overlay District are management facilities involving septic wastes, hazardous materials, and solid waste materials. Also prohibited are hazardous waste disposal facilities and use that generate hazardous wastes. Exemptions include agricultural uses and permitted ISDS.

Unaccounted for in the requirements of this ordinance are specific controls designed to protect groundwater from existing uses (industrial and commercial, septic systems and other nonpoint sources). The broad definition of non-permitted uses that "pollute the aquifer" grants great discretion to the Town official responsible for enforcement. The lack of specific regulations and standards often leads
4. Site Plan Review

The recently enacted Site Plan Review Ordinance (Section 19.1) is a positive step toward controlling the impacts of commercial, industrial, and large residential development. It specifically states as one of its goals the intent to "protect and enhance the ecology and physical characteristics of the community." Its impact analysis requirement can expose possible threats to groundwater and allows a means to modify projects or to negotiate the use of BMPs. Connection to sewer and water systems can be required and the adequacy of disposal of liquid and solid wastes can be a limitation on developments. Again, great discretion is granted to the official responsible for development review and the lack of specific standards can be a positive or negative aspect, depending on the skill and political influence of the parties involved.

5.5 MANAGEMENT APPROACH

Local municipalities often cite the following constraints to efforts to initiate new environmental protection programs: insufficient staffing resources, lack of funding, reluctance of governments to add new regulations to an increasingly regulated way of life, and lack of political and community support. The approach taken in developing these strategies was one emphasizing low funding
requirements, use of existing staff, integration with or modification of existing regulations and programs, and the use of expertise available from State institutions and agencies. New regulations are recommended only where needed to fill significant gaps in protection.

The effective implementation of a WHP Program will to some degree, increase the burden on Town administration, at least initially. However, through the use of community volunteer organizations, coordination with existing State and federal programs, and available outside technological expertise, this additional burden can be kept manageable. Certain aspects of a WHP Program (i.e. source identification and inventory, newsletter production, meeting scheduling, etc.) are well-suited to volunteer capabilities. State and federal agencies (i.e. RIDEM, SCS, EPA, URI) offer many technical services and materials at little or no cost. Drawing on these resources, a local WHP Program Coordinator can provide an effective level of wellhead and aquifer protection.

An effective WHP Program uses information and education to build support for wellhead protection measures. In lieu of developing a whole new regulatory scheme, modification of existing programs and regulations is, in general, more politically acceptable, particularly in a recession economy. Also, the RI Zoning Enabling Act, unchanged since the 1920s, does not afford much legal protection for bold and
innovative land-use regulations. Fear of expensive lawsuits often limits municipalities to a traditional, conservative interpretation of the enabling act authority (EPA, 1989).

The development of an effective WHP Program often requires changes to a community's zoning and subdivision ordinances. It is essential that appropriate and thorough legal research be conducted in order to establish the nexus between the regulatory action and the protection goal to be achieved. This usually can be done by the Town Solicitor. However, as environmental protection efforts have become increasingly technical, it may be desirable to consult with outside authorities such as RIDEM, or a legal consultant.

5.6 MANAGEMENT STRATEGIES - Regulatory

As previously stated, there are ways in which groundwater protection can be enhanced by modification of the Town's Zoning Ordinance. Due to fact that much of the WHPAs and the aquifer reservoir and recharge areas are intensely developed (mostly 1 to 1.5 acre lots), an approach that emphasizes source controls rather than land use controls is recommended. Any effort to remove or phase out industrial uses that are potential contamination sources would not be economically and politically feasible at this time.
Modifications and additions to the Zoning Ordinance include:

**Waste Water Management District**

The problems identified regarding septic systems should be addressed in a comprehensive manner. One way of doing this is to establish a Wastewater Management District. In 1987, the legislature of the State of Rhode Island passed enabling legislation allowing towns and cities to establish these districts (RIDEM, 1987). The purpose of this legislation is to prevent contamination of state waters caused by the malfunctioning of individual septic disposal systems through the implementation of inspection and maintenance plans.

Wastewater Management District provisions allow:

* The passage of local officials onto private property to periodically inspect ISDS.

* The ability to raise funds

* The ability to raise funds for the administration of the WWMD by assessing property owners for taxes or annual fees, borrowing or issuing bonds, or setting rates for pumping.

* Establishment of administrative, financial, technical, enforcement, maintenance, and legal structures to effectively implement and conduct WWMD programs.

* Establishment of a public education program.

* Grants to be received and the establishment of a revolving fund for low-interest loans to correct failed septic systems.

* The levying of fines for non-compliance not to exceed $500 for each day of non-compliance.
Adoption of a WWMD can be accomplished in the same manner as the adoption of other municipal ordinances. The program could be administered by the existing sewer authorities or by the creation of a new WWMD Commission appointed by the Town Council.

**Hazardous Materials Ordinance**

Provisions of this ordinance include registration for the storage of more than a certain amount (for example, 25 pounds dry weight) of hazardous materials, design standards, and housekeeping requirements (logs, inventories, labeling) for the above and below ground storage of hazardous materials, a broader category which includes hazardous wastes (refer to Appendix G, the Charlestown, RI Hazardous Material Ordinance). Design standards are determined for hazardous material transport and loading facilities and for contaminant containment structures. Methods and procedures for a Spill Prevention Control and Cleanup Plan (CCAMP, 1988) should be listed. Hazardous material users should be required to provide Emergency Facility Plans (and updates) in a timely manner to the RI Emergency Response Commission and to the Town. At present only three North Smithfield companies have complied with this regulation (K. Sherman, pers comm. 1991).
Underground Storage Tank Registration and/or Ordinance

An EPA survey determined that there were 12,444 incidents of releases from USTs as of 1984. The U.S. Congress, Office of Technical Assistance estimates that 25 billion gallons of petroleum products are stored in USTs and that 13.8 billion gallons of hazardous materials (solvents, organic chemicals) are also stored in this manner. Many of the existing tanks are constructed of steel which deteriorate faster in a humid climate (Jaffe and DiNovo).

Many existing tanks are old and are potential sources of groundwater contamination. Federal and State underground storage tank regulations are directed at industrial and commercial tanks larger than 1100 gallons. Several communities (Jamestown, Tiverton, Glocester) have adopted more stringent measures that more effectively address local UST problems.

Protection strategies include:

* Creation of a local registry and map of existing underground storage tanks.

* Creation of a tank tagging program that would require tank owners to attach a tag to tanks specifying age and contents. Non-compliance would result in fines or tank removal at owner’s expense.

* The petitioning of RIDEM for more stringent monitoring and for an early leak detection program.

A ban on the installation of new tanks in the WHPAs would provide a higher level of long term protection and would have a limiting effect on land uses within these areas. If the community is committed to maintaining and
upgrading the current water system, a ban on USTs would be politically acceptable and would enjoy public support.

**Modification of the Groundwater Protection Overlay District**

The existing Groundwater Overlay Protection District includes a provision that permitted uses are those that do not pollute groundwater or utilize hazardous materials. There currently exist many uses in this area that can definitely cause groundwater pollution. ISDS that have received DEM approval and agricultural uses are allowed in the District. Existing and potential ISDS in the sensitive WHPAs and aquifer reservoir areas pose a significant threat due to the transport of ISDS-derived contaminants through excessively permeable soils and to the inadequate regulation of ISDS (setbacks and siting procedures) (Myers, 1988). According to the draft North Smithfield Comprehensive Plan, 2,900 acres of the available developable land in the Town are environmentally constrained. Industrial and commercial users of hazardous material operate within designated groundwater protection areas. The authority granted by this ordinance is essentially unused because of political and economic impracticability.

Application of the provisions of a WWMD, a Hazardous Materials Ordinance, and a modified Groundwater Aquifer Protection District would dramatically raise the level of protection afforded to groundwater reserves. Modification
of this ordinance could initiate performance controls (i.e. number of septic tank fields per acre, septic tank construction standards, limits on impervious or built area per parcel, limits on the volume of discharge to septic systems) for new development and could require BMPs for the many existing uses and practices that threaten groundwater quality. The inclusion of a specific list of prohibited uses would make the ordinance more legally defensible (refer to Appendix G, Model Ordinances).

Pesticide and herbicide use for commercial agriculture in the WHPAs is limited due to the small amount of land in agricultural use. However, many homeowners use these substances liberally without regard (or knowledge, in many cases) for the impacts on groundwater quality. A specific list of those substances banned for the purposes of this ordinance should be developed.

Although politically difficult, the lowering of densities where appropriate (on undeveloped land that will not be serviced by sewers), will result in a reduced groundwater contamination threat. This "down zoning" action requires a rational connection between the minimum lot size and resource protection goals (Horsley et al., 1990). Again, this is a step that requires strong community support.
Septic System Cleaner Ban

Septic system cleaners contain solvent compounds (e.g. 1,1,1-trichloroethane) that travel easily through groundwater, are persistent in the environment, and pose significant health risks. The effectiveness of these compounds is questionable and they are capable of destroying bacteria that are an important part of the waste treatment cycle within a septic system. Additionally, less than 30% of the delineated WHPAs are sewered: densely settled areas that overlie the WHPAs contain many septic systems (and many cesspools). In order for this ban to be effective, the public must be educated about the effects of these cleaners.

Modification of Site Plan Review (SPR)

A Site Plan Review requirement can be an extremely useful tool in the implementation of a WHP Program because it is an "effective mechanism for reviewing and enforcing other requirements" (EPA, 1989). If required as part of a subdivision or zoning ordinance, it ensures compliance with all appropriate ordinances before construction starts. The North Smithfield SPR ordinance can require an impact statement from a developer. This provision could be made mandatory in a WHPA in order to assess impacts on groundwater. Additionally, a site plan review process focuses on ensuring that future development occurs in a desirable manner rather than changing existing conditions.
Because the goal of SPR is to promote appropriate development rather than restricting certain land uses, it has political acceptability.

A complex and detailed Site Plan Review ordinance, such as one used in East Providence RI, requires that a community have sufficient technical expertise and a knowledgeable staff in order to perform the review. The discretion granted by the North Smithfield SPR requires a high level of expertise by the reviewing party. It has been noted that "the less precise the requirements being reviewed, the more difficult it will be to evaluate reviews consistently and the more likely the requirements will be challenged in court." (EPA, 1989).

The addition of a specific listing of detailed requirements (accompanied by an SPR Ordinance checklist) would have three effects: (1) the ordinance be better able to withstand legal challenges, (2) a consistent process for SPR would be provided, and (3) developers would have a better idea of what is expected of them. Detailed requirements would include performance standards (such as zero-net runoff requirements, limits on percentage of impervious surfaces), contaminant source prohibitions, and design and landscaping requirements. In an effort to draw on outside expertise, The Town could request that SPR applications be reviewed by an Environmental Review Team from the RI Resource Conservation & Development agency.
Cluster Ordinance

Cluster zoning is used primarily to control residential development. It allows higher densities on sections of a parcel while preserving open space (under common ownership). This approach would be suitable for undeveloped areas of the WHPAs and aquifer protection areas because it promotes the recharge of clean runoff and is a low-risk land use. Although made mandatory in some critical areas in other communities, it is proposed that the cluster option be made available and encouraged in North Smithfield (refer to Appendix G, Model Ordinances).

Modification of Subdivision Regulations

As with SPR, subdivision requirements are mainly useful for controlling future development and are thus a less objectionable means of control. Ways in which the North Smithfield Subdivisions can be modified to provide wellhead and aquifer protection include the addition of certain requirements for developments that are located within WHPAs and aquifer reservoir or recharge zones. It can be required that development in WHPAs be connected to the sewer system and design standards and source controls (i.e. a prohibition on the placement of hazardous materials storage containers in a wellhead area) that protect groundwater quality can be added. Limits on percentage of impervious area and open space requirements are appropriate conditions.
for subdivisions to be built in recharge areas. A modified set of Subdivision Regulations may be of limited use in the Slatersville area WHPAs due to the already developed conditions. However, given the Town’s reliance on groundwater as a drinking source, the presence of a GAA aquifer, and the large, undeveloped tracts of land that exist in North Smithfield, these modifications can raise the level of groundwater protection town-wide.

**Stormwater Management Provisions**

One source of groundwater contamination is stormwater runoff and it is directly related to the use of land. The main contaminants in stormwater runoff are bacteria and viruses, nitrates, pesticides, solvents, chloride, sodium, metals, and sediments (Jaffe and DiNovo, 1987, RIDEM, 1988).

Protection strategies include:

* Adding language to subdivision and site plan review ordinances that encourages the overland flow of runoff and the recharge of uncontaminated runoff into the soil through the use of low-tech best management practices such as grassed swales, riprap channels, and drywells.

* Strengthening of the existing earth removal ordinance by adding specific measures regarding disposal methods, removal of topsoil, and construction mitigation measures.

* Retrofitting of existing drainage systems to reduce contamination from oil/grease and hydrocarbons with management practices such as catch basins and infiltration devices.

* Adopting measures to minimize the use of fertilizers and pesticides. Require the use of slow-release nitrogen fertilizers.
5.7 MANAGEMENT STRATEGIES - Non-Regulatory

Public Education Program

Public knowledge and understanding of groundwater processes and pollution can be expanded through an aggressive public education program. Developed by a committee of local citizens and Town officials, this program can target residents and businesses within the WHPAs initially and then be expanded to include all Town residents. This program provides an opportunity for citizen involvement through volunteer work. Production of an environmental newsletters, brochures, or calendars that provides information about household chemicals, fertilizers and pesticides, car fluid disposal practices, and water conservation for the Town could be handled by volunteer organizations with guidance from the Planning Department and the SWC. Publications can be produced geared to specific users such as local business and industry. Volunteer organizations can act as liaisons to local newspapers and magazines.

Environmental awareness community programs could be organized by citizens groups. Environmental Days could be held at the high school (and other community centers) with slide shows or demonstration projects concerning topics such as air, water (with emphasis on groundwater), conservation, and the Narragansett Bay. The Town could contact agencies such as the URI Cooperative Extension Service and the
EPA/RIDEM Land Management Project to conduct workshops on environmental issues which could be coordinated with local programs.

**Source Reduction Program**

The many industrial land uses that exist in or near the WHPAs have been in operation for many years. As previously stated, it would not be economically or politically possible to eliminate those uses. Source reduction is possibly the "best long-term strategy for groundwater protection" (National Research Council, 1986).

The RIDEM Office of Environmental Coordination conducts a voluntary State program that encourages commercial businesses and industrial plants to substitute non-hazardous materials for currently used hazardous ones. Grants are available to businesses for feasibility studies of alternative processes. Town officials could encourage local industries to take advantage of this little-publicized program. According to RIDEM's Gene Pepper, this office provides on-site waste reduction assessments by a chemical engineer for industrial plants and conducts seminars regarding the reduction of hazardous materials. The Office has also developed a database that tracks new and less hazardous processes and chemicals. Abstracts of this information will soon be available.
Comprehensive Planning Process

The Rhode Island Comprehensive Planning and Land Use Regulation Act includes as one of its goals the "promotion of growth and development that recognizes the natural characteristics of the land" and the protection of natural resources of the community (RIDEM, 1989). North Smithfield’s Comprehensive Planning process provides the Town with an opportunity to review existing and potential land uses over aquifer and wellhead protection areas.

As stated in the North Smithfield Recreation, Conservation, and Open space Plan in 1986, groundwater reservoir areas should be permanently protected. One of the ways in which the Comprehensive Planning process can be used to protect WHPAs is to establish a policy that targets these areas for permanent protection. The community’s Zoning Ordinance will have to be amended to be consistent with the land use policies set forth in the Comprehensive Plan.

Household Hazardous Waste Days

The RIDEM Hazardous Waste Collection program consists of a traveling team that periodically collects household hazardous wastes at different publicized locations around the state. This avoids practices such as dumping of used motor oil into storm sewers and flushing solvents and thinners down the drain. Local environmental programs could be coordinated with the RIDEM schedule to provide
information about household wastes prior to the collection
days and thus increase participation.

**Land Acquisition/Conservation Easements (PDR)**

An additional part of a WHP Program could be the
determination of all undeveloped parcels within areas to be
protected (all parcels affected by the WHPAs are listed in
Appendix H). An assessment of the zoning status of these
parcels for potential threats to groundwater would be made.
Prioritization of parcels targeted for acquisition would be
based on groundwater protection values (among other
environmental values). This effort could be coordinated
with the efforts of other environmental groups such as the
Audubon Society and the Blackstone Valley Watershed
Association. The Town committed $250,000 for land
acquisition projects three years ago and over $200,000 of
that fund has not yet been used (K. Sherman, pers. comm.

An alternative, less costly means of acquiring interest
in these properties would be the acquisition of conservation
easements which would keep the affected land on the tax
rolls. The lower cost of the conservation easement approach
would allow the Town to acquire interests in more parcels.
The local Conservation Commission could take charge of
negotiation efforts to purchase property or conservation
easements. The Commission could seek out charitable,
community-minded landowners and attempt to acquire land through donations or "bargain sales." Those landowners who donate land can take advantage of federal and state income and real estate tax benefits.

**Protective Industrial Development**

The North Smithfield Industrial Development Commission is currently investigating new sites for industrial development. A review of a recent industrial site search document, prepared by C.E. Maguire, showed that characteristics such as proximity to highways and railroads and access to communication systems, were high priorities in this search: environmental factors, such as groundwater protection, receive little mention. The Town should encourage the Commission to take groundwater (and other natural resource) protection into account in seeking new industrial sites.

**Road Deicing Practices**

A survey conducted by the Salt Institute, of Alexandria, VA, showed that during the winter of 1982-83, over 29,000 tons of salt were applied to Rhode Island's 3,015 lane miles of road (Conservation Foundation, 1987). Most RI communities determine a certain mixture of sand and salt that is sufficient for safe road conditions and apply that mixture to all areas of the community. The Town could
institute a procedure by which WHPAs (Main St. wells #1 and #2 are particularly vulnerable to contamination from road salt) and aquifer protection zones would receive a different sand/salt ratio that would reduce the amount of sodium and chloride that infiltrates into the ground. Only major roads in these areas would receive heavy treatment and trucks could be outfitted with the more accurate delivery systems that are now available. In addition, the use of road runoff BMPs such as retention basins may be feasible in some of the more sensitive areas (for ground and surface water quality protection). Salt storage facilities should utilize BMPs to reduce the risk of groundwater contamination.

Upgrade Slatersville Water Company System

On August 2, 1990, the RI Department of Health conducted a sanitary survey of the Slatersville water system in compliance with provisions of the federal Safe Drinking Water Act. The inspectors identified many shortcomings within the system and made recommendations for corrections. Major recommendations include: the installation of a treatment system for water from the stratified drift wells that are close to the Slatersville Reservoir, security measures to protect the wellheads from vandalism and contamination, equipment and structural repairs, documentation of certain procedures (i.e. chlorination), installation of master meters, the cleaning of wellhead
areas, annual flushing of dead end mains, and the provision of standby power.

The report stated that the system was "woefully inadequate in supply and capacity" and that major fires or power outages could jeopardize the supply. Permanent interconnections with adjacent water systems and the development of additional source supplies were strongly recommended. There exists no workable emergency plan.

If the Town acts on these recommendations, the SWC will continue to serve the Slatersville community. An additional source of water supply (and a good emergency connection) could be obtained through a connection with the Industrial Park well on Tifft Road (this option is being pursued according to Karen Sherman, Town Planner). Work is underway on the development of another well within the Industrial Park. An additional interconnection with the Woonsocket water system would provide adequate emergency protection. Most of the structural repairs have been or will soon be completed.

A major expenditure of funds will be required if a filtration system is to be installed at a cost of $500,000. The Town must assess whether it can develop regulatory and non-regulatory means to adequately protect its groundwater supplies so that system expansion is a worthwhile effort. If groundwater quality cannot be maintained, it may require extensive technical upgrading in the near future.
6.1 FRAMEWORK FOR IMPLEMENTATION

The strategies recommended in this report were developed with the Town's staffing and funding capabilities in mind. The best wellhead protection measures will not be effective unless the resources and support for implementation exist. This section provides a framework for prioritization and implementation of the recommended strategies (see Table 6, Implementation Matrix). Criteria considered for this framework are:

* responsibility for action;
* imminent need for a particular strategy;
* the level of involvement required of Town staff and community groups;
* financial considerations;
* coordination opportunities;
* organizational requirements;
* volunteer/citizen resources;
* community support.

Successful implementation of several of these strategies would provide an immediate benefit in terms of groundwater protection and these are identified as high priority strategies. For these approaches, the overriding factors considered are the measure of groundwater protection afforded and the ease of implementation.
<table>
<thead>
<tr>
<th>STORIES</th>
<th>INITIATIVE</th>
<th>ORGANIZATIONAL NEEDS</th>
<th>FUNDING</th>
<th>COMMUNITY ACCEPTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regulatory Approaches</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastewater Management District</td>
<td>Water &amp; Sewer Personnel/Conserv. Commission</td>
<td>Existing Water &amp; Sewer Personnel</td>
<td>Grants/Service Fees, Pumpsing Fees</td>
<td>Opposition to imposed fees</td>
</tr>
<tr>
<td>UST Ordinance/Program</td>
<td>Planners/Town Council Planning Board</td>
<td>Existing Staff Volunteers</td>
<td>Registration Fees Grants</td>
<td>Community support to protect wells</td>
</tr>
<tr>
<td>Groundwater Aquifer Protection District</td>
<td>Planner/Planning Board</td>
<td>Planner/Town Solicitor</td>
<td>Minimal</td>
<td>Restrictive/ Public education</td>
</tr>
<tr>
<td>Septic System Cleaner Ban</td>
<td>Planner/Town Council Planning Board</td>
<td>Town Solicitor</td>
<td>Minimal</td>
<td>Difficult to enforce/Public education</td>
</tr>
<tr>
<td>Site Plan Review</td>
<td>Planner/Town Council Planning Board</td>
<td>Planner/Town Solicitor</td>
<td>Minimal</td>
<td>Developers may oppose new reg.</td>
</tr>
<tr>
<td>Cluster Development</td>
<td>Planner/Conservation Comm./Town Council</td>
<td>Town Planner Town Solicitor</td>
<td>Minimal</td>
<td>Well accepted/ used successfully in RI</td>
</tr>
<tr>
<td>Strengthen Subdiv. Regulations</td>
<td>Planner/Town Council Planning Board</td>
<td>Planner/Town Solicitor</td>
<td>Minimal</td>
<td>Public educ./ Developer opposition</td>
</tr>
<tr>
<td><strong>Non-Regulatory Approaches</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Education</td>
<td>WHP Committee/Planner Town Council</td>
<td>Planner/Outside Tech. Assistance</td>
<td>Grants WWMD Fees</td>
<td>Opportunity for Citizen Involv.</td>
</tr>
<tr>
<td>Source Reduction</td>
<td>Planner/Industrial Comm./ Town Council</td>
<td>RIDEM Coordination Personnel/Planner</td>
<td>Minimal</td>
<td>Overcome industry image of DEM</td>
</tr>
<tr>
<td>Comprehensive Planning Process</td>
<td>Planner/CAC/WHP Committee</td>
<td>CAC/Planner/ Consultant</td>
<td>Minimal</td>
<td>Citizen Involv. Set policy</td>
</tr>
<tr>
<td>Hazardous Waste Collection</td>
<td>WHP Committee/Planner Emerg. Mgt. Director</td>
<td>Coordinate with DEM/Planner</td>
<td>Minimal</td>
<td>Popular State Program</td>
</tr>
<tr>
<td>Land Acquisition/Cons. Easements</td>
<td>Conservation Comm./Env. Groups</td>
<td>Conservation Comm./Volunteers/State</td>
<td>Existing Open Space Funds</td>
<td>Strong support for conservation</td>
</tr>
<tr>
<td>Protective Industrial Development</td>
<td>Planner/Conservation Comm./Industrial Comm</td>
<td>Planner/Industrial Comm/Consultant</td>
<td>Minimal</td>
<td>Sensitive areas education</td>
</tr>
</tbody>
</table>

**Table 6. Framework for Implementation**
Individuals or groups who could be responsible for taking the initiative to start a strategy implementation process are identified. These parties were selected based on position in Town government, level of expertise, and links to other organizations.

Community acceptance of strategies is critical to the success of a local wellhead protection plan. It is intended that public education and involvement programs will help build such support (EPA, 1989). Community support issues to be examined include:

* wellhead protection measures that require intrusion on private property rights;

* measures that impose a heavier burden on one segment of the community over the other, and;

* strategies that have succeeded elsewhere under similar conditions.

These implementation recommendations should be viewed as a starting point for action, not as a definitive how-to-do list. Once a core of interested citizens and Town officials have decided to act on wellhead and aquifer protection (possibly through the formation of a Wellhead Protection...
Committee), they will develop a framework for action that will be keyed to local resources and to the Town's political and social environment.

6.2 IMPLEMENTATION OF STRATEGIES: REGULATORY

Wastewater Management District

Initiation of this strategy would be best handled by Water and Sewer Department personnel given their jurisdiction over the sewer system. This State-sponsored program provides funding, technical assistance, and materials for local participation. Additional funding can be obtained through the authorized use of fees, fines for non-compliance, and the issuance of bonds. The community can also establish a revolving low-interest loan program for the upgrading and repair of septic systems. After review by the Town Solicitor, the program can be adopted as an ordinance.

Hazardous Materials Ordinance

A logical choice for an initiator of this strategy would be the local Director of the Emergency Management Agency, although it could also be done by the Planning Department or the Town Council. The Planning Department could research this issue and obtain model ordinances. By working with the Town Solicitor, a suitable bylaw could be developed for the Town. If design standards for transport and loading
facilities are part of this bylaw, inspection training would be required for Town personnel (perhaps the Town Engineer). The Planning Department would be responsible for reviewing spill prevention/clean up plans.

**Underground Storage Tank Ordinance/Registry**

As stated earlier in this report, many existing USTs are unregulated by State regulations due to their smaller size. Due to the age and condition of USTs that are located over WHPAs and aquifer protection areas, a significant threat to groundwater quality exists.

Recommended control over USTs could take different forms, depending on Town objectives. A UST ordinance could be designed to ban these tanks in WHPAs or to create design standards (i.e. spill detection measures, double-walled tanks, and monitoring wells). This ordinance could be initiated by the Planning Department, Planning Board, or the Town Council. The Town Solicitor and the Planning Department could research the issue and contact other local communities where such ordinances have been instituted (i.e. Jamestown, Tiverton, Glocester) to obtain information and advice on developing the bylaw. The preparation of a UST inventory list and map of all UST locations could be part of this effort. Funding could be obtained through a registration fee and through grants.

A non-regulatory option would be the creation of a UST
registry and mapping program. This voluntary program could be carried out by citizen volunteers and local environmental organizations or the Conservation Commission. Data collection and field surveys could be handled by volunteers. Grant money from federal, state, or private organization sources may be available for community volunteer efforts such as this. Program participants could obtain technical assistance from RIDEM or other technical agencies mentioned in this report.

Modification of the Groundwater Protection Overlay District

Research into other communities' groundwater overlay ordinances by the Planning Department would provide the basis for modification of the Groundwater Protection Overlay District bylaw to make it a more detailed and specific instrument. Recommended modifications, if adopted, would immediately raise the level of groundwater protection within these designated areas. Review by the Town Solicitor would be required. The detailed and more restrictive nature of a modified overlay bylaw would have better community acceptance and compliance after the public has been exposed to a groundwater protection educational program.

Septic System Cleaner Ordinance

Although easy to draft and requiring minimal staff and funding resources, a ban on the use of septic system
cleaners is difficult to enforce. Public cooperation can be improved through the implementation of the recommended public education program.

**Modification of Site Plan Review Ordinance and Subdivision Regulations**

Members of Town government who are responsible for development review could initiate actions leading to the modification of the existing Site Plan Review (SPR) Ordinance and the Subdivision Regulations. Examination of other communities’ development review procedures and ordinances would be helpful in developing these modifications. Consultation with the Town solicitor would be required. Although some developers would oppose the additional restrictions involved in these modifications, most builders would welcome a higher level of consistency in development review processes.

**Cluster Ordinance**

The Cluster Ordinance strategy would call for Planning Department research into other communities’ experiences with this form of development. With this information, the Planning Department and the Town Solicitor could craft a cluster bylaw that is suited to the Town’s objectives. The Planning Department, Planning Board, and Town Council would promote and encourage the use of the cluster option wherever deemed appropriate (particularly in WHPAs and aquifer
protection districts). Many RI communities have adopted this type of ordinance and cluster design is generally well-accepted by developers.

**Stormwater Management Provisions**

The RIDEM Office of Environmental Coordination publishes a manual containing recommended stormwater management practices that can be incorporated into local action. Most of these practices could be administered by the Department of Public Works and would require little additional funding. Stormwater management provisions could be part of the Modification of SPR and Subdivision Regulations strategy; there are many opportunities in these processes in which to inject stormwater management measures. Stormwater management processes would be explained to the community in the public education component of the WHP Program.

**6.3 IMPLEMENTATION OF STRATEGIES: NON-REGULATORY**

**Public Education Program**

This necessary component of any WHP Program brings groundwater protection issues in the public arena in a way that all in the community will learn of environmental issues that affect them daily. Many people do not realize that some of their everyday practices are harming natural systems. This recommended course of action will provide many opportunities for citizens involvement at all levels,
from delivery of newsletters to shaping Town environmental policy. Interested community members could take part in the formation of a Groundwater Protection Committee which, in concert with the Planning Department and the Planning Board, could develop an educational program that would be effective in North Smithfield. Funds derived from the Waste Water Management District program could be used to purchase materials, to publish newsletters, and to cover administrative costs for the Committee activities. Federal and State environmental agencies can be drawn upon for technical assistance and guidance.

**Source Reduction Program**

The Planning Department, the North Smithfield Industrial Commission, and the Town Council could encourage local industries to participate in the RIDEM Source Reduction Program and make them aware that grant money is available to them to develop new, safer industrial processes. Personnel from the RIDEM Office of Environmental Coordination are committed to increasing their involvement in this program which is considered one of the most effective ways that industrial areas can be made more environmentally safe. The Town can act as a liaison between the businesses and the RIDEM.
Comprehensive Planning Process

As in the Public Education program, this approach allows citizens involvement in setting future policy for the Town. This is an excellent time to take advantage of the ongoing Comprehensive Planning process to create policies designed to protect the area's groundwater resources and wellheads. Members of the Citizens Advisory Committee and the Groundwater Protection Committee could research groundwater issues to provide needed information or the Plan consultant could be required to provide such information.

Household Hazardous Waste Collection Days

The Groundwater Protection Committee could coordinate its public information program with the RIDEM's Hazardous Waste Collection Program in order to increase community participation. The Director of the local Emergency Management Agency could also have a part in initiating this effort because of his experience with hazardous substances. This popular State program could be even more effective if communities act in coordination with the RIDEM.

Land Acquisition/Conservation Basements

Many state and local groups are involved in land acquisition programs for various purposes ranging from river corridor recreational areas to wildlife habitat protection. The Conservation Committee and other local environmental
action groups are good candidates for initiating a system to coordinate land acquisition efforts in the North Smithfield area and to seek out new sources of funding (grants from public and private agencies and foundations) for land acquisition and the purchase of conservation easements. Many members of these groups have valuable negotiating experience. The Town has over $200,000 earmarked for land acquisition and the above groups could aid in identifying the most valuable parcels from an environmental standpoint.

**Protective Industrial Development**

The Planning Department and the Conservation Commission should provide the Industrial Commission with land suitability information to aid in the search for new industrial sites. If the Industrial Commission sees that there is institutional and public support for siting industrial development outside of critical protection areas then those factors will have greater weight in any decisions made.

**Road Deicing Practices**

The Planning Department and the Conservation Commission could work with the Public Works Department and its contractors to develop safer salting practices, especially in groundwater protection areas. It may be difficult to find funding for new salt measuring devices for trucks, but
other less expensive measures can be taken (apply less salt, lightly salt sensitive areas, utilize protective salt storage methods).

Upgrade Slatersville Water Company System

The Water and Sewer Department has corrected many of the structural deficiencies noted in the RIDOH Sanitary Survey of August, 1990 (K. Sherman, pers. comm. 1991). It is difficult to find wide support for providing a new filtration system (as recommended by the DOH) at the cost of one-half million dollars in the current fiscal environment. The question facing the Town is whether the investment is worthwhile (and who would bear the cost) for a system that serves only 445 households. If the community commits to expanding and upgrading the system, it will be the responsibility of the Water and Sewer Department to hire consultants and contractors. No decision has been reached on this issue.
CONCLUSIONS

In the course of conducting research for this report, materials regarding the protection of groundwater in other states were reviewed. The political and legislative environment of many states allows local communities to institute groundwater protection measures that are more stringent and detailed than Rhode Island communities have initiated.

Rhode Islands antiquated zoning and subdivision acts retain a traditional zoning perspective that grants little authority to local government. Constrained by this lack of authority, local environmental officials act conservatively, ever wary of litigation. Although the trend is slowly being reversed, there remains many areas in which inadequate protection measures threaten the integrity of the State’s natural resources, including groundwater. Because people can not see groundwater contamination, it does not receive the same attention as visible surface water pollution. However, many other areas of the country have been made aware of the extreme vulnerability of groundwater resources and legislators there have acted to protect this resource.

If the Rhode Island legislator passes the proposed Zoning Enabling Act, local communities will have greater authority to provide environmental protection and will possess a wider array of regulatory tools to use in resource protection.
The people of North Smithfield, like most Rhode Islanders, have become increasingly aware of environmental protection issues and how their lives can be affected by pollution. Research done for this report has revealed that there exists further opportunities for the town to adopt environmental protection measures and regulations that will not overburden existing town staff or require excessive funding. Coordination with Federal and State technical assistance programs can be explored further and there are possibilities for successful volunteer action.

Successful Wellhead Protection Programs depend on community support and involvement. This support can best be developed through public education programs that target all segments of the community; school children to senior citizens, suburbanites to farmers. Through these programs, citizens learn of their responsibilities to protect the environment and how small changes in their everyday life can have a large impact on groundwater quality.
REFERENCES


North Smithfield, Town of, *Zoning Ordinance and Subdivision Regulations.*


PERSONAL COMMUNICATIONS

Bobiak, Sofia. Groundwater Section, RI Department of Environmental Management.

DiCicco, Tony. Assistant Administrator, RI Department of Labor.

Swallow, June. RI Department of Health, Division of Water Supply.

RADIO BROADCAST

APPENDIX A

WHPA DELINEATION
Wellhead Protection Area (WHPA) Delineations for Community Wells in North Smithfield

I am writing this memorandum to describe the general methodology used to delineate the draft initial WHPAs for community wells in North Smithfield used by Richard Ribb and Mark Gardella to develop a Wellhead Protection plan as part of their internship with the Town of North Smithfield.

A total of eight community wells are present in the town of North Smithfield. Three are screened or dug in stratified drift, and five are finished in bedrock. A combination of analytical modeling with hydrogeologic mapping was used for these delineations.

For the bedrock wells, the downgradient area is a circle with a radius calculated from the Theis equation (see Rhode Island Wellhead Protection Program, pp. 18-19). The upgradient area was delineated using hydrogeologic boundaries.

<table>
<thead>
<tr>
<th>Bedrock Well</th>
<th>Discharge (gpm)</th>
<th>Theis Radius (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slater Village Condominium</td>
<td>40</td>
<td>2,600</td>
</tr>
<tr>
<td>No. Smith. (Slatersville) Park Well 3</td>
<td>40</td>
<td>2,600</td>
</tr>
<tr>
<td>Coast Guard Housing</td>
<td>30</td>
<td>2,400</td>
</tr>
<tr>
<td>No. Smith (Slatersville) Halliwell School 5</td>
<td>10</td>
<td>1,750</td>
</tr>
<tr>
<td>Woodland Convalescent Center Well</td>
<td>3</td>
<td>1,750</td>
</tr>
</tbody>
</table>

In the case of the stratified drift wells, the downgradient portion was delineated using the MWCAP Module of the WHPA Code, an EPA approved software package. The MWCAP Module is an analytical model which utilizes the uniform flow equation in conjunction with particle tracking. The model requires information such as pumping rate, hydraulic gradient, transmissivity and saturated thickness. These data were obtained from a variety of sources, including a US Geological Survey report (Water-Resources Investigations 18-74). Hydrogeologic mapping completed the upgradient portions of these WHPAs.

Should you have any further questions, please contact me at 277-2234.

cc: Richard Ribb  
Mark Gardella
EQUATIONS PERTINENT TO WELLHEAD PROTECTION DELINEATION

THEIS EQUATION: \[ s = \frac{114.6 \ Q}{T} \ W(u) \quad u = \frac{1.87r^2s}{Tt} \]

where: \( s \) = drawdown (ft)  
\( Q \) = well pumping rate (gpm)  
\( T \) = transmissivity (gpd/ft)  
\( S \) = storage coefficient (dimensionless)  
\( r \) = distance from pumped well to observation well  
\( t \) = time (days)  
\( W(u) \) = well function (dimensionless)

UNIFORM FLOW EQUATION: \[ \frac{Y}{X} = \tan \left( \frac{2\pi Ki}{Q} \right) \]

\[ X_l = - \frac{Q}{2\pi Ki} \quad Y_l = \pm \frac{Q}{2Ki} \]

where: \( Q \) = well pumping rate (ft³/day)  
\( K \) = hydraulic conductivity (ft/day)  
\( b \) = saturated thickness (ft)  
\( i \) = hydraulic gradient (dimensionless)  
\( X_l \) = distance to downgradient null point (ft)  
\( Y_l \) = lateral boundary limit (ft)  
\( X \) & \( Y \) = cartesian coordinates of points along the groundwater divide

THIEM EQUATION for unconfined aquifer: \[ h_2^2 - h_1^2 = \frac{1055 Q \ (\log r_2/r_1)}{K} \]

where: \( h_1 \) = hydraulic head at point nearest well (ft)  
\( h_2 \) = hydraulic head at point farther from well (ft)  
\( Q \) = well pumping rate (gpm)  
\( K \) = hydraulic conductivity (gpd/ft²)  
\( r_1 \) = distance from well to point at \( h_1 \) (ft)  
\( r_2 \) = distance from well to point at \( h_2 \) (ft)

VOLUMETRIC FLOW EQUATIONS:

for cylinder: \[ r = \sqrt{\frac{Qt}{\pi n H}} \]

for cone: \[ r = \sqrt{\frac{Qt}{.333\pi n H}} \]

where: \( r \) = radius of cylinder or base of cone (ft)  
\( Q \) = well pumping rate (ft³/day)  
\( t \) = time (days)  
\( n \) = porosity (dimensionless)  
\( H \) = height of cylinder or cone (ft)
Steady-State, and 10- and 25-Year Time-Related Capture Zones Delineated Using MWCAP. For The Time-Related Capture Zones the Number of Pathlines is 50.
APPENDIX B

RHODE ISLAND GROUNDWATER CONTAMINANTS
## Table 4B-8 Contaminants Detected in Groundwater

### Synthetic Organic Chemicals/
#### Volatile and Semi-Volatile

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemical</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>Trichlorofluoromethane</td>
<td>1,1,2,-Tricloro-1,2,2-trifluoroethane</td>
</tr>
<tr>
<td>Benzene</td>
<td>1,1,1-Trichloro-1,2,2-Trichloroethylene</td>
<td>Vinyl Chloride</td>
</tr>
<tr>
<td>Benzo (a) anthracene</td>
<td></td>
<td>Xylenes</td>
</tr>
<tr>
<td>Benzo (a) pyrene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzo (b) fluoranthene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromoform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Tetrachloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloroethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloroethene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloroform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chrysene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dibenzo (a,h) anthracene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dibromochloromethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,4 - Dichlorobenzene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dichlorodifluoromethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1 - Dichloroethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,2 - Dichloroethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1 - Dichloroethene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,2 - Dichloroethene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dichloromethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,2 - Dichloropropane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,3 - Dichloropropene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Di-n-butylphthalate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioxane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene glycol monoethylether</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluorantheme</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Oil #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Oil #4</td>
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<td></td>
</tr>
<tr>
<td>Fuel Oil #6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indeno (1,2,3 -cd) pyrene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl Ethyl Ketone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl Isobutyl Ketone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl t-Butyl Ether</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - Methylphenol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naphthalene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phenanthrene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phenol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polychlorinated biphenyls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1,2,2 - Tetrachloroethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetrahydrofuran</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1,1 - Trichloroethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1,2 - Trichloroethane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Synthetic Organic Chemicals/
#### Pesticides

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldicarb</td>
<td>Atrazine</td>
</tr>
<tr>
<td>Butylate</td>
<td>Carbofuran</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>Oxamyl</td>
</tr>
<tr>
<td>Dicamba</td>
<td>Dinoseb</td>
</tr>
</tbody>
</table>

### Inorganic Chemicals/
#### Heavy Metals

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>Barium</td>
</tr>
<tr>
<td>Barium</td>
<td>Cadmium</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Chromium</td>
</tr>
<tr>
<td>Chromium</td>
<td>Copper</td>
</tr>
<tr>
<td>Copper</td>
<td>Lead</td>
</tr>
<tr>
<td>Lead</td>
<td>Mercury</td>
</tr>
<tr>
<td>Mercury</td>
<td>Nickel</td>
</tr>
<tr>
<td>Nickel</td>
<td>Selenium</td>
</tr>
<tr>
<td>Selenium</td>
<td>Silver</td>
</tr>
</tbody>
</table>

### Other Inorganic Chemicals

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boron</td>
<td>Calcium</td>
</tr>
<tr>
<td>Chloride</td>
<td>Cyanide</td>
</tr>
<tr>
<td>Fluoride</td>
<td>Iron</td>
</tr>
<tr>
<td>Iron</td>
<td>Magnesium</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Manganese</td>
</tr>
<tr>
<td>Manganese</td>
<td>Nitrate</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Potassium</td>
</tr>
<tr>
<td>Potassium</td>
<td>Sodium</td>
</tr>
<tr>
<td>Sodium</td>
<td>Zinc</td>
</tr>
<tr>
<td>Zinc</td>
<td>Radon</td>
</tr>
<tr>
<td>Radon</td>
<td>Strontium - 90</td>
</tr>
<tr>
<td>Strontium - 90</td>
<td>Technetium - 99</td>
</tr>
</tbody>
</table>

### Radionuclides

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radon</td>
<td></td>
</tr>
<tr>
<td>Strontium - 90</td>
<td></td>
</tr>
<tr>
<td>Technetium - 99</td>
<td></td>
</tr>
</tbody>
</table>

### Microbiological

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coliform Bacteria</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

RHODE ISLAND DEPARTMENT OF HEALTH

WATER QUALITY REPORT: SLATERSVILLE WATER COMPANY
Dear Jim Decelles, Water Supt.: 

Under the Safe Drinking Water Act Amendments of 1986, the Environmental Protection Agency (EPA) promulgated monitoring requirements for 8 regulated solvents VOC’S (volatile organic chemicals) and 51 unregulated organic chemicals. These became effective in Rhode Island on October 30, 1989. As stipulated by these regulations public water systems serving 3,300 to 9,999 people were to begin analyzing their source water by January 1, 1989. Systems serving <3,300 people were to begin by January 1, 1991.

The Division Of Drinking Water Quality has completed these monitoring requirements for your system and the analytical results have been forwarded to you. The following water sources were monitored: DUG WELL, DRIVEN WELL, PACHECO PARK WELL, HALLIWELL SCHOOL WELL, WELL#6. If you are unable to locate any or all of the analytical results, or wish to receive a complete set, please call our office at 277-6867.

The test results for the 8 volatile organic compounds revealed the following: TRICHLOROETHENE 1 to 2 PPB HALLIWELL SCHOOL WELL. This office will continue quarterly surveillance of the well(s) for the presence of these 8 volatile organic chemicals. Should the running average concentration of these chemicals remain below their respective maximum contaminant levels over a three year period the monitoring will then be reduced to annually. However should the running average of a volatile organic chemical exceed its respective MCL value, then treatment must be adopted for the source and a public notice issued by the water system.

Samples from the same water sources were also analyzed for the 51 unregulated organic chemicals. The results CANNON BUILDING, Three Capitol Hill, Providence, Rhode Island 02908-5097 

Telecommunication Device for the Deaf (TDD) 277-2506
are as follows: all were non-detectable at current MDL’s. Further testing will be suspended until 1992 (3 year cycle).

This Division will inform EPA that monitoring of the water system sources for both the 8 volatile organic chemicals and the 51 unregulated organic chemicals have been completed. Under State and EPA regulations cited above, you are required to notify your customers by way of a public notice in the first set of water bills following receipt of this letter or by written notice within three(3) months of this date that: monitoring for the 51 unregulated organic chemicals has been completed and the results are available for public review. A draft of this notice with all necessary verbiage must be submitted to our office for approval prior to mailing. The notice must include a contact person and a telephone number for information regarding the monitoring results. If you need any assistance, please call this office at 277-6867.

Should any questions arise regarding the health effects of any organic chemicals found as a result of the 1989 monitoring, Dr. Bela Matyas, M.D., Chief, Environmental Health Risk Assessment may be consulted at 277-3424.

The results of this 1989 survey are public information and may be released. Your cooperation in this endeavor is essential.

Sincerely,

June Swallow, P.E.
Acting Chief
Drinking Water Quality

cc: Walter S. Combs Jr.
    Edgar Girard
April 5, 1990

Dear Mr. DECELLES:

In response to your inquiry as to the necessary verbiage required for the VOC notification for the 8 regulated and 51 unregulated organic chemicals, the following is an example.

*********************************************
Public Notice
Slatersville Water System

As required by the Safe Drinking Water Act Amendments of 1986 testing has been completed during 1989 for the 8 regulated and 51 unregulated organic chemicals. The data indicates that none of these chemicals are present in amounts that would pose a threat to the health of the consumer.

Please be advised that the results are available for public review at the Town Hall in Slatersville. Anyone requiring more detailed information may contact Jim Decelles at 767-2202 between the hours of 8am and 4pm.

Jim Decelles
Water Superintendent
Slatersville Water Department

If this example notice is acceptable to you, please advise this department. The water system may notify its consumers by inserting this notice with the next water bill within three months or by notification in a newspaper that is received by a majority of its consumers. If you would kindly provide this office with a copy of the printed notice, we will regard it as sufficient evidence that Slatersville has satisfied the requirement of the Safe Drinking Water Act Amendment of 1986.

HEALTH - A WAY OF LIFE

Telecommunications Device for the Deaf (TDD): 277-2506
If you have any additional questions, please contact me at 277-6867.

Sincerely,

Edgar Girard
Principal Sanitarian
Drinking Water Quality

eg/
cc: June Swallow
<table>
<thead>
<tr>
<th>Volatile Organics</th>
<th>Result</th>
<th>Standard</th>
<th>Result</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromoform</td>
<td>&lt; 100.000s</td>
<td>Bromoform</td>
<td>&lt; 100.000s</td>
<td>Bromoform</td>
</tr>
<tr>
<td>1,2-Dibromoethane</td>
<td>&lt; 100.000s</td>
<td>Benzene</td>
<td>&lt; 0.5</td>
<td>Benzene</td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td>&lt; 0.5</td>
<td>Trichloroethane</td>
<td>&lt; 0.5</td>
<td>Trichloroethane</td>
</tr>
<tr>
<td>1,1-Dichloroethylene</td>
<td>&lt; 0.5</td>
<td>Ethylbenzene</td>
<td>&lt; 0.5</td>
<td>Ethylbenzene</td>
</tr>
<tr>
<td>1,1,1-2-Trichloroethane</td>
<td>&lt; 1.0</td>
<td>1,1,1,2-Tetrachloroethane</td>
<td>&lt; 1.0</td>
<td>1,1,1,2-Tetrachloroethane</td>
</tr>
<tr>
<td>Tetrachloroethane</td>
<td>&lt; 1.0</td>
<td>1,2,3-Trichloroethylene</td>
<td>&lt; 1.0</td>
<td>1,2,3-Trichloroethylene</td>
</tr>
<tr>
<td>Xylene</td>
<td>&lt; 20.000s</td>
<td>1,2-Dibromo-3-Chloropropane</td>
<td>&lt; 10</td>
<td>1,2-Dibromo-3-Chloropropane</td>
</tr>
<tr>
<td>n-Butylbenzene</td>
<td>&lt; 1.0</td>
<td>1,1,2,3-Trichlorobenzene</td>
<td>&lt; 1.0</td>
<td>1,1,2,3-Trichlorobenzene</td>
</tr>
<tr>
<td>Hexane</td>
<td>&lt; 0.5</td>
<td>1,1,2,4-Trimethylbenzene</td>
<td>&lt; 0.5</td>
<td>1,1,2,4-Trimethylbenzene</td>
</tr>
</tbody>
</table>

**NOTE:**
- Maximum Contaminant Level, s=Secondary Maximum Contaminant Level
- Unit: ppm=Parts Per Million, ppb=Parts Per Billion, pCi/l=PicoCurie Per Liter, ntu=Nephelometric Turbidity Units

The Continued Presence Of A Volatile Organic Compound Was Detected In The Sample, Continued Quarterly Testing Will Be Done To Satisfy Regulations.

**Date Collected:** 03/06/91
**Lab Number:** 85943

**JIM DECELLES, WATER SUPT.**
SLATERSVILLE PUBLIC SUPPLY
MEMORIAL TOWN BUILDING
SLATERSVILLE, RI 02876

**Date:** June 19, 1991

**Owner:** JIM DECELLES, WATER SUPT.
**Src:** Raw Halliwell Well
**Address:** 85943
Rhode Island Department of Health
Cannon Building, Providence, Rhode Island 02908-5097

RESULT  STANDARD

INSECTICIDES (in ppb)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Result</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldrin</td>
<td>&lt;0.2</td>
<td></td>
</tr>
<tr>
<td>Dieldrin</td>
<td>&lt;0.06</td>
<td></td>
</tr>
<tr>
<td>Heptachlor Epoxide</td>
<td>&lt;0.1</td>
<td></td>
</tr>
<tr>
<td>Toxaphene</td>
<td></td>
<td>5.0000e+</td>
</tr>
<tr>
<td>Chlorodane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endrin</td>
<td>&lt;0.2</td>
<td>20000e+</td>
</tr>
<tr>
<td>Lindane (GBHC)</td>
<td>&lt;1</td>
<td>4.0000e+</td>
</tr>
<tr>
<td>DDT-Para,Para</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Heptachlor</td>
<td>&lt;0.1</td>
<td></td>
</tr>
<tr>
<td>Methoxychlor</td>
<td>&lt;3</td>
<td>100.0e+</td>
</tr>
</tbody>
</table>

HERBICIDES (in ppb)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Result</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D</td>
<td>&lt;0.05</td>
<td>1.000e+</td>
</tr>
<tr>
<td>2,4-D, 5-TP Silvex</td>
<td>&lt;0.005</td>
<td>0.010e+</td>
</tr>
</tbody>
</table>

MICROBIOLOGICAL (units as indicated)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coliform (MF-per 100ml)</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

PHYSICAL CHARACTERISTICS (units as indicated)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity (ntu)</td>
<td>0.1</td>
</tr>
<tr>
<td>Sediment</td>
<td>0</td>
</tr>
<tr>
<td>Odor</td>
<td>0</td>
</tr>
<tr>
<td>Color (color units)</td>
<td>15.000</td>
</tr>
</tbody>
</table>

BASIC CHEMISTRY (in ppm)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dissolved Solids</td>
<td>178</td>
</tr>
<tr>
<td>Solids-Loss on Ignition</td>
<td>18</td>
</tr>
<tr>
<td>Free Ammonia as N</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Nitrate as N</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>Alkalinity, Total</td>
<td>11</td>
</tr>
<tr>
<td>Chloride</td>
<td>82.9</td>
</tr>
<tr>
<td>Hardness, Total</td>
<td>13.9</td>
</tr>
<tr>
<td>Iron</td>
<td>0.02</td>
</tr>
<tr>
<td>pH (Field Test)</td>
<td>5.70</td>
</tr>
<tr>
<td>Chloride</td>
<td>82.9</td>
</tr>
<tr>
<td>Fluoride</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Iron</td>
<td>0.02</td>
</tr>
<tr>
<td>Manganese</td>
<td>&lt;0.2</td>
</tr>
</tbody>
</table>

Jim Decelles  WATER SUPT.
Slatersville Public Supply
Memorial Town Building
Slatersville, RI 02876

Date Collected 04/17/90
City/Town: North Smithfield
Owner: Jim Decelles  WATER SUPT.
Src: Raw-Dug Well

June A. Swallow, Acting Chief, Drinking Water Quality
May 22, 1990
<table>
<thead>
<tr>
<th>Substance</th>
<th>Result</th>
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<tbody>
<tr>
<td>Sodium</td>
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<td>Magnesium</td>
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<td>Potassium</td>
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<tr>
<td>Sulfate</td>
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<td>250.00s</td>
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<tr>
<td>Calcium</td>
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<tr>
<td>Heavy Metals (ppm)</td>
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<tr>
<td>Arsenic</td>
<td>&lt;0.005</td>
<td>0.0500</td>
</tr>
<tr>
<td>Bismuth</td>
<td>&lt;0.005</td>
<td>0.0500</td>
</tr>
<tr>
<td>Barium</td>
<td>&lt;0.02</td>
<td>1.0000</td>
</tr>
<tr>
<td>Cadmium</td>
<td>&lt;0.001</td>
<td>0.0100</td>
</tr>
<tr>
<td>Copper</td>
<td>&lt;0.02</td>
<td>1.0000</td>
</tr>
<tr>
<td>Lead</td>
<td>&lt;0.005</td>
<td>0.0500</td>
</tr>
<tr>
<td>Nickel</td>
<td>&lt;0.02</td>
<td></td>
</tr>
<tr>
<td>Selenium</td>
<td>&lt;0.005</td>
<td>0.0100</td>
</tr>
<tr>
<td>Silver (NRE)</td>
<td>&lt;0.001</td>
<td>0.0500</td>
</tr>
<tr>
<td>Zinc</td>
<td>&lt;0.02</td>
<td>5.0000</td>
</tr>
</tbody>
</table>

**ADDITIONAL CHEMICALS (units as indicated) :**

- MBAS (ppm) < 0.05

**COMMENT(s):** Refer to the enclosed summary sheet for the following codes:

- Maximum Contaminant Level (m)
- Secondary Maximum Contaminant Level (s)

**UNITS:**

- ppm = Parts Per Million
- ppb = Parts Per Billion
- pCi/l = Picocurie Per Liter
- ntu = Nephelometric Turbidity Units

---

**JIM DECELLES**  **WATER SUPT.**
**SLATERSVILLE PUBLIC SUPPLY**
**MEMORIAL TOWN BUILDING**
**SLATERSVILLE, RI 02876**

**Date Collected:** 04/17/90
**City/Twn:** North Smithfield
**Owner:** JIM DECELLES  **WATER SUPT.**
**Src:** Raw-Dug Well

**June A. Swallow, Acting Chief, Drinking Water Quality**
**May 22, 1990**
<table>
<thead>
<tr>
<th>Components</th>
<th>Result</th>
<th>Standard</th>
<th>Result</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Alpha (pCi/l)</td>
<td>3.2 MDL: 1.2 µSv/h</td>
<td>5.000 µSv/h</td>
<td>Gross Beta (pCi/l)</td>
<td>1.1 MDL: 1.6 µSv/h</td>
</tr>
</tbody>
</table>

**Basic Chemistry (in ppm)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (Field Test)</td>
<td>6.90</td>
</tr>
</tbody>
</table>

**Comments:** Refer to the enclosed summary sheet for the following codes ->

Alpha Radiological Results Are High And The Four Quarterly Test Will Be Evaluated To Determine Its Status.

- Maximum Contaminant Level
- UNITS: ppm = Parts Per Million, ppb = Parts Per Billion, pCi/l = Picocurie Per Liter, ntu = Nephelometric Turbidity Units

**JIM DECELLES, WATER SUPT.**
**SLATERSVILLE PUBLIC SUPPLY**
**MEMORIAL TOWN BUILDING**
**SLATERSVILLE, RI 02876**

Date Collected: 03/06/91
Lab Number: 85942

June A. Swallow, Chief, Drinking Water Quality
Apr 1, 1991
Rhode Island Department of Health
Cannon Building, Providence, Rhode Island 02906-5097

RESULT STANDARD
Radium 226(pCi/l) .57 3.0000
Radium 228(pCi/l) .88 5.0000

COMMENT(s): Refer to the enclosed summary sheet for the following code -> 5
The Results Of The Radium 226 And 228 Are Within Acceptible Range

a=Maximum Contaminant Level
UNITS: ppb=Parts Per Billion, pCi/l=Picocurie Per Liter, ntu=Nephelometric Turbidity Units

Date Collected 06/13/90
Cty/Twn: North Smithfield
Owner: JIM DECELLES, WATER SUPT.
Src: Raw Well Pacheco Park

JIM DECELLES, WATER SUPT.
SLATERSVILLE PUBLIC SUPPLY
MEMORIAL TOWN BUILDING
SLATERSVILLE, RI 02876

PWSID: 1615614

June A. Swallow, Acting Chief, Drinking Water Quality
Jul 19, 1990
APPENDIX D

LAND USE IMPACTS
Land Uses and Potential Contaminants

This matrix identifies what contaminants may be associated with certain land uses. Not all land uses have necessarily resulted in demonstrated contamination problems from all pollutants listed. Sources of information are listed below.

Key: = threat to surface water  = threat to groundwater  = threat to surface and groundwater

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Key Pollutants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture - cropland</td>
<td>Nitr, phos, pest, sed</td>
</tr>
<tr>
<td>Ag. - pasture/hay land</td>
<td>Nitr, phos, pest</td>
</tr>
<tr>
<td>Ag. - feedlots, manure pits</td>
<td>Nitr, phos, ox, path</td>
</tr>
<tr>
<td>Airports</td>
<td>Petr, solv</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>Nitr, phos</td>
</tr>
<tr>
<td>Asphalt plants, storage</td>
<td>Petr</td>
</tr>
<tr>
<td>Auto: car washes</td>
<td>Surfc, petr</td>
</tr>
<tr>
<td>Auto salvage</td>
<td>Metals</td>
</tr>
<tr>
<td>Auto service shops</td>
<td>Solv, petr</td>
</tr>
<tr>
<td>Beauty parlors</td>
<td>Surfc</td>
</tr>
<tr>
<td>Boat use &amp; maintenance</td>
<td>Path, petr</td>
</tr>
<tr>
<td>Boat yards/builders</td>
<td>Petr, solv</td>
</tr>
<tr>
<td>Cemeteries</td>
<td>Nitr, phos</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Any hazardous material</td>
</tr>
<tr>
<td>Combined sewer lines</td>
<td>Nitr, phos, path, other</td>
</tr>
<tr>
<td>Construction</td>
<td>Sed</td>
</tr>
<tr>
<td>Dry cleaners</td>
<td>Solv</td>
</tr>
<tr>
<td>Furniture stripping</td>
<td>Solv</td>
</tr>
<tr>
<td>Golf courses</td>
<td>Nitr, phos</td>
</tr>
<tr>
<td>Hazardous mat. stor/trans.</td>
<td>Any haz. material</td>
</tr>
<tr>
<td>Household haz. wastes</td>
<td>Solv, surf, petr</td>
</tr>
<tr>
<td>Household lawn/garden</td>
<td>Nitr, phos, pest</td>
</tr>
<tr>
<td>Hydrologic modifications</td>
<td>Sed, therm</td>
</tr>
<tr>
<td>Infiltration wells/basins</td>
<td>Petr, sod, chlor</td>
</tr>
<tr>
<td>Jewelry, metal plating</td>
<td>Metals, acids, bases</td>
</tr>
<tr>
<td>Landfills, dumping grounds</td>
<td>Any</td>
</tr>
<tr>
<td>Laundromats</td>
<td>Surf, path, solv</td>
</tr>
<tr>
<td>Machine &amp; metal shops</td>
<td>Metals, acid, base, solv</td>
</tr>
<tr>
<td>Manufacturing: misc.</td>
<td>Various</td>
</tr>
<tr>
<td>Printing, photography</td>
<td>Metals, acid, base, solv</td>
</tr>
<tr>
<td>Research labs, hospitals</td>
<td>Various</td>
</tr>
<tr>
<td>Road de-icing</td>
<td>Sodium, chlor, sed</td>
</tr>
<tr>
<td>Road maint. depots</td>
<td>Sodium, chlor, petr</td>
</tr>
<tr>
<td>Road runoff</td>
<td>Nitr, phos, path, other</td>
</tr>
<tr>
<td>Road/bridge construction</td>
<td>Sed, petr</td>
</tr>
<tr>
<td>Sand &amp; gravel operations</td>
<td>Sed</td>
</tr>
<tr>
<td>Septic systems (IODE)</td>
<td>Nitr, phos, path</td>
</tr>
<tr>
<td>Sewer lines &amp; plants</td>
<td>Nitr, phos, path, other</td>
</tr>
<tr>
<td>Silviculture</td>
<td>Sed</td>
</tr>
<tr>
<td>Sludge disposal sites</td>
<td>Various</td>
</tr>
<tr>
<td>Stormwater drains/lines</td>
<td>Sed, chl, petr, mat, ther</td>
</tr>
<tr>
<td>Underground storage tanks</td>
<td>Petr, metals, other</td>
</tr>
<tr>
<td>Urban runoff</td>
<td>Various</td>
</tr>
<tr>
<td>Waste lagoons, pits</td>
<td>Various</td>
</tr>
<tr>
<td>Wood preserving</td>
<td>Phenols, metals</td>
</tr>
</tbody>
</table>

*Primary source of information was: Stewart, G. J. 1988. Source Interactions Enter by Non Point Source Pollution (draft), U.S. EPA, Boston, MA.

List of Categories of Potential Sources of Groundwater Contamination (See explanatory notes on following page.)

**Higher Risk**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airports-Commercial (maintenance &amp; repair, fuel storage)</td>
<td>Landfills, Machine Shops, Metal &amp; Drum Cleaning/Reconditioning, Paint Shops, Photographic Processors, Printers, Blueprint Shops, Railroad Yards, Repair Shops (engines, appliances, etc.), Rust Proofers, Service Stations (gas stations), Waste Storage, Treatment, &amp; Recycling (hazardous &amp; non-hazardous waste)</td>
</tr>
<tr>
<td>Automotive Repair Shops</td>
<td></td>
</tr>
<tr>
<td>Automotive Body Shop</td>
<td></td>
</tr>
<tr>
<td>Boat Builders &amp; Refinishers</td>
<td></td>
</tr>
<tr>
<td>Bus &amp; Truck Terminals</td>
<td></td>
</tr>
<tr>
<td>Chemical Manufacturers</td>
<td></td>
</tr>
<tr>
<td>Dry Cleaners</td>
<td></td>
</tr>
<tr>
<td>Dumps</td>
<td></td>
</tr>
<tr>
<td>Fuel Oil Distributors (product storage, equipment maintenance &amp; storage)</td>
<td></td>
</tr>
<tr>
<td>Furniture Strippers, Refinishers</td>
<td></td>
</tr>
<tr>
<td>Industrial Manufacturers</td>
<td></td>
</tr>
<tr>
<td>Junkyards &amp; Salvage Yards</td>
<td></td>
</tr>
</tbody>
</table>

**Moderate Risk**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Related Activities* (pesticide &amp; fertilizer storage &amp; application, machinery maintenance &amp; fueling)</td>
<td>Military Facilities (past &amp; present), Nursing Homes, Pipelines (oil &amp; sewer), Prisons, Research Laboratories, Road Salt Storage, Schools, Colleges &amp; Trade Centers, Wastewater Treatment Plants (past or present sludge disposal), Wood Preservers</td>
</tr>
<tr>
<td>Asphalt, Coal, Tar &amp; Concrete Companies</td>
<td></td>
</tr>
<tr>
<td>Car Dealers</td>
<td></td>
</tr>
<tr>
<td>Dredge Disposal Sites</td>
<td></td>
</tr>
<tr>
<td>Medical Facilities (hospitals, clinics, laboratories)</td>
<td></td>
</tr>
</tbody>
</table>

**Lower Risk**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Care &amp; Holding Areas (stables, kennels, pet shops)</td>
<td>Residential Development (lawn care, septic systems), Restaurants &amp; Taverns, Retail Shopping Centers, Malls, Sand &amp; Gravel Mining Operations, Sawmills, Stormwater Management Facilities (leaching systems), Transmission Line Rights of Way, Transportation Corridors (road deicing, materials transport), Utility Substations/Transformers, Waste Transfer Stations</td>
</tr>
<tr>
<td>Auto Parts Stores</td>
<td></td>
</tr>
<tr>
<td>Beauty Salons</td>
<td></td>
</tr>
<tr>
<td>Construction Sites</td>
<td></td>
</tr>
<tr>
<td>Food Processors (meat packers, dairies, bakeries)</td>
<td></td>
</tr>
<tr>
<td>Funeral Homes &amp; Cemeteries</td>
<td></td>
</tr>
<tr>
<td>Golf Courses</td>
<td></td>
</tr>
<tr>
<td>Hotels &amp; Motels</td>
<td></td>
</tr>
<tr>
<td>Land Application of Sewage Sludge</td>
<td></td>
</tr>
<tr>
<td>Laundromats</td>
<td></td>
</tr>
<tr>
<td>Nurseries</td>
<td></td>
</tr>
</tbody>
</table>

J-11
APPENDIX E

SUN OIL/DB MART DOCUMENTATION
February 22, 1991

Mr. William Hawkins, President
Town Council, Town of North Smithfield
Town Hall Main Street
Slatersville, Rhode Island 02876

Dear Mr. Hawkins,

Enclosed please find a copy of the Consent Agreement entered into between the Department of Environmental Management and the Sun Refining and Marketing Company concerning the remediation of groundwater contamination at the North Smithfield Sunoco and in the Woodland Road neighborhood. A copy has been sent to the town clerk for filing in the land evidence records.

The agreement requires Sun Refining and Marketing (Sun) to submit plans for further investigation, monitoring and remediation of the contamination. The remedial plan must be designed with the goal of restoring the drinking water supply to all affected areas. While the agreement was being finalized, Sun prepared and submitted a remediation plan. The plan, which is under DEM review, is being supplemented by additional information to be submitted by Sun. In accordance with the plan and with DEM approval, Sun has gone forward and installed the components of a groundwater treatment system and obtained the necessary discharge permits. The groundwater treatment system became operational this week. It will be periodically monitored to an evaluation of its effectiveness over time.

Pursuant to the agreement, Sun was required to provide an interim drinking water supply to all private homes in the area whose water was contaminated by gasoline constituents above drinking water standards. Sun has complied by installing carbon filters to all those residences indicating any presence of contamination—both above or below drinking water standards. The filter systems will be monitored monthly and the results will be made available to the individual homeowners.

The DEM Groundwater Section will continue its oversight role with respect all remediation and monitoring activities. If you should have any questions concerning this matter, please do not hesitate to contact me at 277-2234.

Sincerely,

Susan Kiernan
Deputy Chief

cc: Elizabeth Faricy
Stephen Morin, DEM
January 24, 1991

Mr. Phil Kaczorowski
Director of Public Works
P.O. Box 248
Slatterville, Rhode Island 02876

Re: Groundwater Treatment System Connection
to Storm Sewer System
Sunoco Service Station
1047 Eddie Dowling Highway
North Smithfield, Rhode Island

Dear Mr. Kaczorowski,

The following information is submitted to inform you of the status of the above referenced project. The project is scheduled to begin February 1, 1991.

SITE LOCATION
Sunoco Service Station
1047 Eddie Dowling Highway
North Smithfield, Rhode Island

SUNOCO CONTACT
Mr. Carl Borkland, Hydrologist
Sun Refining & Marketing
35 Terminal Road
Providence, RI 02908
(401) 461-9105

Attached you will find an area map and site plan detailing the proposed connection to the catch basin.

REASON FOR DISCHARGE  The Rhode Island Department of Environmental Management (RIDEM) is requiring the installation of a ground water treatment system at the site location referenced above. The ground water treatment system will result in a discharge of treated ground water into the Rhode Island Department of Transportation (RIDOT) storm sewer system. Discharge to the storm sewer system will be to a catch basin located at the intersection of Eddie Dowling Highway and Iron Mine Road.

TREATMENT SYSTEM  The treatment system will consist of a single 6 inch diameter pumping well. The pumping well will pump ground water to a packer tower air stripper treatment system. Effluent from the air stripping tower will be treated or "polished" prior to discharge using two 500 pound capacity granular activated carbon adsorption (GACA) units piped in series.
ESTIMATED FLOW RATE  Treatment system effluent flow rate is expected to be approximately 7 gallons per minute.

DISCHARGE POINT  Effluent from the treatment system will be piped to the RIDOT storm sewer system. Rhode Island Department of Transportation permits and local authorization will be secured prior to discharging into the storm sewer system. A site map has been provided detailing where the proposed connection will be made. The connection to the catch basin will be made in accordance with all RIDOT Blue Book specifications.

EFFLUENT SAMPLING  Effluent sampling and monitoring will be conducted in accordance with the RIDEM Order of Approval issued. A copy of the Order of Approval has been provided.

If you require additional information, please do not hesitate to contact our office.

Sincerely,

James Wagner
Environmental Scientist
Permits Manager

Enclosures

cc w/attachments:

Carl Borkland, Sun Refining & Marketing
Phil Fielding, RIDOT
RECEIVING WATER CLASSIFICATION:  B

The facility which is the source of the wastewater discharge is engaged in the storage and sale of gasoline. The permit authorizes the discharge of groundwater from a treatment system which consists of two (2) granular activated carbon adsorption filters arranged in series. Discharge limitations were established to ensure that minimum Database Guidelines for Benzene, Ethyl-benzene, Toluene and Total Xylene are met at the end of the discharge pipe. This discharge is subject to State antidegradation provisions. The RIDEM has made the determination that the impact to the receiving water is insignificant and does not warrant further review at this time.

PERMIT NUMBER:  RI002197E

NAME AND MAILING ADDRESS OF APPLICANT:

SUN REFINING AND MARKETING COMPANY
Ten Penn Center
1801 Market Street
Philadelphia, PA 19103-1699

NAME AND ADDRESS OF THE FACILITY WHERE DISCHARGE OCCURS:

SUNOCO SERVICE STATION
1047 Eddie Dowling Highway
North Smithfield, RI

RECEIVING WATER:

Wetland Tributary to Crookfall Brook

RECEIVING WATER CLASSIFICATION:  A

The facility which is the source of the wastewater discharge is engaged in the storage and sale of gasoline. The permit authorizes the discharge of groundwater from a treatment system consisting of a packed-tower air stripping column followed by two (2) activated carbon filters arranged in series. The discharge concentrations must be below the analytical detection limit of one (1) part per billion for Benzene, Ethyl-benzene, Toluene and three (3) parts per billion for Total Xylenes. This discharge is subject to State antidegradation provisions. The RIDEM has made the determination that the impact to the receiving water is insignificant and does not warrant further review at this time.
NAME AND MAILING ADDRESS OF APPLICANT:
DeBLOIS OIL COMPANY
P.O. BOX 6027
PROVIDENCE, RI 02940

NAME AND ADDRESS OF THE FACILITY WHERE DISCHARGE OCCURS:
DB MART
80 EDDIE DOWLING HIGHWAY
NORTH SMITHFIELD, RI

RECEIVING WATER: Unnamed Stream Tributary to Spring Brook

RECEIVING WATER CLASSIFICATION: A

The facility which is the source of the wastewater discharge is engaged in the storage and sale of gasoline and other services. The permit authorizes the discharge of groundwater from a treatment system consisting of a packed-tower air stripping column followed by two (2) activated carbon filters arranged in series. The discharge concentrations must be below the analytical detection limit of one (1) part per billion for Benzene, Ethyl-benzene, Toluene and three (3) parts per billion for Total Xylenes. This discharge is subject to State antidegradation provisions. The RIDEM has made the determination that the impact to the receiving water is insignificant and does not warrant further review at this time.

PERMIT NUMBER: RI0000191

NAME AND MAILING ADDRESS OF APPLICANT:
KENYON INDUSTRIES, INC.
10 EAST 39th STREET
NEW YORK, NY 10016

NAME AND ADDRESS OF THE FACILITY WHERE DISCHARGE OCCURS:
THE KENYON PIECE DYEWOKKS, INC.
MAIN STREET
KENYON, RI 02836

RECEIVING WATER: Pawcatuck River

RECEIVING WATER CLASSIFICATION: C
APPENDIX F

FEDERAL AND STATE REGULATIONS AFFECTING GROUNDWATER
The Clean Water Act (CWA) as amended by the Water Quality Act of 1987 (Public Law 92-500)

The Clean Water Act has two goals: (a) the achievement of a level of water quality that provides for the propagation and protection of fish and wildlife and for recreation in and on the water and (b) the elimination of the discharge of pollutants in United States waters. This act regulates all discharges from all point sources into the navigable waters of the United States. Outfalls from land-based facilities such as sewage treatment plants and industrial plants are subject to regulation under the CWA through the National Pollution Discharge Elimination System (NPDES). A permitting program, co-administered with the Army Corps of Engineers, regulates discharge of dredged or fill material into U.S. waters. Water quality standards are set for all significant surface waterbodies. Also included are provisions for water quality management plans (under Section 208) which some states have used to develop their own groundwater protection plans.

Although there is an emphasis on control of point sources, Section 319 (1987) of the Act also provides for the development and implementation of non-point source pollution management plans (subject to EPA review). These plans can include BMPs and other regulatory and non-regulatory programs. State plans deemed inadequate can cause ineligibility for Section 319 grant funds. The non-point source management plans are required to be developed, whenever possible, on a watershed-by-watershed basis. One other aspect of the 1987 amendments is the requirement that states take into account the impact of management practices on groundwater quality in order to prevent protection of surface water quality at the expense of groundwater quality.


While this act does not specifically address public drinking water supplies, it does require that states adopt an "Anti-degradation Policy" that prohibits the introduction of any new pollution source that would degrade waters designated by the State as "high quality." This would included surface water reservoirs and groundwater aquifers.

The Safe Drinking Water Act (SWDA)

This act was passed 1974, authorizing the EPA to adopt regulations for a system of national standards and treatment
technologies for public drinking water. Maximum contaminant levels (MCLs) were also required to be set. States may adopt more stringent standards and may regulate more substances than provided for in the federal act. Monitoring and testing of community and non-community wells is required to ensure that drinking water quality meets SWDA standards. It was amended on 1986 in part to more adequately address implementation efforts. The amendments included a requirement for groundwater protection.

RIDEM regulates point sources of pollution and has been authorized to establish regulations to protect groundwater quality. The 1986 amendments to the Act established a federal Wellhead Protection Program (WHPP). EPA guidelines for WHPPs are adopted by the states in the development of state WHPPs which are subject to EPA approval. Elements of the WHPP include the delineation of wellhead protection areas (states are given great flexibility in defining these areas), the inventory of contamination sources, the development of management strategies, public education, and contingency planning.

The amendments include provisions for underground injection control. This method of underground waste disposal poses great risks to groundwater resources due to the possibility that these wastes will not remain isolated in one area and could migrate into potable water supplies. Some states, such as Minnesota and Wisconsin, discourage the use of underground injection devices.

The 1986 amendments to the SWDA also contain provisions for the designation of Sole Source Aquifers (SSA). The EPA reviews projects which receive federal financial assistance in their development and implementation. Projects which may result in adverse impacts on groundwater resources may be prohibited from construction by preventing a commitment of federal funds. The Act is used to negotiate modifications to projects that will reduce negative impacts. It is important to note that this provision affects only federally-funded projects, leaving sole source aquifers vulnerable to threats from private or state projects.

Resource Conservation and Recovery Act (RCRA)

This federal statute provides standards for treatment, storage, and disposal facilities for hazardous wastes all aimed at preventing contamination of surface and groundwater and at public safety. Hazardous wastes are tracked from "cradle-to-grave" (point of generation to point of ultimate disposal). The importance of this type of regulation is underscored by the fact that approximately one ton of hazardous wastes is generated each year for every person in the United States (US Congress, Office of Technology Assessment, 1983). The Act was amended in 1984 to address groundwater contamination from leaking underground storage
tanks. An underground storage tank is subject to RCRA regulation if 10 percent of a tank's volume is beneath the ground surface and if the tank contains a material regulated under RCRA or CERCLA.

The US EPA has not added to the list of RCRA-regulated materials since 1980 although several states have requested that the list be expanded (Jaffe and DiNovo, 1987). Four factors are used to classify hazardous wastes under RCRA: ignitability, corrosivity, reactivity, and toxicity. Substances not regulated under RCRA are those that are carcinogenic, infectious, and able to cause birth defects (teratogenic) although there are provisions in the 1986 amendments to add such substances.

**Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)**

This act established the Superfund - a funding source used to clean up existing or closed toxic waste sites. There are three such sites in the Town of North Smithfield. Toxins disposed of or stored at waste sites have been found to leach into groundwater. This act created a funding mechanism for clean-up actions. The broad powers this act grants of assigning liability for cleanup of such sites to hazardous waste transporters, generators, and landfill owners acts as a deterrent to continued toxic dumping practices. CERCLA sets forth a cost-sharing formula in which the states must contribute 10 to 50 percent of the cost of clean-up, depending on whether the site in question was publicly or privately owned. The high costs associated with toxic waste removal or remediation has hampered the effectiveness of this act as many states currently do not have the financial resources to allocate funds for CERCLA actions.

The Superfund Amendments and Reauthorization Act (SARA) Title III requires businesses to notify governments (Right-to-Know) of potentially hazardous substances stored or used on-site. SARA records for the State of Rhode Island are managed by the RI Department of Labor.

**Toxic Substances Control Act**

Passed in 1976, this act authorizes the EPA to regulate toxic pollutants from generation to disposal. The EPA can require the testing of chemical substances manufactured or processed by a company and any adverse effects must be reported to the EPA. Authorization is granted to the EPA to regulate or to ban any chemical on the basis of unreasonable risk to human health or the environment.

**Federal Insecticide, Fungicide, and Rodenticide Act**
This legislation provides for the establishment of procedures for the registration, classification, sale, use, research, monitoring, and disposal of pesticides. Pesticide use has been the source of much groundwater contamination in the U.S., particularly in agricultural regions. Through this act, the EPA can require extensive study of pesticide effects on humans, animals, and the environment to determine if there are any adverse effects.

**National Environmental Policy Act (NEPA)**

NEPA requires that any project involving federal legislation, funds, or activities that could significantly alter the quality of the human environment must be the subject of an environmental impact statement (EIS). The purpose of the act is to raise environmental protection to the same level as other considerations in the decision-making process of federal agencies.

**STATE GROUNDWATER PROTECTION**

In 1983, the State of Rhode Island's Water Pollution Control Act was amended to include groundwaters under the definition of the State's waters. In doing so, the RIDEM was given authority to regulate the prevention of groundwater contamination and to restore groundwater quality to acceptable levels. The State enacted the Groundwater Protection Act in 1985 which was designed to provide for the development of a comprehensive groundwater protection program. Policies established by the Act provided measures to restore, protect, and maintain the quality of the State's groundwaters. These measures included aquifer, recharge area, and watershed protection. Degradation of groundwater was prohibited unless the state chose to allow "lower quality as a result of essential, desirable, and justifiable economic, commercial, industrial, or social development" (RI Groundwater Protection Strategy, RIDEM 1989). This act also directed the RIDEM to identify and classify groundwater aquifers and to establish standards for the four classes of groundwater.

**STATE STATUTES**

**Water Pollution RIGL 46-12**

This statute provides for the control of pollution of the waters of the State, including groundwater and established the Underground Storage Tank Replacement Revolving Loan Fund. The statute prohibits the location of drinking water wells within 1000 feet of any solid waste disposal facility unless the water samples meet quality standards set by the Department of Health. It also includes
the Underground Injection Control Program which regulates this subsurface method of waste disposal.

Groundwater Protection Act RIGL 46-13.1

This statute establishes state policies for groundwater protection and requires the RIDEM to classify and develop standards for the State's groundwater resources.

Underground Storage Tanks (UST) RIGL 46-12.1

State regulations for the control of design, siting, and location of USTs are based on the federal program which does not regulate tanks under 1100 gallon capacity. Though small, many of these tanks are located in the vicinity of public drinking wells and present a significant threat due to tank failure of aging systems. The petroleum products usually stored in USTs are very mobile in groundwater.

Department of Health Regulations RIGL 46-14

The RI Department of Health (DOH) monitors the quality of drinking water wells to insure compliance with federal standards. The Department has the power (authorized by Section 46-14 "Contamination of Drinking Water Act") to inspect public water supply systems, to enter onto private property, and to order the removal of any substances that endanger a public drinking water supply. In practice, the DOH does not go beyond the testing of drinking water quality.

ISDS Permit Regulations RIGL 42-17.1, 17.2

The purpose of the ISDS regulations is to ensure that the siting, design, and operation of septic systems occur in such a manner as to protect public health and environmental quality. Regulation involves a series of setback regulations.

General Setbacks:
Surface drinking water supplies or tributaries 200 feet
Watercourses 50 feet
Public drinking water supply well 400 feet
Private well 100 feet

On-site septic systems are prohibited in areas where the groundwater table is less than three feet from the original ground surface or where an impervious layer is less than five feet from the original ground surface. The regulations do provide a variance procedure. A Wetlands permit is required if the ISDS is to be within 50 feet of a wetland, 100 feet of a river less than 10 feet wide, 200 feet of a river more than 10 feet wide, or if it is to be
located in a floodplain.

For ISDS in proximity to the ocean on a site that is subject to erosion, the minimum setback from the solstice tide elevation to the edge of the system shall not be less than 150 feet.

ISDS regulations identify three areas as critical resource areas and provide more stringent requirements for systems located in these areas. The critical areas are the South Shore Coastal Ponds, the Scituate Reservoir and its watershed, and the Narrow River and its watershed. For large systems (over 2,000 gallons per day) in these areas, the separation distances to water table and impervious layer are increased to five feet and seven feet, respectively. Large ISDS are not allowed in areas of highly permeable soils (faster than three inches per minute) unless proven otherwise for a site. Horizontal distances to waterbodies and wells are increased to three times the minimum required. For subdivisions designed to produce over 2,700 gpd of sewage, an assessment of impacts to groundwater, freshwater wetlands, and coastal wetlands in critical resource areas, can be required.

Critical Area Setbacks:

Coastal Ponds and Narrow River shoreline features and tributaries 150 feet
Indirectly connected watercourses 100 feet
Private wells 150 feet
All watersheds to surface water reservoirs including contributing perennial streams 200 feet

Requests for variances are heard by a review committee composed of representatives from the Dept. of Health, the Division of Groundwater and Freshwater Wetlands ISDS Section, and the Board of Engineering and Land Surveyors. Variances are allowed if they are deemed not contrary to the public health or interest.

Wastewater Management Districts

The RI General Assembly passed legislation in 1987 that enables cities and towns to establish Wastewater Management Districts (WWMD). Adopted in the same manner as an ordinance, a WWMD is designed to eliminate and prevent the contamination of the state's waters caused by malfunctioning individual septic disposal systems. This goal is achieved through the use of inspection and maintenance programs. Provisions of the WWMD legislation include:
* authority for the passage of local officials onto private property to periodically inspect septic systems;

* the ability to raise funds for the administration of a WWMD through taxes, annual fees, borrowing or issuing of bonds, and septic system pumping fees.

* authority to establish administrative, financial, technical, enforcement, maintenance, and legal structures to implement and conduct WWMD programs;

* the establishment of a public education program;

* the establishment of revolving funds for low-interest loans to be used to correct failed septic systems;

* authority to levy fines not to exceed $500 for each day of non-compliance.

RI Wellhead Protection Program - mandated by the 1986 amendments to the federal Safe Drinking Water Act (SDWA) Section 1428. Administered by the Groundwater Section of RIDEM.

This program is designed to delineate wellhead areas in need of protection, identify contamination sources, develop locally administered management strategies and ordinances, to guide siting of new wells, and to provide contingency plans in the event of public well contamination. Land use control measures are the responsibility of local governments. RIDEM will provide technical assistance and administrative tools to be used by local authorities in groundwater protection initiatives.


The purpose of these regulations is to implement a registration system, establishing facility design requirements, tank testing schedules and procedures, and measures for siting of new USTs that will protect the groundwater and the surface water of the State from pollution that can result from the use of USTs.


These regulations are designed to protect the environment and the public health and safety from the effects of improper, inadequate, or unsound management of hazardous waste. This is accomplished through regulations governing the storage, transport, treatment, and disposal of
such wastes. Permits from the RIDEM Division of Air and Hazardous Materials are required for hazardous waste activities. Section 10.1 (the Hagan Amendment) authorizes cities and towns to adopt ordinances which prohibit the disposal of hazardous wastes in the recharge zones of public drinking water supply wells.

**Solid Waste Regulation** RIGL 23-18.9

An amendment to the Refuse Disposal Act 1982 authorized the DEM and local governments to prohibit the disposal of solid waste in groundwater aquifer areas which are existing or potential public drinking water supplies.

**Underground Injection Control Program** RIGL 42-17.1 and 46-12.

These regulations are intended to preserve the quality of the groundwaters of the State by assuring the proper location, design, construction, maintenance, and operation of injection wells and other subsurface waste disposal systems. Permitting is the responsibility of the RIDEM Division of Groundwater and Freshwater Wetlands, Groundwater Section.

**Public Drinking Water Protection Act of 1987** RIGL 46-15.3

In order to protect the quality and safety of the public drinking water supply, this act grants authority to public water supply agencies to impose a charge (currently $0.01 per 100 gallons) on water use. This charge will provide funding for the acquisition of watershed land in order to protect water supplies (both surface and groundwater) and for certain other water quality protection measures, such as the development of Water Quality Protection Plans and monitoring programs. Educational programs regarding watershed and aquifer protection that target planning boards, zoning boards, and other officials can be funded through this act. Also funded are pollution prevention activities and remedial actions.

**46-13.2 Drilling of Drinking Water Wells**

This act establishes the RI Well Drilling Board and authorizes the DEM to promulgate regulations for the design, construction, installation, and maintenance of wells. Drillers and installers are required to submit well data to the State.

**46-13 Public Drinking Water Supply**

Under this act, the Department of Health is authorized to establish requirements for public water supply systems
that will ensure that the public is provided with a safe and potable drinking water supply.

42-44.1 Sewage and Water Supply Failure Fund

This act establishes a fund to be used for the mitigation of problems caused by failed septic systems and the contamination of private drinking water wells.

45-22.1 Comprehensive Planning and Land Use Act

In requiring communities to update their Comprehensive Plans, this act adds provisions for groundwater resource inventories and for policies regarding the management and protection of these resources.

23-19.4 Septage, Industrial Wastes and Waste Oil Pumping, Cleaning and Transportation

Any business that is engaged in the business of pumping, cleaning, or transporting septage, industrial wastes, or waste oil is required by this regulation to obtain a permit from RIDEM.

23-19.5 Percolation Tests and Water Table Elevation Determination

Percolation tests and water table elevation determinations are required by RIDEM prior to the conveyance of real property where a sewer system is not available and ISDS will be required.

23-19.6 Used Oil Recycling

This act prohibits the improper disposal of used oil and requires a public education program on the benefits of collecting and recycling used oil.

23-19.7 Hazardous Waste Management Facilities

This act establishes a process for the siting of hazardous waste management facilities that provides protection to groundwater resources.
APPENDIX G

MODEL ORDINANCES
Appendix C-1

Well Field Protection Ordinance

Broward County, Florida, May 1984, Draft

Section 1. Short Title; Applicability; Construction

(1.01) This Ordinance shall be known as the "Potable Water Supply Well Field Protection Ordinance." The provisions of this ordinance shall be effective countywide within Broward County, Florida, and shall be considered an ordinance setting minimum standards to prevent potable water-supply contamination by toxic substances, and an ordinance protecting against the destruction of the resources of the county belonging to the general public, pursuant to Section 8.04 of the Broward County Charter. This ordinance shall be liberally construed to effect the purposes set forth herein.

Section 2. Legislative Intent

(2.01) The intent and purpose of this ordinance is to safeguard the public health, safety, and welfare of the residents of Broward County, Florida, by providing scientifically established criteria for regulation of the storage, handling, use, and/or production of toxic substances within identified zones of influence surrounding well fields, thereby protecting potable water supply wells from contamination.

(2.02) The substances to be controlled include but are not limited to certain known toxic substances that are prone to be persistent in the environment, to pass downward through surface soils in the event of spillage, to enter into groundwater strata, to mix with groundwater, and to be transported by the movement of groundwater to water supply wells.

Section 3. Definitions

(3.01) The following definitions apply within this ordinance:

(a) Aquifer. A rock formation, group of rock formations, or part of a rock formation that contains enough saturated permeable material to yield significant quantities of water.

(b) Biscayne Aquifer. The aquifer underlying Dade, Broward, and Palm Beach Counties, which supplies these counties with potable water.

(c) Broward County Water Resource Management Division. Division of county government charged with responsibility for management, control, regulation, and planning in relation to water resources.

(d) Contamination. The presence of any harmful or deleterious substances in the water supply.

(e) Groundwater. Subsurface water in the saturated zone from which wells, springs, and groundwater runoff are supplied.

(f) Lithology. The general characteristics of any rock formation.

(g) One-Foot Drawdown Contour. The locus of point around a well or well field where the free water elevation is lowered by one (1) foot due to the pumping of the well or well field.

(h) Permitted Pumping Capacity. The amount of water authorized to be pumped from a well during one (1) year period.

(i) Person. Any natural person, individual, public or private corporation, firm, association, joint venture, partnership, municipality, governmental agency, political subdivision, public officer, or any other entity whatsoever or any combination of such, jointly or severally.

(j) Pollutant Travel Time. The time required by pollutants to travel from one point to another.

(k) Pollution. The presence of any substance (organic, inorganic, radiological, or biological) or condition (temperature, PH, turbidity) in water that tends to degrade its quality so as to constitute a hazard or impair the usefulness of the water.

(l) Potable Water. Water that is satisfactory for drinking, culinary, and domestic purposes, meeting current drinking water standards.

(m) Public Utility. Any privately, municipally, or
county-owned system providing water or wastewater service to the public that has at least fifteen (15) service connections or regularly serves an average of at least twenty-five (25) individuals daily for at least sixty (60) days of the year.

(a) Toxic Substance. Any substance that has the capacity to produce personal injury or illness to humans through ingestion, inhalation, or absorption into the body.

(o) Transmissivity. The rate at which water is transmitted through a unit width of any aquifer under a unit of hydraulic gradient.

(p) Travel-Time Contour. A locus of points from which water takes an equal amount of time to reach a given designation such as a well or well field.

(q) Travel Time Zones. The area bounded by travel time contours.

(s) Water Pollution. The introduction in any surface or underground water, or tidal saltwater, or any organic or inorganic deleterious substance in such quantities, proportions, and accumulations that are injurious to human, plant, animal, fish and other aquatic life, or property, or that unreasonably interferes with the comfortable enjoyment of life or property or the conduct of business.

(t) Well. A pit or hole sunk into the earth to reach a resource supply such as water.

(u) Well Field. A tract of land that contains a number of wells for supplying water.

(v) Zones of Influence. Zones delineated by iso-travel time contours around wellfields, within which toxic substances will be regulated to protect the quality of the groundwater resource. These zones are calculated, based on the rate of movement of groundwaters in the vicinity of wells with an allowance for the dispersion of a pollutant entering into and moving with the groundwater.

Section 4. Maps of Zones of Influence

(4.01) Zone of influence maps and any amendments thereto are incorporated and made a part of this ordinance. These maps shall be on file at the Water Resources Management Division. Any changes, additions, or deletions to said maps shall be approved by the Board of County Commissioners of Broward County. The Broward County Water Resources Management Division, or its successor agency, shall maintain these maps of the zones of influence of public utility potable water-supply well fields. Said maps shall be provided to the Office of Planning, the Building and Zoning Enforcement Division, the Broward County Health Department, the Broward County Planning Council, the Environmental Quality Control Board, and any other agency requesting said maps.

(4.02) The Zone of Influence maps may be updated on an annual basis. The basis for such an update may include, but is not limited to, the following:

(a) Changes in the technical knowledge concerning the Biscayne Aquifer relating to:

1. Transmissivity;
2. Lithology;
3. Extent

(b) Changes in permitted pumping capacity of municipal well fields.

(c) Addition of wells to existing well fields.

(d) Designation of new well fields.

(4.03) The zones of influence indicated on the Zone of Influence maps are as follows:

(a) Zone 1: The land area situated between the well(s) and the ten (10) day travel time contour.

(b) Zone 2: The land area situated between the ten (10) day and the thirty (30) day travel time contours.

(c) Zone 3: The land area situated between the thirty (30) day and the two hundred ten (210) day travel time contours, or the thirty (30) day and the one-foot drawdown contours, whichever is greater.

Section 5. Prohibitions and Restrictions Within Zones of Influence

(5.01) No person who engages in nonresidential activities within Zone 1 as indicated on the Zone of Influence Maps shall store, handle, use, and/or produce any toxic substances set forth in Table 1, attached hereto and made a part of hereof.

(5.02) All persons who engage in nonresidential activities within Zone Two (2) and Zone Three (3) of the Zones of Influence as indicated on the Zone of Influence Maps, who store, handle, use, and/or produce any toxic substances set forth in Table 1 shall obtain a Well Field Protection Permit from the Water Resources Management Division and shall comply with the provisions of this ordinance and the rules and regulations promulgated hereunder.

(5.03) A Well Field Protection Permit shall be renewed annually and shall not be transferable.

(5.04) Prior to the issuance of a new or renewal permit, the applicant shall pay to the county a permit fee that shall be established by resolution of the Board of County Commissioners. Such fee shall be used to defray the cost of monitoring the compliance to the rules and regulations.

(5.05) Any person who engages in nonresidential activities relating to the storage, handling, use, and/or production of any toxic substances set forth in Table 1 who is exempted from this ordinance by law shall not be subject to the restriction contained herein.

Section 6. Protection of Future Well Fields

(6.01) The prohibitions and restrictions set forth in this ordinance and in the regulations shall apply to any new well field sites developed as new well fields or designated for development as new well fields within Broward County.

Section 7. Determination of Location Within Zones

(7.01) In determining the location of properties within the zones depicted on the Zone of Influence Maps, the following rules shall apply:

211
(a) Properties located wholly within one (1) zone reflected on the applicable Zone of Influence Map shall be governed by the restrictions applicable to that zone.

(b) For properties having parts lying within more than one (1) zone as reflected on the applicable Zone of Influence Map, each part shall be governed by the restriction applicable to the zone in which the part of the property is located.

Section 8. Well Field Protection Enforcement
(8.01) A Well Field Protection Officer shall be designated by the County Administrator to supervise the implementation and enforcement of this ordinance. The duties and responsibilities shall be as set forth in the regulations.
(8.02) The Water Resources Management Division through the Well Field Protection Officer designated by the County Administrator shall, by the issuance of a Notice of Violation as provided herein, have the power and authority to enforce the provisions of this ordinance and any rules and regulations promulgated hereunder.
(8.03) The Well Field Protection Officer shall

### Table 1

Toxic substances are prohibited in Zone 1 and regulated in Zone 2 and Zone 3 of the zones of influence as indicated on the Zones of Influence Maps. Toxic substances include but are not limited to the following:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Substance</th>
<th>Substance</th>
<th>Substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acephate</td>
<td>Guthion</td>
<td>Heptachlor</td>
<td>Isopropylbenzene</td>
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<tr>
<td>Aldicarb</td>
<td></td>
<td></td>
<td>Lead</td>
</tr>
<tr>
<td>Aldrin/Dieldrin</td>
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<td></td>
<td>Lin dane</td>
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<tr>
<td>Arsenic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
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<td></td>
<td></td>
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<tr>
<td>Bromodichloromethane</td>
<td>Malathion</td>
<td>Methoxychlor</td>
<td></td>
</tr>
<tr>
<td>Bromoform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbaryl</td>
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<td></td>
<td></td>
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<tr>
<td>Carbon Tetrachloride</td>
<td>Methylene Chloride</td>
<td>Methoxychlor</td>
<td></td>
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<tr>
<td>Chlordane</td>
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<td></td>
<td></td>
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<tr>
<td>Chlordecone</td>
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<td></td>
<td></td>
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<tr>
<td>Chlorbenzene</td>
<td>Nickel (excluding elemental metal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloroform</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Chlorotoluene(s)</td>
<td>Nitrates</td>
<td>Oxyamyl</td>
<td></td>
</tr>
<tr>
<td>Chromium (total)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium (hexavalent)</td>
<td></td>
<td></td>
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<tr>
<td>Copper (excluding elemental metal)</td>
<td>Parathion</td>
<td>Phenolic Compounds</td>
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<tr>
<td>Cyanide</td>
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<td>2,4-D</td>
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<td>DDT</td>
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<td>Demeton</td>
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<tr>
<td>Diazinon</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dibromochloromethane</td>
<td>Styxene</td>
<td>1,1,1,2-Tetrachloroethane</td>
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<tr>
<td>1,2-Dibromo-3-Chloropropane</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dichlorobenzene(s)</td>
<td>Tetrachloroethene</td>
<td></td>
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<tr>
<td>1,1-Dichloroethane</td>
<td></td>
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<tr>
<td>1,2-Dichloroethane</td>
<td>Toluene</td>
<td>Toxaphene</td>
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</tr>
<tr>
<td>1,1-Dichloroethene</td>
<td>Trichlorobenzene(s)</td>
<td>1,1,1-Trichloroethane</td>
<td></td>
</tr>
<tr>
<td>cis and/or trans 1,2-Dichloroethene</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dichlorodimethane</td>
<td></td>
<td>Trichloroethene</td>
<td></td>
</tr>
<tr>
<td>1,2-Dichloropropane</td>
<td>Vinyl Chloride</td>
<td>Xylene(s)</td>
<td></td>
</tr>
<tr>
<td>cis and/or trans 1,3-Dichloropropene</td>
<td></td>
<td>Zinc (excluding elemental metal)</td>
<td></td>
</tr>
<tr>
<td>Disulfoton</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endosulfan(s)</td>
<td>Gasoline</td>
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<tr>
<td>Endothall</td>
<td></td>
<td>Kerosene</td>
<td></td>
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<tr>
<td>Endrin(s)</td>
<td></td>
<td>Pathogens</td>
<td></td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>Petroleum Products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene Dibromide</td>
<td></td>
<td>Radionuclides</td>
<td></td>
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</tbody>
</table>
designate such inspectors as are necessary to enforce this ordinance and the rules and regulations promulgated hereunder.

Section 9. Inspections

(9.01) The Broward County Well Field Protection Officer or Inspector is hereby authorized and empowered to make inspections of all buildings, structures, and land within well field zones of influence in Broward County, Florida, in order to determine if the provisions of the Broward County Code of Ordinances and regulations relating to well field protection are being followed.

(9.02) Inspections may be made without notice, and it shall be a violation of this ordinance to refuse an inspection. A refusal of an inspection shall be sufficient grounds to revoke a permit.

(9.03) The Well Field Protection Officer or Inspector shall have the power and authority to enter and inspect all buildings and structures within well field zones of influence for the purpose of making an inspection.

(a) In the event a person who has common authority over a building structure shall not permit an inspection, such person shall reschedule an inspection for a time certain within forty-eight (48) hours of the inspector’s initial contact. Failure of such person to thereafter permit an inspection shall be sufficient grounds and probable cause for a court of competent jurisdiction to issue a search warrant to the Water Resources Management Division to inspect such premises.

(b) In the event a building or structure appears to be vacant or abandoned, and the owner cannot be readily contacted in order to obtain consent for an inspection, the officer or inspector may enter into or upon any open or unsecured portion of the premises in order to conduct an inspection thereof.

(9.04) The Well Field Protection Officer or Inspector shall have the power and authority to enter upon and inspect all vacant, fenced, or enclosed land with or without the consent of the owner or occupant thereof in order to conduct an inspection.

(9.05) The Well Field Protection Officer or Inspector shall be provided with official identification and shall exhibit such identification when making any inspection.

(9.06) It shall be the duty of all law enforcement officers to assist in making inspections when such assistance is requested by the officer or an inspector.

Section 10. Notice of Violation and Hearing

(10.01) Whenever the officer or an inspector determines that there is a violation of this ordinance, he shall give notice thereof in the manner hereinafter provided.

(a) A notice of violation shall:

(1) Be in writing;

(2) Be dated and signed by the officer or inspector;

(3) Specify the violation or violations;

(4) State that said violation(s) shall be corrected within a specified period of time as issued in writing by the inspector;

(5) State that if the violation is not corrected within said specified period of time the Well Field Protection Officer may request a hearing before the Board of County Commissioners within thirty (30) days from the expiration of the period of time stated in the violation recommending that the permit be revoked.

(10.02) If the Well Field Protection Officer finds that revocation of a permit is warranted, he shall notify the permit holder and the board of such finding in writing, by certified mail within twenty (20) days prior to the hearing. Thereafter, upon notice to the concerned permit holder, a hearing shall be held by the Board of County Commissioners for the purpose of consideration of the revocation of the permit.

Section 11. Injunctive Relief

(11.01) If any person who engages in non-residential activities stores, handles, uses, and/or produces toxic substances listed in Table 1 within the well field zones of influence, as indicated on the Zone of Influence Maps, without having obtained a permit as provided for herein or continues to operate in violation of the provisions of this ordinance, then Broward County may file an action for injunctive relief in the circuit court of the Seventeenth Judicial Circuit in and for Broward County, Florida.

Section 12. Penalties

(12.01) Any person who violates any provision of this ordinance shall, upon conviction, be punished by a fine not to exceed five hundred dollars ($500) or by imprisonment in the county jail not to exceed sixty (60) days or by both such fine and imprisonment.

Section 13. Severability

(13.01) If any section, sentence, clause, or phrase of this ordinance is held to be invalid or unconstitutional by any court of competent jurisdiction, then said holding shall in no way affect the validity of the remaining portions of this ordinance.

Section 14. Inclusion in Code

(14.01) It is the intention of the Board of County Commissioners that the provisions of this ordinance shall become and be made a part of the Broward County Code; and that the sections of this ordinance may be renumbered or relettered and the word “ordinance” may be changed to “section,” “article,” or such other appropriate word or phrase in order to accomplish such intentions.

Section 15. Effective Date

(15.01) This ordinance shall become effective (date).
Model General Bylaw: Hazardous Materials

Appendix B-3


Section 1: Authority
This bylaw is adopted by the town under its home rule powers, its police powers to protect the public health and welfare, and its authorization under Mass. Gen. Laws, ch. 40, §21.

Section 2: Purpose
The purpose of this bylaw is to protect, preserve, and maintain the existing and potential groundwater supply, groundwater recharge areas, and surface water within the town from contamination with hazardous materials.

Section 3: Definitions
The following definitions shall apply in the interpretation and implementation of this Bylaw.

Section 3.1
"Hazardous material" means a product or waste, or combination of substances that, because of quantity, concentration, or physical, or chemical, or infectious characteristics, poses in the board of health's judgment a substantial present or potential hazard to the human health, safety, or welfare, or the environment when improperly treated, stored, transported, used or disposed of, or otherwise managed. Any substance deemed a hazardous waste in Mass. Gen. Laws, ch. 21C, shall also be deemed a hazardous material for the purpose of this bylaw.

Section 3.2
"Discharge" means the disposal, deposit, injection, dumping, spilling, leaking, incineration, or placing of any hazardous material into or on any land or water so that such hazardous material or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters.

Section 4: Registration
Section 4.1
Every owner or operator of a commercial or industrial establishment (including home occupations) storing hazardous materials in quantities totaling more than 50 gallons liquid volume or 25 pounds dry weight shall register with the board of health the types, quantities, location, and method of storage of said hazardous materials. Registration required by this provision shall be initially submitted by [initial date] and annually thereafter within 30 days of [month, day] each year.

Section 4.2
Owners or operators of commercial or industrial establishments who have not previously registered in accordance with Subsection 4.1 shall, if they meet registration requirements, register initially within 30 days of meeting such requirements and thereafter within 30 days of [month, day] each year.

Section 4.3
In addition to registration, owners or operators of commercial or industrial establishments registered in accordance with Subsections 4.1 and 4.2 shall maintain on the premises an inventory, reconciled on a monthly basis, of purchase, use, sale, and disposal of hazardous materials. The purpose of this account is to detect any product loss and to provide an ongoing record of all quantities of hazardous materials within the town over the registration threshold.

Section 4.4
Upon the request of the board of health, owners or operators shall produce within 24 hours the latest reconciled inventory.

Section 4.5: Hazardous Wastes Generally
Wastes containing hazardous materials shall be held
on the premises in product-tight containers for removal by a licensed carrier and for disposal in accordance with the Massachusetts Hazardous Waste Management Act, Mass. Gen. Laws, ch. 21C

Section 4.6: Aboveground Storage of Hazardous Wastes
Aboveground containers of wastes containing hazardous materials shall be stored on a surface impervious to the material being stored. The storage area shall be enclosed by a permanent dike of impermeable construction. The volume of the area enclosed by the dike shall be equal to or greater than the capacity of the containers within the dike.

Section 5: Underground Storage
The following provisions shall apply to all underground liquid hazardous material storage systems with capacities of 55 gallons or greater.

Section 5.1
Owners shall file with the Board of Health the size, type, age, and location of each tank, and the type of hazardous material stored in each, or on before [initial date]. Evidence of date of purchase and installation, including Fire Department permit, if any, shall be included along with a sketch map showing the location of such tanks on the property.

Section 5.2
Owners of tanks for which evidence of installation date is not available shall, at the order of the board of health, have such tank systems tested. If either the board of health or the head of the fire department determines that the tank is not product-tight, it shall be disposed of under the direction of the board of health or the head of the fire department.

Section 5.3
All steel tanks shall be subject to one of the following tests 15 years after installation and annually after 20 years or if evidence of installation date is not available: a five-pounds-per-square-inch air pressure test performed on an empty tank, or a Kent-Moore Pressure test, or any other testing system approved in advance by the board of health or the head of the fire department. Certification of testing shall be submitted to the board of health and the head of the fire department. Any tanks failing the test shall be disposed of under the direction of the board of health or the head of the fire department.

Section 5.4
Newly installed tanks shall be protected from internal and external corrosion and shall be of a design approved by the board of health and the head of the fire department. The following tank construction systems are considered to provide adequate corrosion protection: all fiberglass construction steel with bonded fiberglass and internal lining; the Steel Tank Institute 3-Way Protection System; and such other tank construction systems as the board of health and the head of the fire department shall approve.

Section 6
The following provisions apply to all underground hazardous material storage systems of any capacity.

Section 6.1
All leaking tanks must be emptied by the owner or operator within 12 hours of leak detection and removed by the owner or operator in a time period to be determined by the board of health.

Section 6.2
Tank installations on lots not having a permit prior to adoption of this bylaw are not permitted within four feet of maximum high water table or within 100 feet of a surface-water body.

Section 7: Variances
The Board of Health may vary the application of any provision of this bylaw, unless otherwise required by law, in any case when, in its opinion, the applicant has demonstrated that an equivalent degree of environmental protection required under this bylaw will still be achieved. The applicant at his own expense must notify all abutters by certified mail at least 10 days before the board of health meeting at which the variance request will be considered. The notification shall state the variance sought and the reasons therefore. Any variance granted by the board of health shall be in writing. Any denial of a variance shall also be in writing and shall contain a brief statement of the reasons for the denial.

Section 8: Enforcement
Section 8.1: Protection
All discharges of hazardous material within the town are prohibited.

Section 8.2: Reporting of Discharge
Any person having knowledge of a discharge of hazardous material shall immediately report the discharge to the board of health, and if involving flammable or explosive materials, to the head of the fire department.

Section 8.3: Right of Entry
The board of health and its agents may enter upon privately owned property for the purpose of performing their duties under this bylaw.

Section 8.4: Penalty
Any person who violates any provision of this bylaw shall be punished by a fine of not more than $______. Each day or portion thereof during which a violation continues shall constitute a separate offense; if more than one, each condition violated
MODEL GENERAL BYLAW/HEALTH REGULATION TO
CONTROL TOXIC AND HAZARDOUS MATERIALS IN
THE TOWN OF ____________________ (December 1981)

Section 1. Findings

The Town of ____________________ finds that—
(1) The groundwater underlying this town is the sole source of its existing and
future water supply, including drinking water;
(2) The groundwater aquifer is integrally connected with, and flows into, the
surface waters, lakes, streams, and coastal estuaries which constitute sig-
nificant recreational and economic resources of the town used for bathing
and other water-related recreation, shellfishing, and fishing;
(3) Accidental spills and discharges of petroleum products and other toxic and
hazardous materials have repeatedly threatened the quality of such
groundwater supplies and related water resources on Cape Cod and in
other Massachusetts towns, posing potential public health and safety haz-
ARDS and threatening economic losses to the affected communities;
(4) Unless preventive measures are adopted to prohibit discharge of toxic and
hazardous materials and to control their storage within the town, further
spills and discharges of such materials will predictably occur, and with
greater frequency and degree of hazard by reason of increasing con-
struction, commercial and industrial development, population, and vehicular
traffic in the Town of ____________________ and on Cape Cod;
(5) The foregoing conclusions are confirmed by findings set forth in the Envi-
ronmental Impact Statement and Water Quality Management Plan for
Cape Cod (September 1978), prepared by the Cape Cod Planning and Eco-

nomic Development Commission pursuant to Section 208 of the Federal
Clean Waters Act; by the report entitled Chemical Contamination (Sep-
tember 1979), Commonwealth of Massachusetts; and by the report, Chemi-
cal Quality of Ground Water, Cape Cod, Massachusetts (1979), prepared
by the U.S. Geological Survey.

Section 2. Authority

The Town of ____________________ adopts the following measures
under its home rule powers, its police powers to protect the public health and
welfare, and its authorization under Chapter 40, M.G.L.A., Sec. 21. (FOR
HEALTH REGULATION: under its authorization under Chapter 111,
Sec. 31.)

Section 3. Definitions

(a) The term, “discharge” means the accidental or intentional spilling, leak-
ing, pumping, pouring, emitting, emptying or dumping of toxic or hazard-
ous material upon or into any land or waters of the Town of

Appendix H

Discharge includes, without limitation, leakage of such materials from failed or discarded containers or storage sys-
tems, and disposal of such materials into any on-site sewage disposal sys-
tem, drywell, catch basin, or unapproved landfill.

The term, “discharge” as used and applied in this bylaw, does not in-
clude the following:
(1) proper disposal of any material in a sanitary or industrial landfill that
has received and maintained all necessary legal approvals for that pur-
pose;
(2) application of fertilizers and pesticides in accordance with label recom-
endations and with regulations of the Massachusetts Pesticide Con-
Control Board;
(3) application of road salts in conformance with the Snow and Ice Con-
Control Program of the Massachusetts Department of Public Works, and
(4) disposal of “sanitary sewage” to subsurface sewage disposal systems as
defined and permitted by Title 5 of the Massachusetts Environmental
Code.

(b) The term, “toxic or hazardous material,” means any substance or mixture
of such physical, chemical, or infectious characteristics as to pose a sig-
nificant actual or potential hazard to water supplies, or other hazard to human
health, if such substance or mixture were discharged in this town. “Toxic or
hazardous materials” include, without limitation, organic chemicals, petro-
leum products, heavy metals, radioactive or infectious wastes, acids,
and alkalis, and include products such as pesticides, herbicides, solvents,
and thinners. The following activities, without limitation, are presumed to
involve the use of toxic or hazardous materials, unless and except to the
extent that anyone engaging in such an activity can demonstrate the con-
trary to the satisfaction of the board of health:

- Airplane, boat, and motor vehicle service and repair
- Chemical and bacteriological laboratory operation
- Cabinet making
- Dry cleaning
- Electronic circuit assembly
- Metal plating, finishing, and polishing
- Motor and machinery service and assembly
- Painting, wood preserving, and furniture stripping
- Pesticide and herbicide application
- Photographic processing
- Printing
Appendix H

ity of Chapter 111, Section 31, issue regulations further identifying specific materials and activities involving the use of materials which are toxic or hazardous.

Section 4. Prohibitions
(a) The discharge of toxic or hazardous materials within the Town of __________ is prohibited.
(b) Outdoor storage of toxic or hazardous materials is prohibited, except in product-tight containers which are protected from the elements, leakage, accidental damage, and vandalism, and which are stored in accordance with all applicable requirements of Section 5 of this bylaw. For purposes of this subsection, road salts and fertilizers shall be considered as hazardous materials.

Section 5. Storage Controls, Registration, and Inventory
(a) Except as exempted below, every owner, and every operator other than an owner, of a site at which toxic or hazardous materials are stored in quantities totaling at any time more than __________ gallons liquid volume or __________ pounds dry weight, shall register with the board of health the types and quantities of materials stored, location, and method of storage. The board of health may require that an inventory of such materials be maintained on the premises and be reconciled with purchase, use, sales, and disposal records on a monthly basis, in order to detect any product loss. Registration required by this subsection shall be submitted within 60 days of the effective date of this bylaw, and annually thereafter. Maintenance and reconciliation of inventories shall begin within the same 60-day period. Exemptions: Registration and inventory requirements shall not apply to:
   (1) Fuel oil stored in conformance with Massachusetts Fire Prevention Regulations and regulations of the Board of Health for the purpose of heating buildings located on the site; or
   (2) The storage of toxic and hazardous materials at a single-family or two-family dwelling, except where such materials are stored for use associated with a professional or home occupation use as defined by Section __________ of the Zoning Bylaws of the Town of __________.

(b) Toxic or hazardous wastes shall be held on the premises in product-tight containers and shall be removed and disposed of in accordance with the Massachusetts Hazardous Waste Management Act, Ch. 21C, MGLA.
(c) The board of health may require that containers of toxic or hazardous materials be stored on an impervious, chemical-resistant surface compatible with the material being stored, and that provisions be made to contain the product.

Section 6. Report of Spills and Leaks
Every person having knowledge of a spill, leak, or other loss of toxic or hazardous materials believed to be in excess of __________ gallons shall immediately report the spill or loss of same to the board of health or other public safety official.

Section 7. Enforcement
(a) The provisions of this bylaw shall be enforced by the board of health. The agent of the board of health may, according to law, enter upon any premises at any reasonable time to inspect for compliance.
(b) Upon request of an agent of the board of health, the owner or operator of any premises at which toxic or hazardous materials are used or stored shall furnish all information required to enforce and monitor compliance with this bylaw, including a complete list of all chemicals, pesticides, fuels, and other toxic or hazardous materials used or stored on the premises, a description of measures taken to protect storage containers from vandalism, corrosion, and spillage, and the means of disposal of all toxic or hazardous wastes produced on the site. A sample of wastewater disposed to on-site septic systems, drywells, or sewage treatment systems may be required by the agent of the board of health.
(c) All records pertaining to storage, removal, and disposal of toxic or hazardous materials shall be retained by the owner or operator for no less than three years, and shall be made available for review upon request of the agent of the board of health.
(d) Certification of conformance with the requirements of this bylaw by the board of health shall be required prior to issuance of construction and occupancy permits for any nonresidential uses.

Section 8. Violation
Written notice of any violation of this bylaw shall be given to the owner and operator by the agent of the board of health, specifying the nature of the violation; and corrective measures that must be undertaken, including containment and cleanup of discharged materials; and preventive measures required for avoiding future violations; and a schedule of compliance. Requirements specified in such a notice shall be reasonable in relation to the public health hazard involved and the difficulty of compliance. The cost of containment and cleanup shall be borne by the owner and operator of the premises.
Appendix B-4

Model Health Regulations
To Prevent Leaking of Underground Fuel
and Chemical Storage Systems

Cape Cod Planning and Economic Development Commission, 1982

Under Chapter 111, Section 31 of the Massachusetts General Laws, the Board of Health hereby adopts the following regulations to protect the ground and surface waters from contamination with liquid fuel or toxic materials from leaking storage tanks. The following regulations apply to all underground fuel and chemical storage systems of 1,000 gallons or greater.

Section 1. Definitions

"Abnormal loss or gain" shall mean a loss or apparent gain in product exceeding 0.5 percent of the volume of product used or sold.

"Operator" shall mean the lessee or person(s) in control of and having responsibility for the daily operation of the facility for the storage and dispensing of flammable and combustible liquids.

"Owner" shall mean the person(s) who owns, as real property, the tank storage system used for the storage and dispensing of flammable and combustible liquids.

Section 2. Tank Registration

(2.1) Every owner of an underground gasoline, fuel, or chemical storage system shall file with the board of health the size, type, age, and location of each tank, and the type of material stored, on or before __________. Evidence of date of purchase and installation, including fire department permit shall be included.

(2.2) Owners of tanks for which evidence of installation date is not available shall at the order of the board of health have such tanks tested or uncovered for inspection. If in the opinion of the agent of the board of health or head of the fire department, the tank is not product-tight, it shall be removed.

Section 3. Inventory Control

(3.1) Every underground storage system shall have a method of accurately gauging the volume contained in the tank and a method of accurately metering the quantity of product removed during service. The metering device shall be maintained in accurate calibration. Storage systems in service at the time of passage of this regulation shall be in compliance within 90 days of the effective date of this regulation.

(3.2) Accurate daily inventory records, as required by Mass. Fire Prevention Regulations-527 CMR 5.05 (3), shall be based on actual daily measurement and recording of tank product and water levels and the daily recording of actual sales, use, and receipts. The inventory records shall include a daily computation of gain or loss. The mere recording of pump meter readings and product delivery receipts shall not constitute adequate inventory records.

(3.3) The owner and operator shall participate in a program of regularly scheduled inventory verification. Frequency of inventory verification shall be as follows: annually, for systems from which less than 25,000 gallons/month of product is sold or used; semiannually for systems from which 25,000-100,000 gallons/month of product is used or sold; quarterly for systems from which more than 100,000 gallons/month is used or sold. Owners shall submit annually to the board of health a certified statement that inventory records have been maintained and reconciled as required by Massachusetts fire prevention regulations. Such records shall be made available to the board of health upon their request.

Where the storage tanks are owned by the operator, inventory verification shall be performed by a certified auditor or other independent qualified person approved by the board of health.

(3.4) All steel tanks shall be subject to a Petro-Tite
204

(Kent-Moore) Pressure Test or any other pressure test providing equivalent safety and effectiveness 15 years after installation and annually thereafter. The 5 PSI air pressure test is a recognized method of leak detection but is not recommended since it can cause explosions.

(3.5) Nonconforming steel tanks installed prior to January 1, 1960, shall be removed and properly disposed of by _____________________. All other nonconforming steel tanks installed prior to the effective date of this regulation shall be removed when 20 years old. At such time, the exhumed tank shall be examined for leaks. If a leak exists, an investigation of amount and location of spilled substance shall be undertaken at the expense of the owner. If, in the opinion of the agent of the board of health, the spilled substance poses a significant threat to health and safety, it shall be removed by the owner.

Section 4. Report of Leaks or Spills
(4.1) Any persons who is aware of a spill or abnormal loss of product shall report such spill or loss immediately to the head of the fire department and, within two hours, to the board of health.
(4.2) All leaking tanks must be emptied within 24 hours of leak detection and either removed or repaired within a time specified by the board of health, under the direction of the head of the fire department.
(4.3) Service companies shall report to tank owners and the board of health any unaccounted for significant increase in heating fuel consumption that may indicate a leak.
(4.4) All tank installations within four feet of a surface water body shall be of fiberglass construction.

Section 5. Tank Selection and Installation
(5.1) All tanks shall be properly installed as per Massachusetts Fire Prevention Regulations and manufacturers specification, under the direction of the head of the fire department. Tanks shall be of approved design and protected from internal and external corrosion. The following tank construction systems are considered to provide adequate corrosion protection: all-fiberglass construction; steel with bonded fiberglass or enamel coating and noncorrosive internal lining, and the Steel Tank Institute 3-Way Protection System. All underground storage of chemicals other than gasoline and fuel shall be contained in tanks approved by the agent of the board of health. Any other system must be shown to provide equivalent protection.
(5.2) Tanks shall be installed by a manufacturer's approved installation contractor.
(5.3) If it is necessary to replace or interior-coat an underground steel tank that developed a corrosion-induced leak, all other steel tanks at the facility that are the same age or older whether or not they are leaking shall be interior-coated or replaced with tanks that meet the requirements of 5.1.
(5.4) If a cathodic protection system is installed, an ongoing monitoring and maintenance program shall be conducted. If sacrificial anodes have been installed, their proper operation shall be confirmed by a qualified person at least once a year.
(5.5) The operator shall notify the head of the fire department prior to the commencement of tank installation. The head of the fire department or the board of health may require repair of protective coatings prior to installation or final cover.

Section 6. Product Storage at Residential Sites
(6.1) Following the effective date of this regulation, the installation of underground fuel, gasoline, or other chemical storage tanks on single-family or two-family residential sites is prohibited.
(6.2) All fuel, gasoline, or other chemical tanks in service at single-family or two-family residential sites on the effective date of this regulation shall be removed from service 30 years after the date of installation. If the date of installation is unknown, it shall be assumed to be January 1, 1960.

Section 7. Proximity to Water Supplies
(7.1) The installation of subsurface fuel, gasoline, or other chemical storage systems within 2,000 feet of a public water supply well is prohibited.
(7.2) The board of health may require the installation of one or more groundwater observation wells at any site where fuel, gasoline, or other chemical is stored underground within 2,000 feet of a public or private water supply well. Water samples from such observation wells may be required by the board of health at any reasonable time and shall be analyzed at the expense of the owner at the order of the board of health.

Section 8. Costs
In every case, the operator shall assume responsibility for costs incurred necessary to comply with this regulation.

Section 9. Variances
(9.1) Variances from this regulation may be granted by the board of health after a hearing at which the applicant establishes that the installation or use of an underground storage tank will not adversely affect public or private water resources.
(9.2) In granting a variance, the board will take into consideration the direction of the groundwater flow, soil conditions, depth to groundwater, size, shape, and slope of the lot, existing and known future water supplies.
APPENDIX H

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