GROUND-WATER PROTECTION REPORT FOR DORCHESTER COUNTY

PREPARED FOR:

DORCHESTER COUNTY DEPARTMENT
OF PLANNING AND ZONING
DORCHESTER COUNTY DEPARTMENT OF HEALTH

JUNE 1988

PREPARED BY:

GERAGHTY & MILLER, INC.
GROUND-WATER CONSULTANTS
ANNAPOLIS, MARYLAND

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

INTRODUCTION

The State of Maryland is committed to protect the physical, chemical, and biological integrity of the (State's) ground-water resources in order to protect human health and the environment, to insure that an adequate supply of the resource is available and that in all situations to manage that resource for the greatest beneficial use of the citizens of the state.

Maryland Ground-Water Steering Committee

Ground water is an extremely valuable natural resource to the citizens of Dorchester County. Ground water is the sole source of drinking water and is essential for both industry and agriculture. The protection of the Dorchester County ground-water resources involves the control of many potential sources of contamination such as underground storage tanks, landfills, lagoons, and the subject of this report, on-site wastewater disposal.

Maryland's regulations for on-site sanitary wastewater disposal in areas where public sewer systems are unavailable were modified in 1985 to better account for the protection of ground-water resources[1]. These regulations address the siting and design of on-site sanitary wastewater disposal systems. The principal mechanism for protecting ground-water resources is the recognition of a 'treatment zone' to occur beneath a septic system infiltration trench. The mandated treatment zone consists of four feet of unsaturated, unconsolidated material sufficient to attenuate effluent below the bottom of the on-site sewage disposal system prior to the waters recharging the uppermost ground-water unit.

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1 COMAR 10.17.02, entitled "sewage disposal systems for homes and other establishments in the Counties of Maryland where a public sewage system is not available."

The 1985 regulations allow for on-site sanitary wastewater disposal systems to be sited in areas where less than four feet of treatment zone is present under specific hydrogeologic conditions, providing a management plan to protect ground-water resources is in place. Such a reduction in the treatment zone thickness is commonly referred to as "ground-water penetration." The Dorchester County Commission has chosen to allow such siting where these specific conditions are met. This ground-water protection report describes those areas in Dorchester County where such conditions may likely occur and presents the proposed management approach to protect the County's vital ground-water resources in the context of on-site sanitary wastewater disposal.

The intent of the ground-water protection reporting effort in Dorchester County was to systematically assess available ground-water resources, in order to develop water supply and on-site sanitary wastewater disposal management strategies appropriate to protect near surface ground-water aquifers for their current and potential use as water supplies. The management plan presented in this report provides a tool for both the development community and public health authorities to achieve needed on-site wastewater disposal and water supply. The report reflects county-wide differences in hydrogeologic conditions and accepted sanitary wastewater disposal practices. The proposed management practices were selected in order to meet State of Maryland criteria and are considered to be protective of groundwater resources.

Report Preparation

The preparation of the Dorchester County Ground-Water Protection Report involved collecting information on existing soil and hydrogeologic conditions, delineating management areas on the basis of information collected, and developing appropriate management strategies for each area.

Geraghty & Miller, Inc. (G&M) was responsible for collecting information pertaining to management Areas A and C (see Figure 1). This information was included in a Phase I report completed in July 1987. Information pertaining to Area B was collected by the Maryland Department of the Environment, Division of Residential Sanitation. Using the information obtained, G&M developed management strategy options for each area. These options were used by the Dorchester County Division of Environmental Health, in conjunction with the Maryland Division of Residential Sanitation, to develop a final, county-wide management plan.

BACKGROUND INFORMATION

Contaminant Migration

The contaminants of concern associated with on-site sanitary wastewater disposal are bacteria, viruses and certain inorganic compounds such as chloride, sulfate, phosphate and primarily, nitrate. The soil is capable of treating these contaminants to such a degree, providing the proper conditions are met, that the water is of acceptable quality for discharge to the groundwater (USEPA, 1980). Attenuation mechanisms influenced by soil properties include mechanical filtration, volatilization, dispersion, chemical and biochemical alterations, oxidation-reduction, ion exchange and biodegradation.

Soil media characteristics including grain size/ texture, porosity (primary and macro/secondary), and permeability influence contaminant transport and both mechanical and chemical attenuation processes. A longer path length and contaminant travel time through the soil allows for the maximization of attenuation processes.

In general, a smaller grain size provides more mechanical filtration than a larger grain size. The decrease in porosity and slower permeabilities of fine-grained materials also increases contaminant travel times and thus increases the contact time of the contaminant with oxygen or the surrounding media.

Oxidation/reduction reactions are controlled by the presence of oxygen in the soil media. Redox reactions may, in some cases, help to attenuate certain contaminants by decreasing their solubility. For example, some heavy metals are prevented from leaching because of the formation of insoluble metal oxides that result from oxidation. However, other oxidation/reduction reactions produce highly soluble salts that can be easily leached to the groundwater.

The oxidation of ammonium to nitrate is of particular concern to on-site wastewater management. Nitrate is the most common contaminant identified in groundwater and is becoming increasingly widespread because of agricultural activities and sewage disposal on and beneath the land surface. Nitrate is the stable form of dissolved nitrogen in the oxygen-rich groundwater environment and is not attenuated to any significant degree (Freeze and Cherry, 1979).

The elimination of bacteria and viruses from the wastewater results from the combined efforts of physical (including temperature), biological, and chemical conditions. Elimination is faster at high temperatures, at pH values of about 7, at low concentrations, and at high levels of dissolved carbon. These conditions activate natural bacteria which act antagonistically towards the pathogenic microorganisms in the waste material (USEPA, 1987). Virus survival is controlled by the climate, clay content and moisture-holding capacity of the soil. Viruses are very persistent and can migrate considerable vertical and horizontal distances. In general, longer residence times in the soil allow for natural die off to occur, thus diminishing virus concentrations (USEPA, 1987).

All of the above mentioned attenuation mechanisms continue to occur in the saturated zone. They are, however, less effective under saturated conditions (USEPA, 1987). Thus a high water table diminishes the treatment capacity of the soil by decreasing the unsaturated zone (USEPA, 1987). The principal attenuation mechanism operating in the saturated zone in dilution. Nitrate concentrations, in particular, are controlled by dilution. Bacteria and virus die off also continues to occur in the saturated zone (see

Table 1). Research appears to indicate, however, that certain organisms can persist for longer periods of time in a low temperature, oxygen-rich ground-water environment (USEPA, 1987).

Treatment Zone Concept

A combination of soil texture and permeability, in combination with distance to the water table, provides the basis for the treatment zone concept employed to treat waste water from on-site disposal systems. The bulk of available data and research indicates that a two- to four-foot depth of suitable, unsaturated soil material will provide a high degree of treatment of septic tank effluent. It has been reported that such a treatment zone provides that almost complete removal of Chemical Oxygen Demand, (COD), Biological Oxygen Demand (BOD), suspended solids, and phosphorus and significant removal of bacterial contaminants can be achieved. Data to support similar reduction of viruses are not as conclusive.

Other chemical constituents, such as nitrogen, exchangeable cations, chloride, sulfates, sulfides, other anions and trace organics, undergo various reactions in the soil treatment zone and may be attenuated to different degrees. Many of these chemical constituents are not attenuated to any great extent and over time will move downward with soil waters and mix with underlying ground waters. Increases in total dissolved solids, chlorides and nitrate-nitrogen of ground waters may be experienced. The significance of these impacts and the resulting degradation of ground-water quality becomes more important as densities of on-site wastewater disposal systems increase. Cumulative effects of impacts from on-site wastewater disposal systems, and other sources of contaminants associated with suburban land use, have

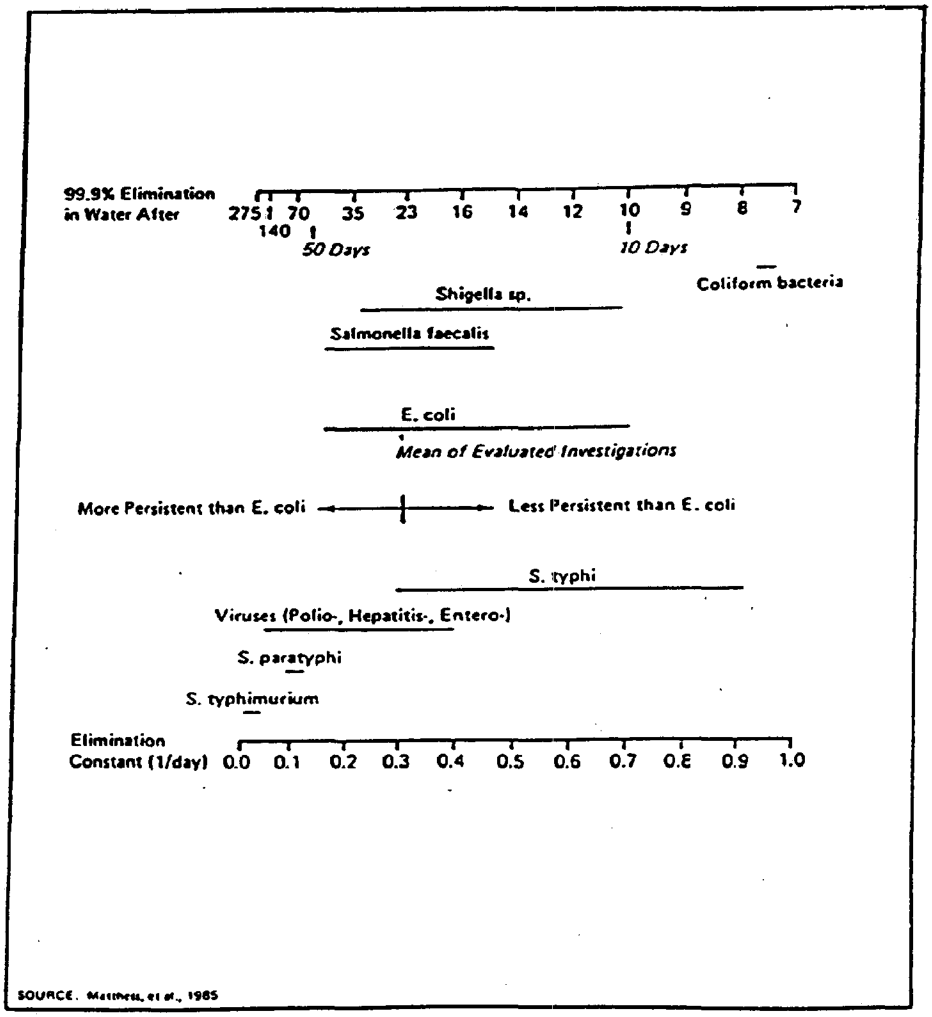

Table 1. Elimination Constant and 99.9% Elimination of Some Relevant Bacteria and Viruses in Ground Water. (USEPA, 1987)

produced significant ground-water pollution in some areas along the Atlantic coast.

The depth of unsaturated soil material below the bottom of on-site systems that is needed for adequate treatment is primarily dependent on site-specific soil properties. Soil properties, such as clay content and mineralogy, percent of rock fragments, and permeability, will have the greatest effect on the degree of treatment of septic tank effluent. Generally, soils with rapid permeabilities may require greater unsaturated depths than soils with slow permeability to achieve the same level of treatment. In some instances of rapid and very rapid permeabilities, even four feet will not provide adequate treatment. It is generally recognized that two to four feet of unsaturated soil provides effective treatment.

With the 1985 regulations, the State has adopted a four-foot treatment zone, not only to provide a high degree of treatment, but for two additional, practical reasons. These reasons involve 1) the difficulty of estimating accurately depth to the seasonal high water table based on minimal observations, and 2) typical installation problems that often result in actual treatment zone depths being less than design depths. Use of a four-foot treatment zone allows for a reasonable margin of safety when considering the practical limitations of evaluating sites and installing systems.

The presence of an unsaturated soil treatment zone will not provide complete treatment of all constituents in septic system effluent waters. Some alteration of ground-water quality in the vicinity of the infiltration field will occur regardless of thickness and soil properties of the treatment zone. While the majority of pathogens and particulate will be removed, various species of nitrogen (particularly nitrates) and inorganic ions such as chlorides will not be significantly removed. For this reason, other management practices, in addition to the treatment zone requirement (i.e., density controls, and well construction controls), may be necessary to more fully protect ground waters that serve as sources of drinking water.

Conditions for Relaxing Treatment Zone Requirement

Maryland Health regulations allow for the use of on-site sanitary wastewater disposal systems with less than four feet of treatment zone if

a) The receiving aquifer had been designated as Type III (other than Type I or Type II), pursuant to COMAR 10.50.01; or

b) The receiving aquifer has limited potential to serve as a drinking-water source. Criteria for determining that an aquifer has a limited potential to serve as a drinking-water source are:

i) Provision of insufficient potable water to serve as a year-round supply due to seasonally fluctuating water tables,

ii) Interconnection with tidewater such that if pumped for water supply, brackish water or saltwater intrusion into the aquifer has or would occur,

iii) Depth to ground water would preclude on-site wastewater disposal except by ground-water penetration and there is evidence the aquifer has already been polluted by, or is in imminent danger of being polluted by, agricultural or other potentially polluting activities in the area.

Current Management Practices

Many areas within Dorchester County have a seasonally high water table at depths that cannot provide the four-foot treatment zone. Previous regulations have allowed Dorchester county, along with Talbot, Wicomico, Somerset, and Worchester Counties, to discharge septic-tank effluent directly into shallow aquifers under the following conditions:

1. Areas of utilization should be confined to those portions of each county where surface soil formations consist of a thick layer of impermeable clay underlain with extensive deposits of water-bearing sand.

2. A minimum separation distance of 150 feet should be maintained between any individual water supply and sewage disposal facilities.

3. Maximum density of housing in these areas should not exceed 160 residences per square mile.

4. Systems are to be empirically sized based on county experience.

5. Wells for potable water supply utilizing shallow aquifers may not be permitted if on-site systems discharge directly to ground water.

This practice has been referred to as ground-water penetration and is used routinely in these counties on necks, peninsulas and islands.

Other coastal plain counties, while prohibited by regulation from using ground-water penetration, have utilized treatment zones that vary from less than one to greater than four feet. Several of these counties have been granted variances to allow ground-water penetration. In addition, many counties have had to resort to ground-water penetration occasionally to remodel failing on-site systems when no other conventional alternative was available.

Local county health departments that routinely use ground water penetration have not associated any major public health problems with these systems. Extensive monitoring and well-documented studies of the impact of these systems on ground water or surface waters, however, have not been conducted.

MANAGEMENT STRATEGIES

Management Area Delineation

Management area evaluation and delineation was made on the basis of hydrogeologic conditions and existing aquifer water quality and use patterns. Hydrogeologic conditions considered included the presence of confining layers and existing soil conditions. The presence of a confining layer between the waste disposal system and the water supply aquifer can act to inhibit or prevent downward migration of contaminants. In cases where there is no confining unit, soil conditions become more important in management area delineation. The thickness and type of soils present in the unsaturated zone controls, primarily, the degree of treatment provided to the wastewater. A thick unsaturated zone with fine-grained soils (loamy texture) provides better treatment than one that is less deep or has sandy soils.

Aquifer water quality and use patterns were also considered when delineating management areas. Stringent protection must be provided to those areas where the uppermost unconfined aquifer is being used as a water supply source. Less stringent protection may be applied to those areas where the uppermost aquifer is of poor quality, or where there is a deeper, confined aquifer of sufficient quality and yield to be a drinking water source.

Pertinent existing hydrogeologic information was compiled to determine the presence of shallow confining units, determine ground-water quality in the surficial aquifer, examine ground water use for drinking water, and to determine, in general, soil types and depth to the water table. Map Sheet 1 shows the location of well logs that were used to assess ground water conditions in Dorchester County.

See Appendix A for a detailed discussion on investigation methods and information obtained from the study.

Three management areas were identified as shown in Figure 1 and Map Sheet 2. Area A can be characterized as having little or no shallow confining material and is subject to maximum protection of the near surface water-supply aquifer. Area B includes those areas where more than 5 feet of shallow confining material separates shallow permeable layers used for disposal of sewage effluent from deeper water-supply. Area B appears to require less stringent protection than Area A. Area C encompasses a portion of the county for which insufficient data are available to map an areally extensive shallow confining unit of at least 5 feet in thickness. An interim management strategy has, therefore, been developed until sufficient data is obtained. It is anticipated that Area C will eventually be reclassified as Area B.

Area B has been subdivided into two subareas: Area B2 in the southwestern part of the County where ground-water elevations are commonly near ground surface and septic systems may penetrate ground water year-round, and Area B1 in the northwestern part of the County bordering the Choptank River where septic systems may have a reduced treatment zone, and will likely penetrate ground water only on a seasonal rather than year-round basis.

It should be stressed that areas outlined on the map in Figure 1 are generalized and based on limited data in some places. Within each management area there may be localized areas which require reclassification when additional data becomes available. The distribution of the management areas will be discussed in greater detail subsequently.

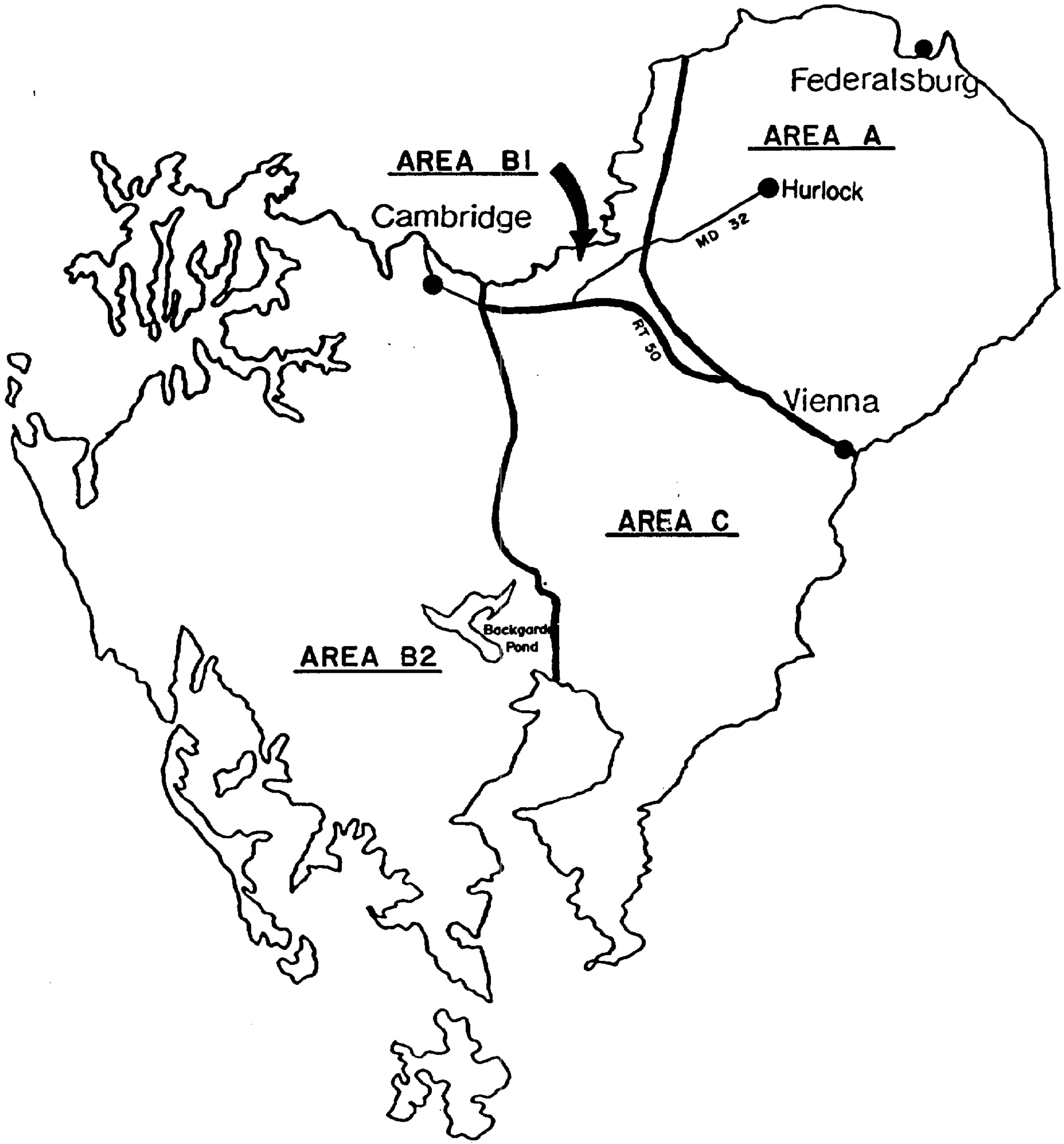

FIGURE 1.

MANAGEMENT AREAS FOR DORCHESTER COUNTY

A management strategy, based on the likelihood of ground-water contamination due to on-site waste disposal systems, has been developed for each of the four management areas. This strategy seeks to combine knowledge of existing hydrogeologic conditions, available treatment zone geometries and aquifer use and quality information with certain management practices to insure that existing and potential water supplies are fully protected. Management practices include consideration of land development densities, well construction practices, on-site waste disposal methods, and site investigation requirements.

Management Strategy: Area A

Management Area A is outlined on Figure 1. It is comprised of the northeastern portion of the County which is underlain by thick, permeable sands and gravels of the Kent Island, Beaverdam Sand and Pensauken Formations. Few areally extensive confining units are found at shallow depth (i.e., within 25' of ground surface) across Area A. These formations currently provide water supplies and have future water supply potential (see Figure 2), but have limited near-surface confining material to provide protection of the aquifer from near-surface sources of contamination.

To protect the existing and potential water supplies available from shallow aquifers in Area A, sewage disposal practices which maximize effluent treatment should be employed. Table 2 presents on-site sewage disposal and water supply options which are appropriate to provide the required protection. The most applicable technology must be determined through on-site evaluation of each site (including soil, topography, and drainage characteristics). A reduction of the minimum four-foot soil treatment zone can be allowed where finer soil textures or fill materials along with in-situ soils can provide adequate sewage effluent renovation

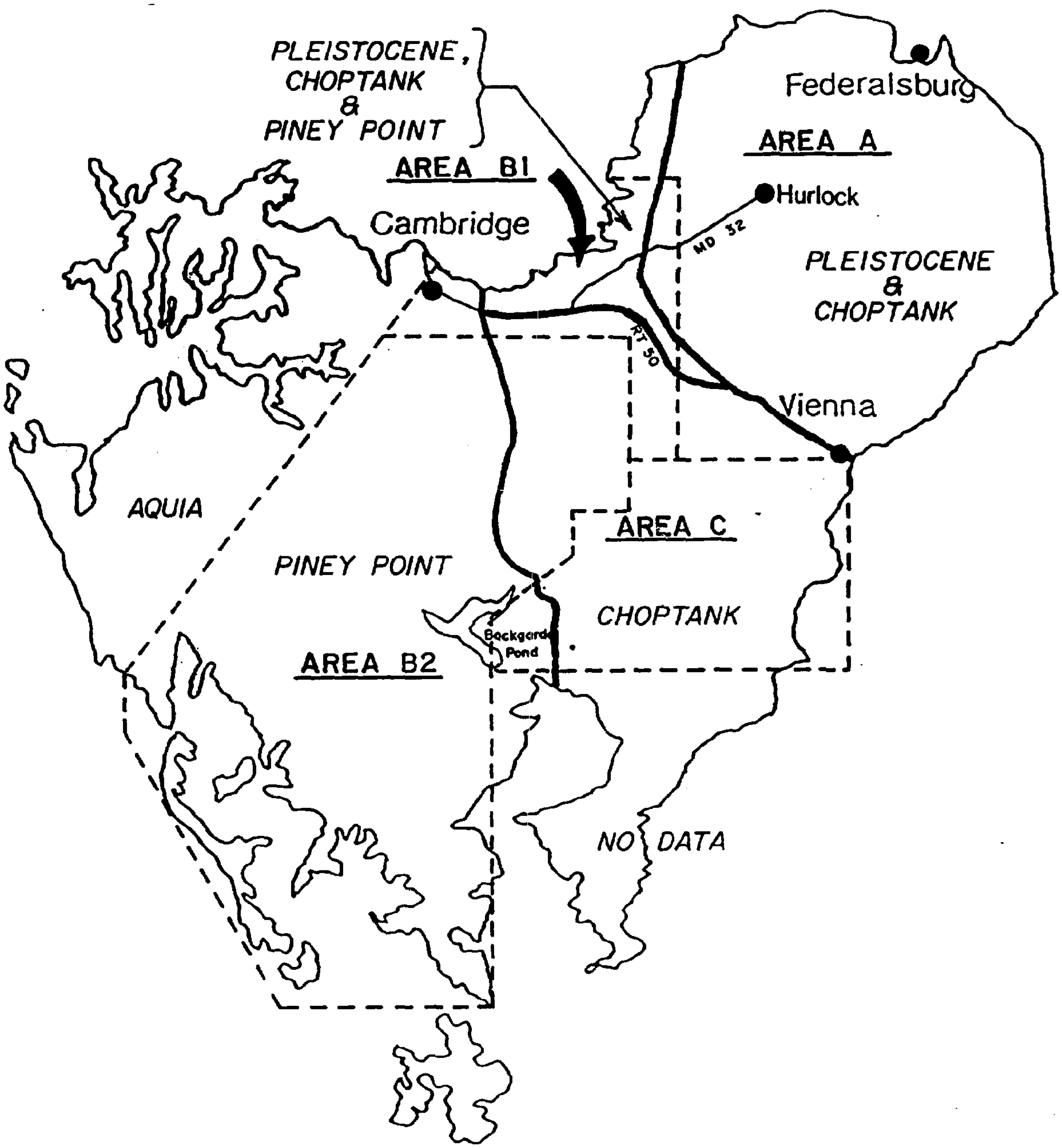

FIGURE 2.

AQUIFER USE AREAS FOR DORCHESTER COUNTY

TABLE 2. MANAGEMENT STRATEGY AREA A

Unsaturated Natural Soil Thickness Beneath Bottom of Sewage Disposal Trenches	Soil Texture	Minimum Lot Size	SEWAGE DISPOSAL OPTIONS AND REQUIREMENTS		Aquifer Type	Minimum Separation Distance: Wells & SDS/SRA	Minimum Depth	Minimum Grouting Depth
			Conventional	Alternative				
1. > 4'	All	Based on zoning & COMAR 10.17.02 & 10.17.03 requirements	Gravity trench	Shallow Pressure Dosing Trench	Unconfined	100'	50'	Top of Screen
					Confined	50'	N/A	COMAR 10.17.13 Requirements
2. 2' - 4'	All	Based on zoning & COMAR 10.17.02 & 10.17.03 Requirements		Sand Mound	Unconfined	100'	50'	Top of Screen
					Confined		N/A	COMAR 10.17.13 Requirements
3. 2' - 4'	Sandy Loam or Finer	2 acres	Gravity trench	Shallow Pressure Dosing Trench (a)	Unconfined	100'	50'	Top of Screen
					Confined		N/A	COMAR 10.17.13 Requirements

(a) At grade sand mounds may be utilized provided all other requirements are met.

for most wastewater constituents of concern (e.g., microorganisms, organic matter, solids, and phosphorus). Protection of valuable surficial aquifers from nitrogen pollution is provided by controlling on-site system density with minimum lot sizes. Minimum lot sizes of two acres provides a mechanism for dilution which should help ensure ground-water levels of NO_3-N will remain at or below 10 mg/l where this level is not already exceeded (see Appendix C for nitrogen dilution calculations).

Sewage disposal trenches should always be installed to maximize the soil treatment zone (i.e., as shallow as possible) utilizing above-grade fill, if necessary. At grade sand mounds may be utilized provided all other requirements are met. The thicker the treatment zone utilized, the better the sewage effluent renovation derived.

A minimum well depth of 50 feet is recommended to provide protection against nitrate pollution from surface sources in the recent past. Additional protection should be afforded to wells in Area A by requiring well construction in the unconfined aquifers to include grouting to the top of the screen. Grouting should be completed from the top of the screen up to the surface, using a tremie pipe to insure that a complete seal is obtained.

In areas such as Area A, in which there are valuable surficial ground-water supplies, care should be taken to eliminate introduction of household chemicals (e.g., solvents, degreasers, pesticides, etc.) into the ground through septic systems. Homeowners should be informed of the risks to sewage disposal systems and to water supplies, in particular their own, from such activities and appropriate alternative disposal options.

Management Strategy: Area B1

Management Area B1 is outlined on Figure 1. It is comprised of a small portion of Dorchester County which lies just to the west of Management Area A bordering the Choptank River. It is underlain by deposits of the Kent Island Formation lying atop older Miocene sediments of the Chesapeake Group. Confining beds in the Kent Island Formation may seasonally perch ground-water which cannot provide year-round water supplies. Confining material within a 25-foot depth below ground surface provides for protection of the underlying Miocene water-supply aquifers.

Table 3 presents on-site sewage disposal and water supply options which are appropriate for the hydrogeologic conditions prevalent in Area B1. These options allow for direct penetration of shallow ground water which may often be of a seasonal nature. Given proper well construction requirements, existing and potential water supply resources available in the underlying confining aquifers should be adequately protected.

As in Area A, soil treatment zone thickness should be maximized to reduce pollutant impacts on surface waters from shallow ground-water discharges and to optimize system hydraulic performance. Minimum lot sizes of two acres are set in order to achieve dilution where less than 4 feet of unsaturated soil treatment zone is employed (see Appendix C for nitrogen dilution calculations). Again, the most applicable disposal technology within the options given must be determined from site-specific characteristics assessed in a field evaluation.

Well construction practices shall preclude the use of unconfined aquifers and require wells to be grouted through the disposal stratum to the top of the screened interval

TABLE 3. MANAGEMENT STRATEGY AREA B1

Unsaturated Natural Soil Thickness Beneath Bottom of Sewage Disposal Trenches	Soil Texture	Minimum Lot Size	SEWAGE DISPOSAL OPTIONS AND REQUIREMENTS		Aquifer Type	Minimum Separation Distance: Wells & SDS/SRA	Minimum Depth	Minimum Grouting Depth
			Conventional	Alternative				
1. > 4'	All	Based on zoning & COMAR 10.17.02 & 10.17.03 requirements	Gravity trench	Shallow Pressure Dosing Trench	Confined	100'	N/A	Top of Screen
2. 2' - 4'	All	Based on zoning & COMAR 10.17.02 & 10.17.03 Requirements		Sand Mound	Confined	100'	N/A	Top of Screen
3. 1' - 4'	All	2 acres	Gravity trench	Shallow Pressure Dosing Trench (a)	Confined	100'	N/A	Top of Screen
4. 0'	All	2 acres		Sand Lined Trench	Confined	150'	N/A	Top of Screen

(a) At grade sand mounds may be utilized provided all other requirements are met.

using a tremie pipe. The well driller shall inform the Dorchester County Health Department prior to the grouting of wells constructed in Area B1 such that they may send a representative to inspect the grouting operation. The Health Department has set, as a minimum goal, the inspection of 10% of all wells constructed in Management Area B1. A record of inspection shall be maintained for their files. A minimum separation distance of 100 feet shall be maintained between any sewage disposal or reserve wastewater area and any water supply wells where an unsaturated soil treatment zone of 1 to 4 feet in thickness is employed. A minimum separation distance of 150' shall be maintained between any sewage disposal or reserve area and any water supply well where direct ground-water penetration will occur.

Management Strategy: Area B2

Management Area B2 is outlined on Figure 1. It is comprised of the southwestern portion of Dorchester County. It is characterized by areally extensive surficial confining beds of the Kent Island Formation which protect the underlying confined aquifers from the downward movement of surface and near-surface contaminants. Water supplies in Area B2 are derived principally from confined aquifer wells in the Piney Point and the Aquia formations (see Figure 2).

Table 4 outlines on-site sewage disposal system and water supply options which are appropriate for the hydrogeologic conditions prevalent in Area B2. These options allow for direct penetration of shallow ground water which, given proper well construction requirements, should protect existing and potential water supply resources available in the underlying confined aquifers. Large areas of poorly drained and slowly permeable soils, such as the Othello series, predominate in Area B2 and indicate the most likely option to be employed, as it has in the past, will be direct

TABLE 4. MANAGEMENT STRATEGY AREA B2

Unsaturated Natural Soil Thickness Beneath Bottom of Sewage Disposal Trenches	Soil Texture	Minimum Lot Size	SEWAGE DISPOSAL OPTIONS AND REQUIREMENTS		Aquifer Type	Minimum Separation Distance: Wells & SDS/SRA	Minimum Depth	Minimum Grouting Depth
			Conventional	Alternative				
1. > 4'	All	Based on zoning & COMAR 10.17.02 & 10.17.03 requirements	Gravity trench	Shallow Pressure Dosing Trench	Confined	100'	N/A	Top of Screen
2. 2' - 4'	All	Based on zoning & COMAR 10.17.02 & 10.17.03 Requirements		Sand Mound	Confined	100'	N/A	Top of Screen
3. 1' - 4'	All	2 acres	Gravity trench	Shallow Pressure Dosing Trench (a)	Confined	100'	N/A	Top of Screen
4. 0'	All	2 acres		Sand-Lined Trench	Confined	150'	N/A	Top of Screen
5. 0'	All	4 acres for Parcel of Record 5 acres in a subdivision		bermed infiltration ponds	Confined	150'	N/A	Top of Screen

(a) At grade sand mounds may be utilized provided all other requirements are met.

ground-water penetration. However, where surface soils are better drained and more permeable, wastewater disposal systems employing an unsaturated soil treatment zone should be utilized as the favored alternative given reasonable indication of satisfactory hydraulic performance. Minimum lot sizes are required to provide dilution and filtration to minimize degradation of ground and surface water resources (see Appendix C for nitrogen dilution calculations).

As in Area B1, well construction practices shall preclude the use of unconfined aquifers and require wells to be grouted through the disposal stratum to the top of the screened interval using a tremie pipe. Well drillers shall inform the Dorchester County Health Department prior to grouting. The County has set, as a minimum goal, the inspection of 10% of all wells constructed in Area B2. A record of inspection shall be maintained for their files.

A minimum separation distance of 100' will be required between water supply wells and sewage disposal systems and reserve areas employing an unsaturated soil treatment zone. A minimum separation distance of 150' will be required between water supply wells and sewage disposal systems and reserve areas utilizing direct ground-water penetration.

<u>Management Strategy: Area C</u>

Management Area C is outlined on Figure 1. It is comprised of the southeastern portion of Dorchester County. It is underlain by deposits of the Kent Island Formation lying atop the sands and gravels of the Beaverdam Sand and Pensauken Formations. Inadequate data exist for Management Area C to characterize the areal extent of near-surface confining beds and their thickness. Existing well records indicate water supplies are derived primarily from deep confined aquifers such as the Piney Point (see Figure 2).

The exception is Elliott Island, where shallow driven wells tap the unconfined Parsonburg Sand atop the Kent Island Formation. Hydrogeologic studies required for major subdivisions (5 lots or more) and physical logging of near surface sediments by the Environmental Health Division, Dorchester County Health Department, for new water supply wells should augment existing data sufficiently to allow an eventual reclassification of Area C as either a Management Area A or B; the latter being most likely.

Table 5 outlines on-site wastewater disposal system and water supply options appropriate to protect existing and potential water supply resources until further data can be collected.

Soil treatment zone thickness should be maximized to reduce pollutant impacts on surface and ground waters and to optimize system hydraulic performance. A minimum one-foot thick unsaturated soil treatment zone will be required. Minimum lot sizes of 2 acres are required where a treatment zone of less than 4 feet is utilized in order to provide dilution and filtration to minimize degradation of ground and surface water resources (see Appendix C for nitrogen dilution calculations).

Well construction practices shall preclude future use of unconfined aquifers and require wells to be grouted through the disposal stratum to the top of the screened interval using a tremie line. Well drillers shall inform the Environmental Health Division, Dorchester County Health Department, prior to installing new wells and grouting, to allow County personnel to physically log near-surface sediments during drilling and inspect grouting. The Environmental Health Division, Dorchester County Health Department, has set as a minimum goal the inspection of 10% of new well construction grouting. A record of inspection

TABLE 5. MANAGEMENT STRATEGY: AREA C

Unsaturated Natural Soil Thickness Beneath Bottom of Sewage Disposal Trenches	Soil Texture	Minimum Lot Size	SEWAGE DISPOSAL OPTIONS AND REQUIREMENTS		Aquifer Type	Minimum Separation Distance: Wells & SDS/SRA	Minimum Depth	Minimum Grouting Depth
			Conventional	Alternative				
1. > 4'	All	Based on zoning & COMAR 10.17.02 & 10.17.03 requirements	Gravity trench	Shallow Pressure Dosing Trench	Confined	100'	N/A	Top of Screen
2. 2' - 4'	All	Based on zoning & COMAR 10.17.02 & 10.17.03 Requirements		Sand Mound	Confined	100'	N/A	Top of Screen
3. b,c 1 - 4'	All	2 acres	Gravity trench	Shallow Pressure Dosing Trench (a)	Confined	100'	N/A	Top of Screen

(a) At grade sand mounds may be utilized provided all other requirements are met.

(b) The sanitarian assigned to evaluate the applicant's lot shall determine if adjacent properties have shallow wells likely to be in the same stratum that is to receive the sewage effluent. If the adjacent property has a shallow well, a 200 ft. separation between shallow welll and septic system is required.

(c) An alternative to the 200 ft. separation is to require the applicant to replace the neighboring shallow well with a deeper well screened in a confined aquifer.

shall be retained for their files. A minimum separation distance of 100' will be required between water supply wells and sewage disposal systems and reserve areas.

Innovative and Experimental On-Site Sewage Disposal Systems

The State Department of the Environment has an effective program to develop innovative/alternative on-site sewage disposal systems. Although the experimental systems are not listed in Tables 2 through 5, their use where site conditions warrant and County personnel are available for site evaluation and monitoring is encouraged. Systems which are considered experimental will change with time as the successful systems become conventional and the unsuccessful systems are no longer used. Appendix E, Status Report to the Governor and General Assembly on the State of Maryland Innovative and Alternative On-Site Sewage Disposal Program, dated February 1987, will provide an overview of the State's program and descriptions of the innovative and alternative systems with which the State is working. This should prove useful in describing the alternative systems listed in Tables 2 through 5 as well as providing an understanding of the experimental systems being developed.

Variances

One goal of adopting a county-wide ground-water protection strategy is to employ a comprehensive rather than a piecemeal approach to ground-water resource management. Therefore, it is prudent to minimize small scale variance to the broad management areas mapped. However, as previously noted, management area boundaries are necessarily imprecise and should be subject to revision as additional data warrant. Decisions on management area placement for properties located along area boundaries will be made at the discretion of the Environmental Health Division, Dorchester County Health

Department, and supported by site-specific field data. Applicants who disagree with this determination in management fringe areas have the opportunity to provide site-specific hydrogeologic information to support a more appropriate determination.

Inclusions of one management area within the confines of another will be restricted to areas in which the total ground-water flow pattern can be adequately characterized and supports the altered area designation. Appendix D provides guidance for conducting hydrogeologic evaluations to support management area determinations and subdivision requests requiring detailed hydrogeologic information.

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APPENDIX A

SUMMARY OF GROUND WATER CONDITIONS

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SUMMARY OF GROUND WATER CONDITIONS

Methods of Investigation

Pertinent existing hydrogeologic information was compiled to determine the presence of shallow confining units, determine ground-water quality in the surficial aquifer, and to examine ground-water use for drinking water within the study area. These criteria were used to concisely determine the areas where a less than four-feet treatment zone may be allowed and to establish appropriate management practices to protect ground-water quality and underground drinking water sources.

Information and data relating to each delineation criteria were collected by the Maryland Department of Environment, Division of Residential Sanitation (Areas B1 and B2) and by Geraghty & Miller, Inc. (Areas A and C). The following is a discussion of each criteria and the methods and references used to obtain pertinent information.

Shallow/Confining Unit

In order to determine, generally, the presence of any confining units within 25 to 50 feet of land surface in the study area, lithologic descriptions from well logs were examined. Geologic logs published by the Maryland Geological Survey and the U.S. Geological Survey were considered primary sources of information (Mack et al, 1971; Rasmussen and Slaughter, 1957; Wilson, 1984). A search for lithologic data was conducted in the records of the Dorchester County Health Department, where copies of all well permits, and well completion reports including water well driller logs, are filed. Over 1000 logs were reviewed. Approximately 50 percent of the water well driller logs were unusable due to incompleteness or difficulties in interpretation. Water well driller logs are not expected to provide detailed descriptions of lithology, but were considered reliable as general indicators of geologic conditions. The log descriptions are made based on cuttings in the drilling mud, not on representative samples taken from discrete depth intervals. Thin confining units are very difficult to detect from drilling cuttings.

The collected logs were recorded on Well Data Sheets along with other information, such as the results of water-quality analysis. The log data sheets are found in Appendix F. Each log data point was then plotted on a County map (see Map Sheet 1) and the depths to the first clay or silt units were noted where such information was available. Areas likely to be underlain by a continuous confining unit within approximately 25 feet of land surface were identified when a confining layer of at least five-feet thickness was indicated consistently at approximately the same elevation (within 10 feet) in at least ten contiguous logs.

Water Quality

Water-quality data for the surficial unconfined aquifer in the study area were assembled from two sources. Basic data report No. 10 of The Maryland Geological Survey, Maryland Ground-Water Information: Chemical Quality Data (Woll, 1978) summarizes previously published shallow-aquifer, water-quality data at a small number of sites in the study area. Additionally, Dorchester County Health Department water-quality data for domestic supply wells was used. Given the objective to characterize the chemical quality of water from the surficial unconfined aquifer, data was accepted only if the depth or screened interval of the sampled well was recorded. No data from wells of 100-feet depth or greater were accepted and only data from those wells greater than 25 feet deep with an accompanying log showing no confining units above the screened interval were accepted. Data from all drive-point wells, which were assumed to be in the water-table aquifer, were accepted.

Nitrate concentration levels were the most frequently reported chemical-quality indicators. Other parameters occasionally recorded in the Dorchester County files included pH, iron, fluoride, chloride, hardness (as $CaCO_3$), ammonia, and total solids. Nitrate level, by far the most numerous data, was chosen as a general indicator of shallow ground-water quality in the study area.

Nitrate concentrations are reported in milligrams per liter (mg/l) of elemental nitrogen. Nitrate concentrations can also be reported as mg/l of NO_3, a value 4.5 times greater than a elemental nitrogen value because the three oxygen atoms are included in the weight. The nitrogen content of fertilizer is also routinely reported as elemental nitrogen. The nitrate concentration at each data point was plotted on a county-wide map and areas of apparent elevated nitrate levels (i.e., greater than 5 mg/l in at least 10 contiguous data points) were generally delineated. Map Sheet 4 shows the location of water quality data points as well as areas of elevated nitrate concentrations. Note that this map was taken from the Phase 1 report and does not reflect recent refinements of the management area boundaries. Also note that no data was available for shallow ground waters in Area B. Elevated levels of nitrate (i.e., concentrations above 3 to 5 mg/l) can be generally associated with human activities resulting in reduced ground-water quality conditions.

Ground-Water Use for Drinking Water

Well completion records submitted to the State of Maryland were used to determine the drinking water use of various aquifers in the study area. The State of Maryland Department of Health and Mental Hygiene provided a computer printout of information on all well permits, i.e., well depth and screened intervals, by Maryland grid coordinates. This information was examined for each Maryland grid cell, an area 10,000 feet by 10,000 feet. The presence of wells in each of the major aquifers was noted and mapped (see Map Sheet 1). In Area B only two representative wells in each grid cell were mapped; however, all wells listed in the well permit computer printout were used to determine aquifer use. Map Sheet 3 shows the general aquifer use patterns in Dorchester County.

Ground-Water Conditions

Information on the geology, soils, and ground-water availability in Dorchester County is available from a number of different sources. Information on soil resources can be found in the Soil Survey of Dorchester County, Maryland (Matthews, 1963). Maryland Geological Survey Report of Investigations #17 (Mack et al, 1971), #18 (Rasmussen and Slaughter, 1957), and #40 (Bachman, 1984) provide information on the hydrogeology and water resources of Dorchester County. A description of the uppermost geologic deposits and corresponding stratigraphy are found in U.S. Geological Survey Professional Paper 1067-A (Owens and Denny, 1979) and the Geologic Map of Dorchester County (Owens and Denny, 1986). These resource documents provide a basic understanding of the distribution of the shallow hydrogeologic conditions in Dorchester County important to the management of ground-water resources and on-site sewage disposal systems.

Dorchester County lies on the Atlantic Coastal Plain, a wedge-shaped mass of unconsolidated sedimentary deposits which overlie hard crystalline rocks. The stratigraphy and associated nomenclature for geologic units of the eastern shore coastal plain are indicated in Table 6. Geologic units found in Dorchester County vary somewhat from that shown in Table 6. The shoreline complex geologic unit refers to the Kent Island Formation. The upper Miocene complex (Pocomoke Aquifer, Ocean City Aquifer, and Manokin Aquifer) are absent. The surficial geologic units are the Beaverdam Formation, the Kent Island Formation, and units of the Chesapeake Group, as shown in Figure 3.

Within these geologic units are layers of water-bearing sands and gravels, referred to as aquifers, that readily supply ground water to wells. Between the aquifers are silty and clayey layers referred to as aquitards or confining units. The principal aquifers found in the study area are:

1) Pleistocene deposits referred to as the Beaverdam sand or the Columbia Formation. This aquifer also includes the Pensauken Formation from Owens and Denny (1986). The Parsonsburg sand may provide water to drive point wells in a few locations in Area C, Elliot Island, for example.

2) Sandy and shelly aquifers in the Choptank and Calvert Formations (Miocene age). In descending order, these aquifers may be referred to in other literature as the Frederica Aquifer (Choptank Formation), Federalsburg Aquifer (Calvert Formation), and Cheswold Aquifer (Calvert Formation).

3) Sands of the Piney Point Formation (Eocene).

4) The Aquia Formation.

TABLE 6
COASTAL PLAIN STRATIGRAPHIC NOMENCLATURE AND AQUIFERS OF THE EASTERN SHORE OF MARYLAND (FROM BACHMAN, 1984)

System	Series (Group)	Geologic Unit	Thickness (feet)	Hydrogeologic Unit(s)	Dominant Lithologic Character
QUATERNARY & TERTIARY (?)	Holocene	Holocene deposits	0 - 40	—	Soil, alluvial sand and silt, dune sand, and peat. Disconformable base.
QUATERNARY & TERTIARY (?)	Pleistocene and Pliocene (?) (Columbia Group)	Shoreline complex	0 - 230	Columbia aquifer	Lenticular deposits of sand, silt, clay, and peat. Some beds of coarse sand and fine gravel. Tan; some gray and blue clay.
QUATERNARY & TERTIARY (?)	Pleistocene and Pliocene (?) (Columbia Group)	Salisbury Formation: Beaverdam Fm. and Pensauken Fm. of Owens and Denny (1979)	0 - 230	Columbia aquifer	Beaverdam Sand: Light gray to light tan, fine to coarse grained, moderately sorted, feldspathic sand. Pensauken Formation: Light tan to orange tan, medium to coarse grained, moderately to poorly sorted, pebbly feldspathic sand.
?	?	?			
TERTIARY	Miocene (Chesapeake Group)	Upper Miocene Aquifer Complex	0 - 50	Upper confining bed	Lenticular silts, clays, and fine sands. Green-blue silt and fine gray sand most common, but occasionally includes blue-green pebbly clay.
TERTIARY	Miocene (Chesapeake Group)	Upper Miocene Aquifer Complex	0 - 80	Pocomoke aquifer	Sand, gray or tan-gray; coarse and pebbly generally, but locally fine.
TERTIARY	Miocene (Chesapeake Group)	Yorktown and Cohansey Formations (?) of Rasmussen and Slaughter (1955)	0 - 85	Lower confining bed	Blue and gray clayey silt and sand; some peat. Some beds of shell and calcite and/or limestone.
TERTIARY	Miocene (Chesapeake Group)	Yorktown and Cohansey Formations (?) of Rasmussen and Slaughter (1955)	0 - 85	Ocean City aquifer	Coarse gray sand, fine gravel.
TERTIARY	Miocene (Chesapeake Group)	Yorktown and Cohansey Formations (?) of Rasmussen and Slaughter (1955)	0 - 240	Manokin aquifer	Fine to very coarse gray sand, and some lignite or peat. Some silty sand and clay. Occasional beds of shell and/or "rock".
TERTIARY	Miocene (Chesapeake Group)	St. Marys Formation	0 - 190	Confining layer	Gray fossiliferous clay, silt, fine sand, and silty and sandy clay.
TERTIARY	Miocene (Chesapeake Group)	Choptank Formation	0 - 240	Frederica aquifer and confining layer	Gray fine sand. Thin beds of shell and calcite. Green or brown clay and fine sand. Thin beds of shell and calcite or limestone.
TERTIARY	Miocene (Chesapeake Group)	Calvert Formation	0 - 680	Cheswold aquifer and confining layers	Gray sand and diatomaceous silt and clay. Shell beds.
TERTIARY	Eocene	Piney Point Formation	0 - 220	Piney Point aquifer	Olive-green to greenish-gray quartz sand, slightly to moderately glauconitic; shell beds.
TERTIARY	Eocene	Nanjemoy Formation	0 - 294	Confining layer	Gray to dark gray, glauconitic, silt, sand, and clay.
TERTIARY	Paleocene	Aquia and Hornerstown Formations (undivided)	0 . 165	Aquia aquifer	Green to brown, fine to coarse grained, glauconitic sand; interstratified with grayish-green silt and clays; calcite cemented sands and fossil beds.
TERTIARY	Paleocene	Brightseat Formation	0 - <100	Confining layer	Dark gray clay and fine, silty, micaceous sand.
CRETACEOUS	Upper Cretaceous	Matawan and Monmouth Formations (undivided)	0 - 960 ?	Matawan-Monmouth aquifers	Dark greenish-gray to reddish-brown, fine to occasionally coarse quartz sand. Facies may be glauconitic, micaceous, shelly and/or clayey.
CRETACEOUS	Upper Cretaceous	Magothy Formation	<50 - 100	Magothy aquifer	Light gray to white "sugary", medium to coarse grained quartz sand and fine gravel; interbedded dark gray clays in upper part.
CRETACEOUS	Lower Cretaceous (Potomac Group)	Patapsco Formation	<50 - 1,750	Aquifers and confining layers	Interbedded, variegated (gray, brown, and red) silt and clay, and argillaceous, subrounded, fine to medium quartz sand.
CRETACEOUS	Lower Cretaceous (Potomac Group)	Arundel and Patuxent Formations (undivided)	<50 - 2,950	Aquifers and confining layers	White to light gray to orange brown, moderately sorted, angular and subrounded quartz sand; also gray to ocherous silt and clay beds, which occur in amounts ranging from less than 25% to greater than 75% of formation.
JURASSIC (?)	---	Unnamed	0 - 135	—	White quartzite conglomerate, dark gray, reddish-green and apple green shales, sandy shales, and arkosic sandstones. Does not outcrop on the Eastern Shore.
PALEOZOIC (?) & PRECAMBRIAN	Basement Complex	Basement Complex		---	Believed to be chiefly schist, granite, gabbro, and gneiss.

1/ The nomenclature is that of the Maryland Geological Survey.

2/ Compiled from Rasmussen and Slaughter (1957), Hansen (1972; oral commun., 1982), and Weigle (1974).

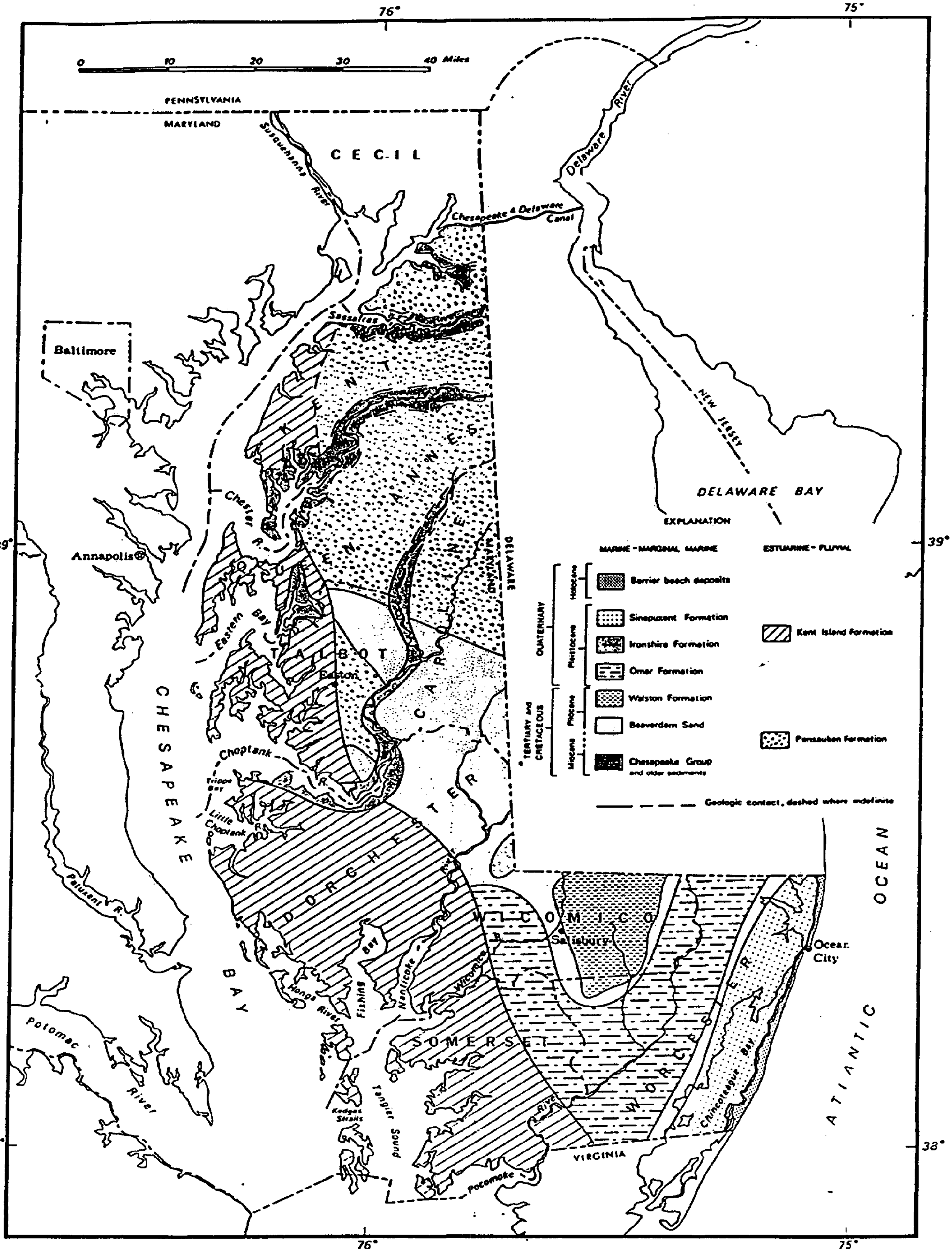

Figure 3. Generalized Geology of the Maryland Part of the Delmarva Peninsula. (From Bachman, 1984 - Adapted from Owens and Denny, 1979 and Ownes and Minard, 1979).

A generalized cross-section showing these aquifer units and the confining units between them are shown in Figure 4. The uppermost aquifer throughout the majority of the study area is the Pleistocene aquifer. A brief description of each of these aquifers taken from Mack et al (1971) follows:

The Pleistocene Aquifer contains the Beaverdam sands and Pensauken Formation, often collectively referred to as the Columbia Formation. Within Area A, the Pleistocene Formation ranges from a few feet to up to 100 feet in thickness. This aquifer is known to have a very high permeability and transmissivity, meaning it can provide large quantities of water to wells providing that there is sufficient available drawdown. Wells in the Pleistocene are reported to be capable of yielding as much as 1,500 gallons-per-minute. Water quality in the Pleistocene Aquifer is generally good. Iron levels are relatively low, the water is soft, and low in total dissolved solids. The Pleistocene Aquifer may have locally elevated concentrations of nitrates, as will be discussed in the water-quality section.

The Miocene Aquifers are found in the Choptank and Calvert Formations. The aquifer in the Choptank Formation is commonly referred to as the Frederica Aquifer. Within the Calvert Formation are two aquifers commonly referred to as the Federalsburg Aquifer and the Cheswold Aquifer. Available information suggests that the Miocene aquifers may be highly interconnected and, therefore, behave as a single aquifer, although in some areas the degree of interconnection may be limited and each of these aquifers, if present, would behave as a single aquifer. The water-bearing sands in the Miocene formations lie approximately 200 to 300 feet below land surface. Generally, the transmissivity of these sands is relatively low, sufficient to support single-family wells, but have limited yield for larger capacity wells. Water

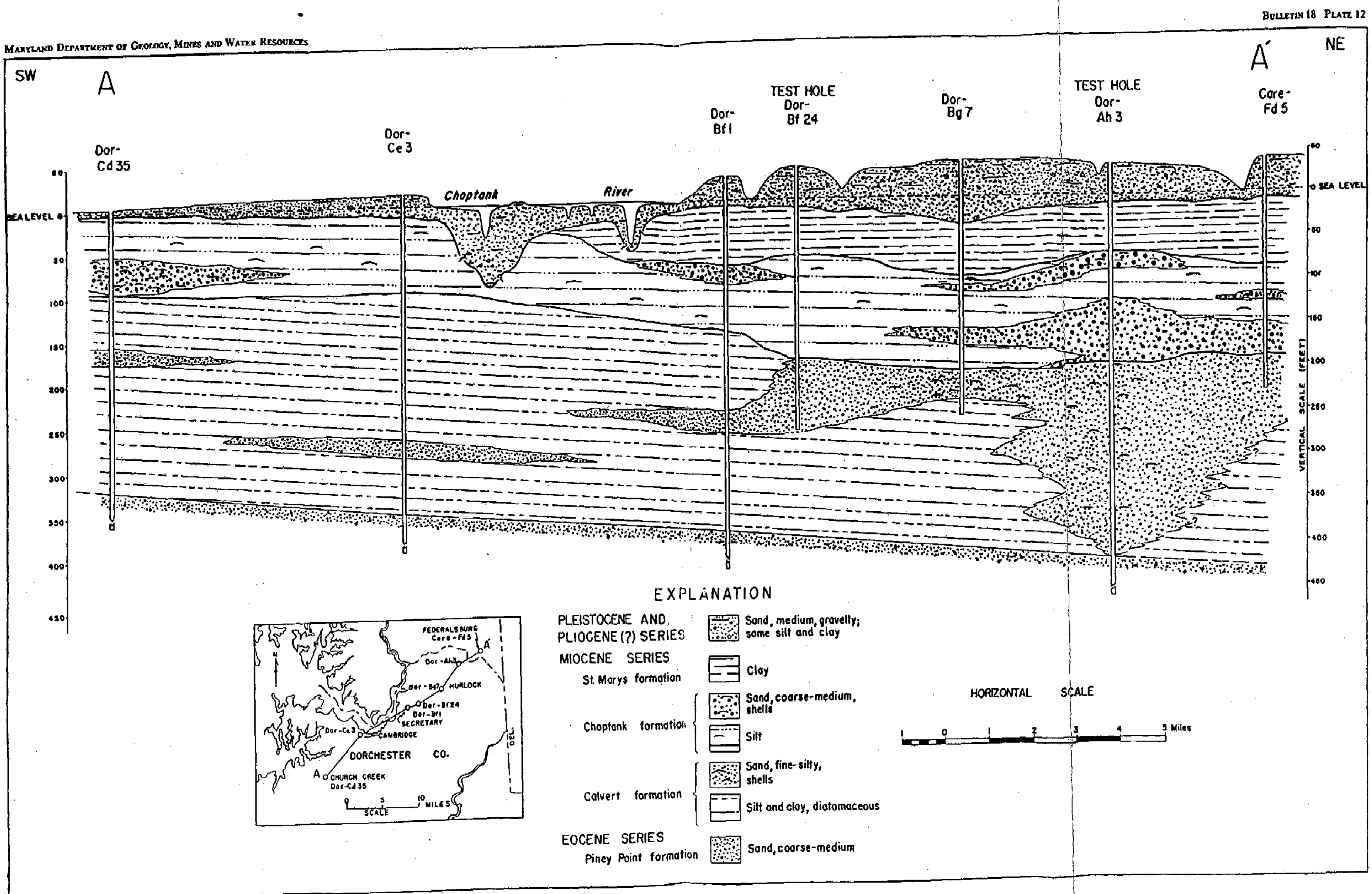

Figure 4. Generalized Geologic Cross-Section for Northeast Dorchester County. (From Rasmussen and Slaughter, 1957)

quality in these aquifers is generally soft. Iron concentrations are generally higher than those of the Pleistocene Aquifer. Southeast of Salem in Area C, the total dissolved solid concentrations are reported to be higher than the recommended limit of 500 mg/l.

The Piney Point Formation (Eocene age) contains water-bearing sands from 400 to 500 feet below land surface. It is the main source of water for Cambridge and is the most important artesian aquifer in Northeastern Dorchester County. The transmissivity of the Piney Point aquifer is relatively high, with one well in the Cambridge area yielding 1,120 gallons-per-minute. However, water levels in the Piney Point aquifer have been lowered extensively in the Cambridge area. Water quality in the Piney Point aquifer is sufficient for domestic and industrial purposes without treatment in Area A. In Area C, the dissolved solids content is reported to be greater than the drinking water standard (500 mg/l). Water quality does vary significantly in the Piney Point aquifer from very hard to soft. The very hard waters often contain excessive iron and are high. South of the Choptank River, water from the Piney Point Formation typically has an odor of hydrogen sulfide which requires treatment such as aeration to remove the gas.

The Aquia Formation Aquifer (Paleocene Age) is present in the northwestern portion of Area B2, west of Cambridge and appears to pinch out on a line north of the Choptank River in Talbot County. It is locally important as a source of drinking water. The Aquia Aquifer occurs approximately 500-620 feet below the land surface and varies in thickness across the study area from 40 to 65 feet. The aquifer is composed of green quartz sand, moderately glauconitic with a few lenses of clay and occasional hard (cemented) layers. The transmissivity of the aquifer is approximately 2000 gpd per foot. Water quality from the Aquia is generally good and is suitable for domestic use without treatment. It is soft, low in iron and contains approximately 300 mg/l dissolved solids.

Very little is known about the geologic or water-bearing characteristics of the aquifers below the Aquia Piney Point Formation throughout the study area. One well penetrating the Magothy Formation (Cretaceous Age) in the Cambridge area found the water quality to be relatively soft with acceptable dissolved solids and iron levels. This aquifer may be present throughout the area of study, but should not be considered as a source of drinking water until additional information is available.

Ground-Water Use for Drinking Water

Ground water is the sole source for drinking water in Dorchester County. A general treatment of ground-water resources of Dorchester County is found in the Maryland Geological Survey Report of Investigations No. 17 (Mack, et al, 1971) and Bulletin 18 (Rasmussen and Slaughter, 1957). As reported, the principal aquifers are the Pleistocene deposits, Miocene aquifers, (i.e., sandy zones in the Choptank and Calvert Formations), the Piney Point Formation and the Aquia Formation. The general pattern of use for drinking water of these four aquifers is shown on Map Sheet 3. Within Areas A & C, the primary sources of drinking water are the Pleistocene Aquifer and Miocene age aquifers. Use of the deeper Piney Point Aquifer is principally in Areas B1 and B2, although wells screened in this unit are found in scattered locations elsewhere. The Aquia Formation is solely used in the northwest portion of Dorchester County. The suitability of deeper aquifers, including the Magothy Formation as a source of drinking water, has not been fully determined. At least one well is known to withdraw from the Magothy in the Cambridge area. Mack, et al, (1971) indicates it may be a significant source.

The available information suggests that, should the surficial aquifer become contaminated, there appears to be deeper confined aquifers capable of supplying limited quantities of drinking water. In Area B the Miocene age aquifers (Choptank and Calvert Formations) appear to be discontinuous across the area and may not always be present as a deeper replacement source to the Pleistocene Aquifer.

The uppermost aquifer is rarely used in Areas B1 and B2. In most cases, wells are screened in the Piney Point Formation and, where available, the Aquia Formation. Because of its limited use, little information is available concerning water quality of the surficial aquifer in Areas B1 and B2.

Within Area C, the uppermost aquifer may be a thin sandy zone within the Kent Island Formation or within the thin Parsonsburg sand deposits, as is the case at Elliot Island. These units are used as sources of drinking water in scattered locations. The Miocene age aquifers are also used and, rarely, the Piney Point aquifer. The available information indicates that both the Miocene age aquifer and the Piney Point aquifer may not in many cases meet secondary Drinking Water Standards (i.e., total dissolved solids less than 500 mg/l) in Area C.

<u>Ground-Water Quality in the Surficial Aquifer</u>

The quality of ground water in the surficial aquifer within the study area is generally reported to be good and can be used for most purposes without treatment (Mack, et al, 1971). However, little information is available on the many constituents of concern to human health. The principal ground-water-quality concern for drinking water is the elevated nitrate levels in the Pleistocene Aquifer (Area A).

Bachman (1984) reports that of 604 water samples taken from wells in the Pleistocene Aquifer across the Delmarva Peninsula, over half of the samples had nitrate concentrations of 3 mg/l as nitrogen or higher, indicating that the water in the aquifer has been affected by human activity. He also reported that nitrogen concentrations exceeded the primary drinking water standard of 10 mg/l in 15 percent of the samples. Nitrate concentrations were found to be higher in areas of urban and agricultural land uses and well drained soils.

Bachman (1984) concluded that the major factors affecting nitrate concentration are the presence of a nitrogen source, hydrogeologic conditions, and soil drainage. Areas with poorly drained soils may have a lower nitrate concentration due to a soil chemical environment that promotes denitrification. Sources of nitrate that enter the ground water with recharging infiltration include on-site wastewater disposal, lagoons, agricultural fertilization, feed lots, and poultry production facilities and lawn fertilization. The high nitrogen levels in some areas were thought to occur due to the rapid leaching through sandy soils. Sandy, well-drained soils have a chemical environment that promotes the nitrification of the other forms of nitrogen and limits chemical processes that remove nitrates (i.e., denitrification).

Water-quality standards for ground-water in Type I and Type II aquifers have been set as part of COMAR 10.50 (see Table 7). These standards include heavy metals, selected

TABLE 7.
MARYLAND GROUND-WATER QUALITY STANDARDS
COMAR 10.50

Inorganic Chemicals	
Arsenic	0.05 mg/l
Barium	1.0 mg/l
Cadmium	0.010 mg/l
Chromium	0.05 mg/l
Lead	0.05 mg/l
Mercury	0.002 mg/l
Nitrate (as N)	10.0 mg/l
Selenium	0.01 mg/l
Silver	0.05 mg/l
Fluoride	4.0 mg/l
Organic Chemicals	
Endrin	0.0002 mg/l
Lindane	0.004 mg/l
Methoxychlor	0.1 mg/l
Toxaphene	0.005 mg/l
2,4-D	0.1 mg/l
2,4,5-TP, Silvex	0.01 mg/l
Total trihalomethanes	0.10 mg/l
Radioactivity	
Combined radium-226 and Radium-228	5 pCi/l*
Gross alpha particle activity activity (including radium-226 but excluding radon and uranium)	15 pCi/l
Average annual concentration of beta particle and photon radioactivity not to produce annual dose equivalent greater than	4 millirem per year

*pCi/l=picocuries per liter

inorganic parameters (including total dissolved solids) and a few volatile organic chemicals and pesticides. With respect to on-site wastewater disposal systems, the principal constituents of concern are nutrients, (e.g., nitrates and phosphates) and pathogens (i.e., bacteria and viruses).

Nitrates are commonly used as an indicator of the presence of other constituents of concern to public health. For example, in agricultural areas, nitrate-contaminated ground waters may also be found to carry leachable pesticides. For this reason, G&M chose to focus on nitrate levels in the surficial ground waters and shallow ground waters. The water-quality data included approximately 87 wells where nitrate concentrations were available and the lithology or the zone of well withdrawal could be clearly determined. The location of these wells and the nitrate content, mg/l, is displayed on Map Sheet 4. These samples were primarily taken from the Pleistocene Aquifer. Approximately 12 percent of the well samples had a nitrate content greater than the drinking water standard of 10 mg/l. The mean nitrate concentrations in surficial ground waters in the area of study was 5.7 mg/l. These results are similar to those reported by Bachman (1984).

Two distinct areas were delineated where the nitrate concentrations appear to be elevated, (i.e., concentrations greater than 5 mg/l) as shown on Map Sheet 4. One such area is in the vicinity of Hurlock and Solomon's Temple. A second area of elevated nitrate concentrations occurs to the north and east of Eldorado. Because of the limited use of the surficial aquifer in Areas B1 and B2, nitrate data is not generally available. A listing of nitrate values are provided in Appendix B.

Presence of Confining Units within 25 Feet of Land Surface

A major emphasis of the investigation was to determine the presence of continuous confining units within 25 feet of land surface that are five feet or greater in thickness. Examination of lithologic logs, including well completion logs, indicates that such units, if present, are relatively sparse in Area A. Data obtained from well completion logs and back hoe pit descriptions have been compiled and are maintained by the Dorchester County Department of Health. This data indicates that there is a laterally extensive confining unit present in Area B. The data were insufficient to draw conclusions about Area C. For this reason, it is recommended that specific site investigations be performed where the presence of such a confining unit is suspected.

Information available from the U.S.D.A. Soil Conservation Service indicates that large portions of Areas A and C are underlain at shallow depth, i.e. within 5 to 10 feet, by a thin, 6- to 24-inch, silty layer of varying thickness. A typical soil description with such a layer is provided in Table 8. The thin silty layer is present generally below the elevation of 35 feet in Area A. The occurrence of this thin silty layer is generally recognized but its presence at any site should be field verified.

The thin silty layer may provide additional protection to underlying ground waters due to 1) a chemical environment favoring denitrification, 2) fine pore sizes to enhance filtering, and 3) an order-of-magnitude smaller permeability than overlying sands that promotes lateral flow toward surface waters.

TABLE 8.
SOIL PROFILE DESCRIPTION OF INGLESIDE SOIL SERIES
WITH SILTY RESTRICTIVE UNIT AT 56 TO 72 INCHES
(COURTESY OF USDA SOIL CONSERVATION SERVICE)

Typical Pedon: Ingleside sandy loam, on a smooth one percent slope in a cultivated field. (Colors are for moist soil).

Ap—0 to 10 niches; dark brown (10YR 4/3) sandy loam; moderate fine granular structure; very friable, slightly sticky, slightly plastic, common very fine, and few fine, and medium roots; common very fine tubular pores; slightly acid; abrupt smooth boundary. (7 to 11 inches thick)

E--10 to 15 inches; brown (10YR 5/3) sandy loam; weak medium subangular blocky structure; very friable, slightly sticky, slightly plastic; common fine and very fine roots; many very fine, and common fine, and few medium tubular pores; slightly acid; abrupt smooth boundary. (0 to 5 inches thick)

Bt1--15 to 24 inches; dark yellowish brown (10YR 4/6) sandy loam; moderate medium subangular blocky structure; friable, slightly sticky, slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; common distinct clay films on faces of peds and clay bridging between sand grains; slightly acid; very clear wavy boundary. (4 to 15 inches thick)

Bt2--24 to 33 inches; strong brown (7.5YR 4/6) sandy loam; moderate medium subangular blocky structure; friable, slightly sticky, slightly plastic; few very fine roots; common very fine and fine tubular pores; common prominent clay films on faces of peds and clay bridging between sand grains; slightly acid; clear wavy boundary. (6 to 15 inches thick)

BC—33 to 43 inches; yellowish brown (10YR 5/6) sandy loam; weak medium subangular blocky structure; very friable, slightly sticky, slightly plastic; few very fine roots; common very fine and fine irregular pores; clay bridging between sand grains; slightly acid; gradual wavy boundary. (2 to 10 inches thick)

C1—43 to 48 inches; yellowish brown (10YR 5/8) loamy sand; single grain; loose; few very fine and fine irregular pores; moderately acid; clear wavy boundary. (9 to 25 inches thick)

C2—48 to 56 inches; light yellowish brown (10YR 6/4) loamy fine sand; common medium distinct light brownish gray (10YR 6/2) mottles, and common medium prominent strong brown (7.5YR 5/8) mottles; single grain; loose, moderately acid; clear smooth boundary. (6 to 10 inches thick)

2C3--56 to 72 inches; pale brown (10YR 6/3) silt loam; common medium faint gray (10YR 6/1) mottles, and common fine prominent strong brown (7.5YR 5/8) mottles; massive; friable, slightly sticky, slightly plastic; moderately acid.

APPENDIX B

INVENTORY OF NITRATE LEVELS IN GROUND-WATER SAMPLES FROM DRINKING-WATER WELLS

APPENDIX B

INVENTORY OF NITRATE LEVELS IN GROUND-WATER SAMPLES FROM DRINKING-WATER WELLS

Map-Parcel No.	Screened Interval (feet)	Sample Date	Nitrate (mg/l)
43-60	37-42	7/75	10.6
43-146	79-89	3/1/78	0.38
43-180	<30	4/15/74	0.14
45-71	50-55	Unknown	3.0
45-82	70-80	11/19/79	8.4
45-121	<30	Unknown	0.15
46-17	47-51	Unknown	3.5
32-9	<30	11/25/80	7.1
33-49	<30	2/28/74	4.0
33-50	<30	10/9/74	2.4
33-64	92-102	5/5/86	3.8
33-86	70-80	2/3/75	6.2
34-54	50-60	6/28/76	0.36
34-54	<30	12/20/84	<0.2
34-56	85-95	12/18/78	<0.2
34-71	34-38	8/25/82	0.7
34-81	<30	Unknown	0.14
34-98	<30	8/24/77	0.32
34-108	<30	3/10/86	<0.2
35-3	<30	Unknown	11.1
35-6	26-61	11/13/86	11.5
35-25	29-34	10/28/85	3.4
35-40	35-40	12/13/84	<0.2
35-41	28-33	10/23/78	0.1
35-59	32-37	10/1/74	8.0
35-72	55-65	8/12/84	9.6
35-85	90-100	9/6/78	0.32
36-2	93-103	7/15/87	3.9
36-19	65-70	2/19/87	3.9
36-31	65-72	3/19/81	4.7
36-39	45-50	4/21/80	3.3
36-64	34-39	8/11/76	1.0
36-68	45-50	1/27/83	7.6
36-84	38-43	1/17/85	6.4
36-121	58-63	12/2/82	8.8
36-144	25-30	8/9/76	6.32
36-152	55-60	4/14/86	8.8
36-156	45-50	9/18/80	4.0
36-161	59-64	2/3/83	4.9
36-1	50-58	2/27/73	0.0
36-76	75-85	6/6/85	7.4
36-160	<30	5/17/78	14.4
36-161	65-75	Unknown	3.6

APPENDIX B

INVENTORY OF NITRATE LEVELS IN GROUND-WATER SAMPLES FROM DRINKING-WATER WELLS (Continued)

Map-Parcel No.	Screened Interval (feet)	Sample Date	Nitrate (mg/l)
22-32	33-37	8/2/84	14.4
22-60	74-94	Unknown	3.38
22-137	<30	10/8/74	4.0
22-172	51-58	3/22/84	1.1
22-191	85-95	Unknown	4.4
23-3	39-94	3/12/79	11.6
23-10	84-94	11/8/79	5.2
23-18	50-54	2/19/81	5.7
23-87	46-48	Unknown	2.2
23-91	47-54	2/28/79	1.4
23-106	85-95	3/12/81	2.2
24-3	79-84	6/6/77	0.17
24-4	32-36	6/30/83	8.2
24-8	<30	9/21/81	4.9
24-12	82-90	12/10/81	4.8
24-17	<30	9/13/78	0.2
24-24	43-47	8/13/85	12.2
24-28	50-60	1/8/80	<0.2
24-79	<30	11/1/84	10.0
24-80	38-48	8/2/84	0.4
24-85	38-43	7/22/74	4.0
25-5	39-49	Unknown	7.5
25-42	70-80	1/16/80	0.6
25-60	70-80	Unknown	0.7
13-46	80-90	8/10/76	0.1
13-60	<30	5/19/75	28.8
13-63	54-94	6/17/76	5.6
13-64	<30	6/17/80	9.5
13-68	80-90	10/29/80	8.6
13-70	54-94	10/29/80	8.6
13-71	40-80	4/28/75	13.8
13-130	48-50	3/19/79	14.8
13-130	40-46	12/5/78	9.1
14-171	47-57	4/28/81	4.9
14-252	30-34	9/25/78	8.0
15-19	60-90	2/28/79	3.5
15-57	65-70	6/11/75	2.2
16-23	51-61	7/19/77	1.8
16-26	50-60	11/15/84	5.9
16-26	50-60	1/3/85	2.4
16-48	<30	2/4/75	56.3
16-49	<50	2/2/65	8.0
16-52	<50	9/30/74	4.0
16-57	47-51	12/2/82	2.3

APPENDIX C

NITROGEN LOADING CALCULATIONS

APPENDIX C

NITROGEN LOADING CALCULATIONS

Method #1: Cornell Nitrogen Balance

$$W = \frac{(4.43)\ (C)\ +\ a(P-ET)\ -\ cP}{(y - a) - y\ (d + n)}$$

Where:

W = wastewater loading (acre/acre - year)
C = removal of nitrogen as crop (lb/acre-year)= 0
a = allowable N concentration in percolat (mg/l= 10
P = precipitation (acre-inch/acre-year infiltration= 15
ET = potential Evapotranspiration (ac-in/ac-yr)= 0
c = concentration of N in precipitation (mg/l)= .5
y = concentration of N in wastewater (mg/l)= 60
d = fraction of N denitrified (% x 10^{-2})= 0
n = fraction of N volatilitized as ammonia (% x 10^{-2})= 0

$$W = \frac{(4.43)\ (0) + 10\ (15 - 0) - (.5)\ (15)}{(60 - 10) - 60\ (0)}$$

$$= \frac{0 + 150 - 7.5}{50 - 0} = \frac{142.5}{50} = 2.85 \text{ acre - inch/ac - yr.}$$

Home WW generation 450 gpd = 164,250 gals/year
27,150 gallons/acre - inch = 6.05 acre - inch/ac - yr
2.85 acre - inch/ acceptable loading

= 2.12 acres/home required to maintain acceptable N loadings to groundwater.

NITROGEN LOADING CALCULATIONS

Method #2: Douglas - Trela Nutrient Dilution Model

$$DWQ = \frac{1\ (CL)}{640\ (R)\ (CE)\ (QE)\ P}$$

where:

DWQ = development density based on H_2O quality for septic systems (DU/acre)

*1 = infiltration to ground water recharge (mgd/mi^2)

APPENDIX C

CL = pollutant concentration limit (mg/l) = 10

640 = conversion factor (acres/mi^2)

R = pollutant renovation factor (decimal fraction) = .9 (Case 1) and .7 (Case 2)

CE = pollutant concentration in septic effluent (mg/l) = 60

QE = septic effluent generation (gpcd) 450 gpd

P = unit occupation (persons/DU)

* 15"/yr. x 27,150 g/acre - inch = 407,250 gallons/acre/yr. = .407250 mgy/ac. x 640 ac/mi^2 365 = .7141 mgd/mi^2

$$\frac{(.7141 \times 10^6)}{60\ (.9)\quad (60)\qquad (450)} = \frac{7141}{15.552}$$

Case #1 (loamy sand)'
.5 Du/Acre 2 acres/DU

(2.18 ac/DU)

Case #2 (sandy loam)

$$\frac{(.7141 \times 10^6)\ (10)}{640\ (.7)\ (60)\ (450)} = \frac{(7.141)}{12.096}$$

= .6 DU/Acre = 1.7 Ac/DU

APPENDIX D

HYDROGEOLOGIC GUIDELINES

APPENDIX D

HYDROGEOLOGIC GUIDELINES

I. Introduction

- A. Purpose of Study
- B. Project Proposal
  1. Project Description
  2. Proposed Water Supply
  3. Proposed Wastewater Disposal
  4. Estimated Wastewater Design Flows

II. Site Description

- A. Location
- B. Topography and Surface Drainage
- C. Soils
- D. Geology
- E. Groundwater
  1. Aquifers
  2. Well Inventory

III. Subsurface Investigation

- A. Soil Map
  1. Detailed Map and Legend
  2. Soil Profile Descriptions
     - a. Test Pits
     - b. Auger Holes
- B. Geologic Framework
  1. Areal Extent and Thickness of Substratum Sands.
  2. Hydraulic Conductivity Measurements - estimated wastewater flows $\geq$ 10,000 gpd require pumping tests with observation wells; number and duration of tests to be proposed by consultant based on hydrogeologic framework.

3. Areal Extent, Thickness, Nature, and Continuity of confining layer (s) available to protect existing/potential water supply aquifers from impact of proposed sewage disposal where maximum sewage treatment will be provided (e.g., direct penetration of groundwater.

4. Underlying Aquifer - physical and water quality description where maximum sewage treatment will not be provided (e.g., direct penetration of groundwater).

C. Groundwater Conditions

1. Potentiometric Surface Map
2. Water Quality Data

IV. Analysis

A. Conceptual Design
B. Impacts

1. Treatment and Ground-Water Movement away from site

2. Surface Water Impacts if applicable based on proximity, environmental sensitivity

V. Conclusions

VI. Recommendations

VIII. Appendices

A. Well Survey Data
B. Well Logs
C. Soil Descriptions/Test Pits
D. Boring Logs and laboratory Analyses
E. Monitoring Well Construction Details
F. Mounding Analyses
G. Water Quality Analyses
H. Large Scale Maps/Geologic Cross Sections

APPENDIX E

STATUS REPORT
TO THE
GOVERNOR AND GENERAL ASSEMBLY
ON THE

STATE OF MARYLAND
INNOVATIVE AND ALTERNATIVE
ON-SITE SEWAGE DISPOSAL PROGRAM

FEBRUARY 1987

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
OFFICE OF ENVIRONMENTAL PROGRAMS
WATER MANAGEMENT ADMINISTRATION
INSPECTION AND COMPLIANCE PROGRAM
DIVISION OF RESIDENTIAL SANITATION

TABLE OF CONTENTS

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This report was prepared under the direction of Jack R. Holthaus, R.S., Chief of the Division of Residential Sanitation, by Clifford E. Stein, Soil Scientist, with contributions from Ching-Tzone Tien, Public Health Engineer, Jane C. Gottfredson, Geologist, Tom Teutsch, Jay Prager, and Barry Glotfelty, Sanitarians. Other Division staff who have contributed to this effort are: John Covalt, Dave Kerr and Norman Lowery, Regional Consultants; and Clyde Boatwright, Environmental Health Aide. A special thanks is extended to Theresa German for typing and word processing.

EXECUTIVE SUMMARY

ACCOMPLISHMENTS TO DATE

Since 1980, the program has accomplished the following:

1. Eight basic on-site experimental systems have been identified for evaluation:

   Soil Treatment Systems

   - sand mound
   - shallow pressure dosing trench
   - sand-lined pressure dosing trench
   - alternating fields

   Groundwater Penetration Systems

   - sand-lined trench
   - sand filter trench
   - bermed infiltration pond

   Solar Systems

2. Two-hundred and seventy three (273) detailed site evaluations have been conducted.

3. Seventy-nine (79) experimental systems have been or are being installed. Seventy-two (72) for single-family residences and seven for larger, multi-use systems ranging from 1,200 to 16,000 gpd.

4. State I/A grants of $37,500 have been provided to eight counties including Anne Arundel, Kent, St. Mary's, Washington, Allegany, Cecil, Charles and Wicomico Counties. Harford, Carroll, Dorchester and Garrett are likely to become grant participants by July 1987.

5. Training is being continuously provided to local health departments and contractors. 122 sanitarians have participated in site evaluation training workshops which continue to be held throughout the State on a regional basis. Design and construction workshops are presently scheduled for January, February, March and May in four locations around the State.

6. Currently, I/A staff of OEP directly monitor 20 experimental systems throughout the State. By the end of calendar year 1987, this total is expected to increase to 50.

7. COMAR 10.17.02 was adopted in April 1986 incorporating provisions which provide for approval of I/A projects with specific approval of sand mounds to accommodate high water table situations. New grant regulations COMAR 10.17.16 were also adopted which specify how State I/A grants are to be made to local governments and how local governments in turn distribute funds to homeowners.

SYSTEMS UNDER EVALUATION

The eight basic experimental systems under evaluation are all designed to address specific site limitations which relate either to hydraulic performance or soil treatment of wastewater. Site limitations most often encountered include slow to impermeable soils and high water table or shallow soils over fractured bedrock. In the first instance, water will not percolate and ponding and runoff problems are encountered, whereas in the second instance sewage may contaminate groundwater. Following is a description of each of the eight basic experimental systems and the site limitations which the technology is designed to overcome.

Soil Treatment Systems

Systems in this category incorporate a two to four foot treatment zone which provides for renovation of sewage effluent before it is discharged to groundwater or fractured bedrock.

1. Sand Mound. This system consists of a double-compartment septic tank, pump, pumping chamber and an absorption bed elevated above the natural soil surface in a suitable sand fill. Septic tank effluent is pumped into the bed through a pressure distribution network. Treatment occurs as effluent moves downward through the sand fill and into the underlying soil. This system has been studied intensively by a number of investigators and states throughout the country. The Wisconsin site criteria and design are the most accepted and are currently used in this program with two modifications. A cylinder infiltrometer test, that estimates vertical permeability, is used instead of a percolation test and the sand fill specifications are more restrictive. It has been reported that these systems can overcome the following site limitations:

   a. Permeable Soils with High Water Tables;

   b. Shallow Permeable Soils Over Fractured Bedrock;

   c. Slowly Permeable Soils.

   Nineteen systems are currently under evaluation in the program. Sixteen systems are on permeable soils with high water tables and three are on slowly permeable soils. The systems on permeable soils with high water tables have performed well and generally confirm available data. In 1986, the first step in converting sand mound systems to conventional use was taken. Sand mounds for permeable soils, with percolation rates less than 30 minutes/inch and high water tables two feet or deeper, were included in COMAR 10.17.02 as conventional systems. Two systems on the slowly permeable soils are under-utilized and the third is currently experiencing mechanical problems. Results for slowly permeable soils are therefore not conclusive at this time. Additional mound systems on slowly permeable soils are needed to help answer questions regarding soil damage and compaction during construction and the possible use of up-slope interceptor drainage on sloping sites to divert perched water.

2. <u>Shallow Pressure Dosing Trench.</u> This system consists of a double-compartment septic tank, pump, pumping chamber and soil absorption trenches. The trenches generally range between 0.5 and 2.0 feet in width, 1.0 and 1.5 feet in depth and are excavated with a ditch-witch. This system has been and studied primarily by North Carolina and several other states. This system allows shallow placement in the soil to maintain two feet or greater treatment zones below the bottom of trenches. Pressure dosing provides uniform distribution of effluent throughout the trenches and dosing and resting cycles. It has been reported that these systems can overcome the following site limitations:

   a. Permeable Soils with High Water Tables

   b. Shallow Permeable Soils Over Fractured Bedrock

   c. Slowly Permeable Soils

   Over forty-four of these systems have been installed or are under construction. Six systems are currently under evaluation in the program. Thirty-eight systems were installed in the Harney Project in Carroll County and were evaluated by consultants. Four out of the six systems being evaluated by the State, experienced construction related problems with one chronic failure occurring. Additional study of systems installed in Harney and other locations throughout the State is planned. Treatment capability, groundwater mounding and freezing problems that have been reported by other States will be evaluated. On sloping sites, up-slope interceptor drainage to divert perched water tables will also be studied.

3. <u>Sand Lined Pressure Dosing Trench.</u> This system consists of a double compartment septic tank, pump, pumping chamber and soil absorption system constructed in sand fill. Two-foot treatment zones are being used. These systems can only be used where underlying soils are sandy and will not be

damaged by construction. This system is similar to sand lined systems that are installed in Delaware and Pennsylvania. This system is designed to overcome the following site limitations:

a. Very Slowly to Nearly Impermeable Soils

b. Permeable Soils Over Fractured Bedrock

c. Slowly Permeable Soils

No systems are installed at this time. Plans are underway to have systems constructed in 1987. Evaluation of treatment capability and construction methods will be undertaken.

4. Alternating Fields. This system consists of a double-compartment septic tank, diversion valve and two soil absorption fields. Wastewater is diverted to each field alternately, allowing one to rest and be rejuvenated by biodegradation of the clogging mat. It has been reported that this system will extend the design life of the soil absorption field and would allow each field to be designed with 25% less effective soil absorption area. Very little data are available to support this claim. These systems are being evaluated to overcome site limitations of slowly permeable soils.

   One system is being evaluated and plans for additional systems to be installed are underway.

Groundwater Penetration Systems

These systems are constructed to discharge directly to surficial groundwater. They are similar to conventional groundwater penetration systems with the exception that they are designed to provide better treatment of effluent before it is discharged. Areas in the Coastal Plain where these types of systems may be utilized are to be further evaluated through the process of preparing "Groundwater Protection Reports" (GPR's) recently required in COMAR 10.17.02.

5. Sand Lined Trench. This system consists of a double compartment septic tank and soil absorption trenches. The trenches are constructed to discharge directly to groundwater but are backfilled with sand fill instead of gravel. The trenches may be elevated above the original land surface in an impermeable fill in order to obtain adequate hydraulic head for performance when the water table is high. This system has been used in Maryland to overcome site limitations of permeable to nearby impermeable soils with high water tables.

Hundreds of these systems have been installed in the past on the eastern shore coastal plain. The majority are in parts of Worcester, Dorchester, Somerset, and Talbot county. Two systems are being evaluated in this program with plans to include more. Treatment capability and design criteria are being studied.

6. Sand Filter Trench. These systems consist of a double-compartment septic tank, pump, pumping chamber, sand filter and soil absorption trenches. Designs include buried, free-access and recirculating sand filters that incorporate a variety of modifications to reduce nitrogen, phosphorus and fecal coliforms. These systems are designed to overcome limitations of high ground water.

   Seven systems are under evaluation with plans to install more.

7. Bermed Infiltration Pond. A bermed infiltration pond is an excavation approximately eight to ten feet deep with no less than 10,000 square feet in surface area. The excavation exposes a water-bearing substratum overlain by an impermeable soil. Part of the excavated material is placed around the pond perimeter to form a berm. The water from the substratum rises and falls in the pond in accordance with seasonal fluctuations in the water table. Septic tank effluent is discharged near the bottom of the pond for disposal. The biological organisms in the pond complete the treatment process and the water moves into the surficial groundwater surrounding the pond or evaporates.

   Over fifty of these systems have been installed in the Eastern Shore Coastal plain, primarily in Dorchester County. They are reported to perform well and are proposed to be converted into conventional use by the end of 1987. A few questions regarding design and construction remain to be answered.

Solar Systems.

These systems are for the most part independent of soil conditions and therefore theoretically would overcome all site limitations. They consist of a double-compartment septic tank or aerobic tank with discharge within a greenhouse unit. Two basic types have been identified, but only one type is being evaluated. Four systems have been installed. Data collected in 1985 indicated major problems with these systems. In addition, the systems appear economically prohibitive. A contract with the University of Maryland was entered into in August 1986 to perform a more thorough technical evaluation. The final report is due in July 1987 and will provide information for future direction.

SCHEDULE FOR DECISIONS

Each of the eight technologies are being installed in different soil-hydrogeologic settings across the State. Some have more potential than others and will offer greater opportunity for success. Sand mounds offer the most opportunity and solar systems the least. The attached chart entitled "Proposed Decision Schedule" reflects the Department's best judgment as to when decisions are likely to be made with regard to approval of each of these new technologies. Systems for which decisions will be made earlier than others reflects a greater data base usually associated with a greater number of installations, intensive monitoring and higher success rates.

It should be noted that OEP's next technology approval is slated for July 1987 and consists of extending percolation rates to 60 minutes for sand mounds. We also anticipate approving bermed infiltration ponds as conventional technology and making a final decision on the use of the solar system. By December 1987, OEP expects to have enough operating data on sand-lined trenches employing groundwater penetration to have completed design criteria which could be uniformily applied to all Coastal Plain Counties. This criteria will be subsequently included in Regulation 10.17.02 which should be finalized within an additional four to six months.

CONCLUSIONS

1. Training and Staffing

Training local sanitarians to make site evaluations, review designs, make construction inspections and to advise homeowners on O&M requirements for each new technology translates into increased workloads.

2. Data Collection Process

Widely-varying hydrogeologic conditions throughout Maryland require that new technologies be tried in a variety of different settings before general criteria can be established. Systems studied the most to date address high groundwater problems. Slowly permeable to impermeable soils present the greatest problem and fewer technologies have been evaluated to address these site limitations. Costs of large systems designed using lower permeability rates preclude many from installing them for experimental purposes. For these reasons, it is anticipated that sufficient monitoring data to make policy decisions may not be available for several technologies until 1991 or 1992.

3. Construction Problems

Maryland's experience to date, along with that of many other states, is that construction practices are critical to the successful operation of new technologies. In order to address this issue, OEP is developing workshops for installers and is developing capabilities within county health departments to inspect projects during construction.

4. <u>Approvals of New Technologies in 1987</u>

Existing evidence supports:

a. increasing perc rates to 60 minutes for sand mounds, and

b. allowing the use of bermed infiltration ponds.

Preliminary indications are that solar systems are not cost-effective.

Policy statements on each are to be developed by July, 1987 with final rule making by December, 1987.

5. <u>Operation and Maintenance</u>

Each new technology is more complex than existing conventional systems and requires increased homeowner responsibility and understanding. Educational programs and materials need to be developed to provide the homeowner with an understanding of these systems.

6. <u>Costs</u>

I/A technologies may cost two to three times as much as conventional technologies. Although developers are anxious to try anything which will allow for approval of new projects, existing lot owners find these technologies difficult to afford. As a result, not as many existing lot owners are offering to try an I/A technology on an experimental basis as was anticipated.

7. <u>Regional Differences</u>

Many of these I/A technologies may overcome site limitations in some hydrogeologic areas but not in others. Technologies employing the use of soil treatment zones may prove useful throughout the State, whereas groundwater penetration will have limited application within areas of the Coastal Plain.

2/03/87

INTRODUCTION

This status report has been prepared for the Governor and General Assembly in accordance with Section 2, Chapter 498, Acts of 1986 (HB 828). The report describes the Department of Health and Mental Hygiene's (DHMH) Innovative and Alternative On-Site Sewage Disposal Program and presents preliminary findings, conclusions, recommendations and a proposed decision schedule. Information on sand-lined trench systems is included in this report.

BACKGROUND

Reorganization of environmental programs within DHMH in July 1980 provided new opportunities to enhance the study and use of innovative and alternative on-site sewage disposal systems in Maryland. An Innovative and Alternative (I/A) section, within the Division of Residential Sanitation, was created using existing staff to identify and evaluate on-site technologies and coordinate with local county health departments. Division staff assigned to the I/A section consisted of three professionals that devoted approximately half-time to evaluation of on-site technology. Increased staffing at the local county health department level was not funded.

In 1983, the EPA Chesapeake Bay Study recommended that the State continue to evaluate the application of innovative and alternative technology to problems of wastewater disposal (1). As a result, one of the 1984 Chesapeake Bay Program Point Source Pollution Control Initiatives was to enhance the existing on-site I/A program with additional staff and funding (2). One full-time professional position was filled during FY85 and three full-time positions were filled during FY 86.

In addition to the Bay I/A initiative, authority and funding for development of an on-site I/A grant program was established by the legislature in 1984 (3). This program was to provide grants to assist eligible applicants with construction costs of experimental systems. DHMH was authorized to develop regulations, manage the grant program and award grants to eligible political subdivisions. Political subdivisions would then in turn award grants to eligible applicants. Grant awards of $37,500 were made to Anne Arundel, Kent, St. Mary's and Washington Counties in FY85 and to Allegany, Cecil, Charles and Wicomico Counties in FY86. These funds were for construction costs only and do not include funding for staff work and grant program administration at the local county health department level.

PROGRAM DESCRIPTION

Purpose and Scope

The purpose of the program is to identify and evaluate additional types of on-site sewage disposal systems that can be used to remodel failing systems and overcome major site limitations. General eligibility requirements for property owner participation in the experimental program are as follows:

1. Public sewer is not available to the property.
2. Property is legally established and is:
   a. Improved with an existing structure but has a failing on-site sewage disposal system that cannot be repaired using conventional methods; or
   b. Improved with an existing structure but lacks indoor plumbing and cannot meet current requirements for installing a conventional on-site sewage disposal system; or
   c. Unimproved, was platted before 1972, and cannot meet current requirements for installing a conventional on-site sewage disposal system.
3. Property site limitations and conditions are such that an innovative and alternative system could be designed and would provide useful data to the Statewide experimental effort.
4. Property owner agrees to conditions of the experiment and enters into a legally binding document that is recorded with the Deed to the property.
5. Property is not currently proposed to be subdivided into building lots in accordance with COMAR 10.17.03.
6. Local county health department has available staff to perform design reviews, construction inspections and routine monitoring.

Final acceptance of eligible properties into the experimental program and the total number in any one county will be primarily dependent on meeting minimum site screening criteria and availability of local staff for monitoring assistance. Priority for acceptance is given to improved properties with failing systems and existing pollution or public health problems. Exceptions to site criteria and monitoring requirements for improved properties with pollution or public health problems can be given on a case-by-case basis.

Experimental systems may be totally financed by the property owner or, in certain counties, may be partially funded by a State I/A grant or an indoor plumbing program loan. Eligibility requirements for obtaining innovative and alternative grants and details of the grant program are outlined in COMAR 10.17.16 and attachments given in Appendix A.

Experimentation with large innovative and alternative on-site systems is also within the scope of this program. State I/A grant funds, however, are not available for these projects.

Objectives

The specific objectives of the program include:

1. Identifying, installing, monitoring and reporting on experimental systems and the use of these data with field experience to develop new State guidelines, design criteria and regulations.

2. Encouraging local health departments to use identified technologies in remodeling systems and for experimental purposes in order to solve existing pollution problems and to enhance the eventual use of I/A technology for new construction when feasible.

3. Assisting in training local health department staff in obtaining the expertise necessary to review and approve designs and inspect system construction.

4. Reviewing applications for construction permits in cooperation with local health departments until local expertise can be developed; and evaluating opportunities to use centralized sewerage facilities as part of the EPA/State facility planning program.

Evaluation Criteria

Innovative and alternative experimental systems, like conventional on-site systems, must satisfy basic public health and environmental protection criteria in addition to meeting practical considerations. The following sections describe the criteria that are used to identify and evaluate experimental systems in Maryland.

Site Limitations. Experimental systems must have potential for overcoming major site limitations that contribute to on-site system failures or that preclude the use of land for conventional on-site systems.

Performance. Experimental systems should meet or exceed existing performance requirements of conventional on-site systems. The two most important performance requirements are that systems:

1. Hydraulically Function

   System accepts wastewater flows generated throughout the design life without discharging partially treated effluent to the land surface or backing up into buildings and discharging from the plumbing; and

2. Provide Adequate Treatment

   A sufficient depth of suitable, unsaturated soil material is available below the bottom of the disposal system to provide a high degree of treatment before wastewater reaches the underlying groundwater.

Reliability. Experimental systems must perform reliably throughout the design life of the system. Components should meet current industry standards if available. Designs should maximize the use of readily available components that have documented performance records and should incorporate the most appropriate but simplest control systems whenever possible.

Operation and Maintenance. Since in almost all cases experimental systems are more complex than conventional systems, design features should be incorporated to reduce operation and maintenance requirements whenever possible.

Cost. Since in almost all cases experimental systems are more costly than conventional systems, design features and use of suitable but inexpensive building materials should be incorporated whenever possible to reduce cost. In addition, minimization of utility energy requirements and maximization of passive solar energy use should be investigated whenever possible.

Activities

Activities of the program involve ten major types of work tasks. The following sections describe these tasks and summarize accomplishments that have been made to date.

System Identification. Published research data, available data from other States and new proposals are reviewed by OEP staff to identify conceptually feasible systems for experimentation. Preliminary site selection criteria, design criteria, construction guidelines, and monitoring requirements are developed and reviewed with assistance from county health department staff. Currently eight basic types of experimental systems have been identified for evaluation in Maryland. This activity is ongoing and as new experimental systems are identified they will be incorporated into the program for evaluation.

Site Evaluation and Selection. Potential sites are identified and initially screened by county health department staff in most instances. Identification of potential sites may result from routine investigations of failing conventional systems, routine disapprovals for new conventional systems, I/A grant program public information meetings, or hearing decisions. Sometimes potential sites are identified by direct requests from members of the General Assembly. Potential sites that have been screened by county health department staff and recommended for further study generally undergo a detailed site evaluation by OEP before final selection and acceptance in the program. Evaluations include review of available data, making detailed soil descriptions and conducting tests to measure soil permeability. The data are then reviewed by OEP and county health departments and a final decision is made. If potential sites are eligible for I/A grants, additional office screening and prioritization ranking may be necessary to determine if a grant can be awarded. In either case, the property owner will also receive a letter report that contains:

1. Preliminary Design Criteria

2. Design and Construction Guidelines

3. Requirements for Submission of Plans and Specifications

4. Typical System Layout, Cross Section and Details

5. Monitoring Requirements

6. Legal Agreement

Over 273 screening and detailed site evaluations have been conducted since FY 1981. Table I presents the number of detailed evaluations conducted by OEP each fiscal year, including the current fiscal year.

Table I

Number of Detailed Site Evaluations

Fiscal Year	Total Number
1981	2
1982	28
1983	48
1984	80
1985	20
1986	78
1987	17

It is expected that the number of evaluations for FY 1987 will exceed all previous years.

Design and Construction. If a property is selected, the owner must have a consultant design the system and prepare the plans and specifications according to the information contained in the letter report. The plans are then submitted to OEP and local county health department for review. The initial design review generally results in a need for at least one meeting, a submission of revised plans and a final approval letter. Larger systems often require several design reviews, meetings, revisions of plans and letters.

After final approval of the plans and specifications, the owner must hire a qualified contractor. If the owner was selected for an I/A grant, at least two and preferably three cost estimates must be obtained from contractors in order to select the best bid. County health departments have been primarily responsible for construction inspections in order to determine that systems are constructed according to the plans and specifications. This can be a very time consuming and critical activity in the overall process. Four separate inspections may be necessary and in some instances a continuous inspection may be necessary. Over 100 design reviews have been conducted and [illegible]9 systems have been installed or are currently under construction. OEP staff assist with construction inspections when grant money is involved.

Soil Laboratory Analyses. Particle size analyses of sand samples are performed by OEP staff to identify potential suppliers of sand fill for construction. A total of 31 analyses have been conducted.

Monitoring. Monitoring requirements are somewhat different for each basic type of experimental system. Monthly visits are generally required and may include:

1. Visual observations
2. Checks of flow meters, event counters, pretreatment and pumping components
3. Measurements of effluent levels and water table levels
4. Sampling of pretreatment components, observation pipes, monitoring wells or other monitoring devices
5. Homeowner interviews.

County health departments in the past have been primarily responsible for monitoring systems. In FY86, two sanitarians and one environmental health aide were added to the OEP staff and are assisting with monitoring. Currently, 20 systems are being monitored on a monthly basis by OEP. During FY87, it is estimated that an additional 30 systems will be added for a total of approximately 50 systems monitored by OEP on a routine basis.

Problem Investigations. Problems with experimental systems have developed and require thorough investigations to determine the cause and to propose potential solutions. Both OEP and local county health departments become involved in these investigations. Fourteen problem investigations have been conducted since FY85.

Technical Assessment. All available data from EPA, other States and the program in Maryland are assessed to determine if the experimental systems are satisfying evaluation criteria. Depending on the results, the systems may be recommended for conversion to conventional technology and final guidelines may be developed.

Training Programs. Training programs for county health department staff to improve site evaluations and perform design reviews and construction inspections are ongoing and are provided primarily by OEP staff. Site evaluation workshops have been conducted in FY84, FY85, and FY86 providing training to over 122 sanitarians. Special training seminars were presented to five local health departments. OEP staff members also participated in five one-day groundwater protection seminars throughout the State. OEP, with assistance from the Maryland Environmental Training Center, is presently developing ten design and construction workshops for county health department staff, consultants and contractors. Workshops are planned for January, February, March and May in four locations around the State. Contractor workshops in May will be part of a contractor certification program also being developed by OEP as required by COMAR 10.17.02.

Regulation Development. This activity is ongoing and is the responsibility of OEP staff. Regulation development to date has involved minor changes for clarification to existing regulations (COMAR 10.17.02.06); new regulations for grant programs (10.17.16); and major changes to existing regulations to incorporate new conventional on-site technology (10.17.02.05Q).

Grant Program Management. This activity is ongoing and is shared among OEP, county health department, and county government staff. Major activities completed by OEP have involved developing State to County Model Agreements, County to Applicant Model Grant Agreements, and prioritization ranking criteria. Presentations to county government officials, planning meetings and public information meetings are other activities that have been conducted primarily by OEP and county health department staff.

Eight counties are currently included in the grant program. These counties are:

1. Anne Arundel
2. Kent
3. St. Mary's
4. Washington
5. Allegany
6. Cecil
7. Charles
8. Wicomico

Four additional counties are under consideration for inclusion in the grant program. These counties are:

1. Harford
2. Carroll
3. Dorchester
4. Garrett

PRELIMINARY FINDINGS

TECHNICAL ISSUES

Six major technical issues related to the increased use of both conventional and experimental on-site systems have been identified. Experimental efforts of the program attempt to address and resolve these issues.

*Site Limitations

Site limitations within Maryland that are being addressed by the program have been divided into four categories.

Permeable Soils with High Water Tables. This category includes soil and geologic materials that have percolation rates faster than 60 minutes/inch, with water tables that are two to six feet below land surface.

Shallow Permeable Soils Over Fractured Bedrock. This Category includes soil and geologic materials that have percolation rates faster than 60 minutes/inch, with at least one to two feet of suitable soil over fractured pervious bedrock.

Slowly Permeable Soils with High Water Tables. This category includes soil and geologic materials that have percolation rates between 60 and 120 minutes/inch and water tables that are two feet or more below land surface.

Very Slowly to Nearly Impermeable Soils. This category includes soil and geologic materials that have percolation rates slower than 120 minutes/inch. In certain Coastal Plain soil-hydrogeologic environments, very slowly to nearly impermeable soils are underlain by saturated sands and deeper confining clay layers. If the surficial saturated sand aquifer has a low potential for use as drinking water and discharge of partially treated sewage effluent to the aquifer will not cause contamination of deeper aquifers or surface waters, on-site sewage disposal systems may be suitable. This special site limitation category is being examined in more detail under the provisions of the groundwater protection reports (GPR) required by COMAR 10.17.02. The experimental systems that are being evaluated for these types of soil-hydrogeologic environments are discussed in this report under the sections involving groundwater penetration systems. Appendix B contains additional information on the GPR requirements.

*Adequate Treatment

Conventional on-site sewage disposal systems generally consist of a septic tank and a subsurface soil absorption system. Treatment of sewage occurs in the septic tank and in the soil in a properly operating system. In order to accept the septic tank effluent and provide adequate treatment, the soil must be suitable.

The bulk of available data and research indicates a two- to four-foot depth of suitable, unsaturated soil material below the bottom of systems will provide a high degree of treatment of septic tank effluent. It has been reported that almost complete removals of COD, BOD, suspended solids, phosphorus and bacterial contaminants can be achieved. Data to support similar reduction of viruses are not as conclusive. Removals and inactivation of viruses are more variable and depend on the type of virus and a number of conditions such as soil clay content, organic matter, pH, moisture content, and residence time in the soil.

Other chemical constituents such as nitrogen, exchangeable cations, chlorides, sulfates, other anions and trace organics undergo various reactions in the soil treatment zone and may be attenuated to different degrees. Many of these chemical constituents are not attenuated to any great extent and over time will move downward with soil waters and mix with underlying groundwaters. Increases in total dissolved solids, chlorides and nitrate-nitrogen of groundwaters may be experienced. The significance of these impacts and the resulting degradation of groundwater quality becomes more important as densities of on-site systems increase. Cumulative effects of impacts from on-site sewage disposal systems and other sources of contaminants associated with suburban land use have produced significant groundwater pollution in some areas along the east coast. Presently, it appears that nitrate-nitrogen is the constituent of most concern.

Soil Treatment Zones. In COMAR 10.17.02, the State has adopted the use of a four-foot soil treatment zone for conventional on-site systems. This soil treatment zone not only provides a high degree of treatment, but incorporates two additional practical considerations. These involve the difficulty of estimating accurate depths to high groundwater based on minimal observations and typical installation problems that can often result in actual treatment zone depths being less than design depths. Use of a four-foot treatment zone allows for a reasonable margin of safety when considering the practical limitations of evaluating sites and installing conventional systems.

The use of two- to four-foot soil treatment zones and practical limitations of construction are being investigated in the program.

Groundwater Penetration. Many areas within the Maryland Coastal Plain province have seasonally high water tables at depths that cannot provide a four-foot treatment zone below the bottom of on-site disposal systems. Previous regulations have allowed Talbot, Dorchester, Wicomico, Somerset and Worcester to discharge septic tank effluent directly to surficial groundwater aquifers under certain conditions. This practice has been referred to as groundwater penetration and is used routinely in these counties.

Local county health departments that routinely use groundwater penetration have not associated any major public health problems with these systems. Extensive monitoring and well documented studies of the impacts of these systems on groundwater or surface waters, however, have not been conducted. The use of groundwater penetration systems that provide better treatment and nitrogen reductions are being investigated in the program. In addition, sufficient data regarding the design of these type systems is also being collected.

*Construction Practices

In almost all cases, innovative and alternative systems are more complex and require more detailed construction steps and management. Specifications and routine achievement of two-foot treatment zones during construction may not be practical without intensive contractor training and intensive construction inspection.

This issue needs to be assessed as part of the experimental effort and may become the most important issue in deciding whether or how experimental systems are converted to conventional use.

*Equipment Problems

Since many of the innovative and alternative systems are sited on property with high water tables or fractured bedrock, septic tanks and pumping chambers must be water-tight. Existing tanks and chambers in many instances are not adequate and have caused problems. Improvements in tanks and equipment are needed to resolve these problems.

***Operation and Maintenance** Innovative and alternative systems in almost all instances are more complex and involve more operation and maintenance requirements than conventional systems. The actual success or failure of some experimental systems may depend directly on homeowner maintenance. Past experience indicates that many homeowners do not perform the minimal maintenance requirements associated with existing conventional systems and in some instances do not understand their basic function and operation.

Homeowner educational programs need to accompany installation of experimental systems in order for the homeowner to understand:

- the basic function and operation of the system
- how to perform routine maintenance requirements
- how to recognize warning signs that may indicate developing problems or possible malfunction, and
- the costs that will be associated with increased O&M requirements.

Homeowner performance of routine maintenance can then be assessed more objectively in the experimental effort.

*Management of On-Site Systems

An alternative to homeowner responsibility for maintenance of more complex on-site systems is to have a management entity assume this responsibility. Performance of necessary maintenance by a management entity could assure higher confidence that a more complex on-site system would operate properly and meet basic public health and environmental criteria. This approach involves a number of institutional and legal problems. The existing CEP staff cannot examine and resolve these problems.

SYSTEMS UNDER EVALUATION

This section describes the experimental systems under evaluation. Available data, guidelines, and regulations from EPA and other states were reviewed and used along with data collected in Maryland. Systems that incorporate soil treatment zones and that discharge directly to groundwater (i.e., groundwater penetration systems) are presented along with solar systems.

*<u>Soil Treatment Systems</u>

Systems in this category incorporate soil treatment zones between a limiting zone and the bottom of absorption beds or trenches. The treatment zones range in thickness between two and four feet. Where soil treatment zones do not exist naturally, they can be achieved by constructing:

- sand mounds above the natural soil surface,
- shallow trenches near the soil surface, and
- sand fills that have replaced unsuitable soil materials.

Designs generally incorporate pressure dosing to provide:

- uniform distribution which utilizes the entire volume of the absorption bed or trench
- dosing and resting cycles which maintain unsaturated soil conditions resulting in aerobic pores and less restrictive clogging mats

Designs may also incorporate up-slope interceptor drainage to help achieve adequate soil treatment zones above high water tables.

<u>Sand Mound.</u> This system consists of a double-compartment septic tank, pump, pumping chamber and an absorption bed elevated above the natural soil surface in a suitable sand fill. Septic tank effluent is pumped into the bed through a pressure distribution network. Treatment occurs as effluent moves downward through the sand fill and into the underlying soil. This system has been studied intensively by a number of investigators and states throughout the country (4, 5, 6, 7, 8, 9, 10, and 11). The Wisconsin site criteria and design is the most accepted and is currently used in this program with two modifications. A cylinder infiltrometer test, that estimates vertical permeability, is used instead of a percolation test and the sand fill specifications are more restrictive. It has been reported that these systems can overcome the following site limitations:

1. Permeable Soils with High Water Tables;
2. Shallow Permeable Soils Ove: Fractured Bedrock;
3. Slowly Permeable Soils.

Nineteen systems are currently under evaluation in the program. Sixteen systems are on permeable soils with high water tables and three are on slowly permeable soils. The systems on permeable soils with high water tables have performed well and generally confirm available data. In 1986, the first step in converting sand mound systems to conventional use was taken. Sand mounds for permeable soils, with percolation rates less than 30 minutes/inch and high water tables two feet or deeper, were included in COMAR 10.17.02 as conventional systems. Two systems on the slowly permeable soils are under-utilized and the third is currently experiencing mechanical problems. Results for slowly permeable soils are therefore not conclusive at this time. Additional mound systems on slowly permeable soils are needed to help answer questions regarding soil damage and compaction during construction and the possible use of up-slope interceptor drainage on sloping sites to divert perched water.

Shallow Pressure Dosing Trench. This system consists of a double-compartment septic tank, pump, pumping chamber and soil absorption trenches. The trenches generally range between 0.5 and 2.0 feet in width, 1.0 to 1.5 feet in depth and are excavated with a ditch-witch. This system has been studied primarily by North Carolina and several other states. This system allows shallow placement in the soil to maintain two feet or greater treatment zones below the bottom of trenches. Pressure dosing provides uniform distribution of effluent throughout the trenches and dosing and resting cycles. It has been reported that these systems can overcome the following site limitations:

1. Permeable Soils with High Water Tables

2. Shallow Permeable Soils Over Fractured Bedrock

3. Slowly Permeable Soils

Over forty-four of these systems have been installed or are under construction. Six systems are currently under evaluation in the program. Thirty-eight systems were installed in the Harney Project in Carroll County and were evaluated by consultants. Four out of the six systems being evaluated by the State, experienced construction related problems with one chronic failure occurring. Additional study of systems installed in Harney and other locations throughout the State is planned. Treatment capability, groundwater mounding and freezing problems that have been reported by other States will be evaluated. On sloping sites, up-slope interceptor drainage to divert perched water tables will also be studied.

Sand Lined Pressure Dosing Trench. This system consists of a double compartment septic tank, pump, pumping chamber and soil absorption system constructed in sand fill. Two-foot treatment zones will be used. These systems can only be used where underlying soils are sandy and will not be damaged by construction. This system is similar to sand lined systems that are installed in Delaware and Pennsylvania. This system is designed to overcome the following site limitations:

1. Very Slowly to Nearly Impermeable Soils

2. Permeable Soils Over Fractured Bedrock

3. Slowly Permeable Soils

No systems are installed at this time. Plans are underway to have systems constructed in 1987. Evaluation of treatment capability and construction methods will be undertaken.

Alternating Fields. This system consists of a double-compartment septic tank, diversion valve and two soil absorption fields. Wastewater is diverted to each field alternately, allowing one to rest and be rejuvenated by biodegradation of the clogging mat. It has been reported that this system will extend the design life of the soil absorption field and would allow each field to be designed with 25% less effective soil absorption area. Very little data are available to support this claim. These systems are being evaluated to overcome site limitations of slowly permeable soils.

One system is being evaluated and plans for additional systems to be installed are underway.

*Groundwater Penetration Systems

These systems are constructed to discharge directly to surficial groundwater. They are similar to conventional groundwater penetration systems with the exception that they are designed to provide better treatment of effluent before it is discharged. Areas in the Coastal Plain where these types of systems may be utilized are to be further evaluated through the process of preparing "Groundwater Protection Reports" (GPR's) recently required in COMAR 10.17.02.

Sand Lined Trench. This system consists of a double compartment septic tank and soil absorption trenches. The trenches are constructed to discharge directly to groundwater but are backfilled with sand fill instead of gravel. The trenches may be elevated above the original land surface in an impermeable fill in order to obtain adequate hydraulic head for performance when the water table is high. This system has been used in Maryland to overcome site limitations of permeable to nearly impermeable surface soils with high water tables.

Hundreds of these systems have been installed in the past on the eastern shore coastal plain. The majority are in parts of Worcester, Dorchester, Somerset, and Talbot counties. Two systems are being evaluated in this program with plans to include more. Treatment capability and design criteria are being studied.

Sand Filter Trench. These systems consist of a double-compartment septic tank, pump, pumping chamber, sand filter and soil absorption trenches. Designs include buried, free-access and recirculating sand filters that incorporate a variety of modifications to reduce nitrogen, phosphorus and fecal coliforms. These systems are designed to overcome limitations of high ground water.

Seven systems are under evaluation with plans to install more.

Bermed Infiltration Pond. A bermed infiltration pond is an excavation approximately eight to ten feet deep with no less than 10,000 square feet in surface area. The excavation exposes a water-bearing substratum sand overlain by an impermeable soil. Part of the excavated material is placed around the pond perimeter to form a berm. The water from the substratum rises and falls in the pond in accordance with seasonal fluctuations in the water table. Septic tank effluent is discharged near the bottom of the pond for disposal. The biological organisms in the pond complete the treatment process and the water moves into the surficial groundwater surrounding the pond or evaporates.

Over fifty of these systems have been installed in the Eastern Shore Coastal plain, primarily in Dorchester County. They are reported to perform well and are proposed to be converted into conventional use by the end of 1987. A few questions regarding design and construction of small systems remain to be answered. Larger systems, involving more than three homes per pond, are still under study and will not be converted to conventional use by the end of 1987.

*Solar Systems These systems are for the most part independent of soil conditions and therefore theoretically would overcome all site limitations. They consist of a double-compartment septic tank or aerobic tank with discharge enhanced by evapotranspiration within a greenhouse unit. Two basic types have been identified, but only one type is being evaluated. Four systems have been installed. Data collected in 1985 indicated major problems with these systems. In addition the systems appear economically prohibitive. A contract with the University of Maryland was entered into in August 1986 to perform a more thorough technical evaluation. The final report is due in July 1987 and will provide information for future direction.

STAFF REQUIREMENTS

The extra staff time associated with the I/A program and the conversion of sand mounds to conventional use is impacting and will continue to impact county health department programs and services. Table 2 provides our best estimate of staff time required per system to perform work tasks associated with the I/A program and conventional sand mounds. Actual staff requirements related to the I/A program are difficult to estimate. Program goals are to have ten to 15 experimental systems per basic category. Based on this goal and past acceptance rates into the experimental program of ten to 30 percent (i.e., ten to 30 percent of all sites evaluated for the I/A program are accepted for experimental study) and four hours actual work time per day, approximately 0.5 to 1.5 man-years are required to perform the estimated work in each local health department that is active in the I/A program.

After a two- to three- year period, this work load would drop. However, the conversion of I/A technology to conventional use is expected to increase staff requirements substantially.

Table 2. Estimated Staff Time Required Per System[1]

Task	Conventional Sand Mound	Innovative/Alternative Program
	--------Hours Per System	---------
Screening Site Evaluation	2 - 3	2 - 3
Detailed Site Evaluation	4 - 8	4 - 8
Design Review	5 - 10	7 - 10
Construction Inspections	4 - 12	6 - 12
Monitoring[2]	------	48 - 72

1 We expect staff time required to perform tasks to approach low estimates with experience.

2 Monitoring estimates are based on monthly visits for two years and do not include travel time to site.

PROBLEM INVESTIGATION

Fourteen problem investigation have been conducted. Eight involved construction related problems and only one of these appears to have resulted in chronic system failure. Two of the construction problems involved sand mound systems; four involved shallow placement - low pressure pipe systems; one involved an enhanced evapotranspiration systems; and one involved an alternating field system. The apparent chronic failure involving a shallow placement system is believed to be a construction problem but conclusive evidence is not available.

Equipment problems were observed on two systems. These involved leaking septic tanks and a pump failure.

The remaining four problems were related to design. One of these problems is being corrected, the remaining three are still under study.

CONCLUSIONS

Based on the preliminary findings, the following conclusions are presented:

1. Construction related problems that have been experienced appear to be caused by two factors. One is an insufficient number of inspection visits by local county health department staff. The other is the lack of contractor familiarity and experience installing more complex systems. These types of problems are also indicative of problems that could develop if experimental systems are converted into conventional technology without adequate staff to perform the inspection work, and insufficient training of both local county health department staff and contractors.

2. Sand mound systems designed on permeable soils (less than 60 minutes/inch infiltrometer rates) with high water tables and over fractured rock could be converted to conventional technology in 1987. However, the additional staff time involved in detailed site evaluations, design reviews and construction inspections, will increase current workloads of almost all local county health departments, especially during wet season testing periods.

3. Continued experimentation and data collection is needed for all systems currently under evaluation, except sand mounds on permeable soils, before final decisions can be made.

4. Almost all of the systems under evaluation are more complex and costly than conventional systems. They also require increased homeowner responsibility and understanding. Educational programs need to be developed or adapted from other States to provide the homeowner with an understanding of the systems that are converted to conventional use.

5. It should be noted that OEP's next technology approval is slated for July 1987 and consists of extending percolation rates to 60 minutes for sand mounds. We also anticipate approving bermed infiltration ponds as conventional technology and making a final decision on the use of the solar system. By December 1987, OEP expects to have enough operating data on sand-lined trenches employing groundwater penetration to have completed design criteria which could be uniformily applied to all Coastal Plain Counties. This criteria will be subsequently included in Regulation 10.17.02 which should be finalized within an additional four to six months.

RECOMMENDATIONS

Based on the preliminary findings and conclusions, the following recommendations are presented for consideration and action:

1. A seven member advisory task force, composed of a contractor and university and consulting soil scientists, hydrogeologists and engineers should be formed to advise the State on future program direction regarding research needs, homeowner educational programs and on-site system community management.

2. The current classification of on-site sewage disposal systems known as Innovative and Alternative is proposed to be divided into two categories:

   - Innovative

   - Alternative

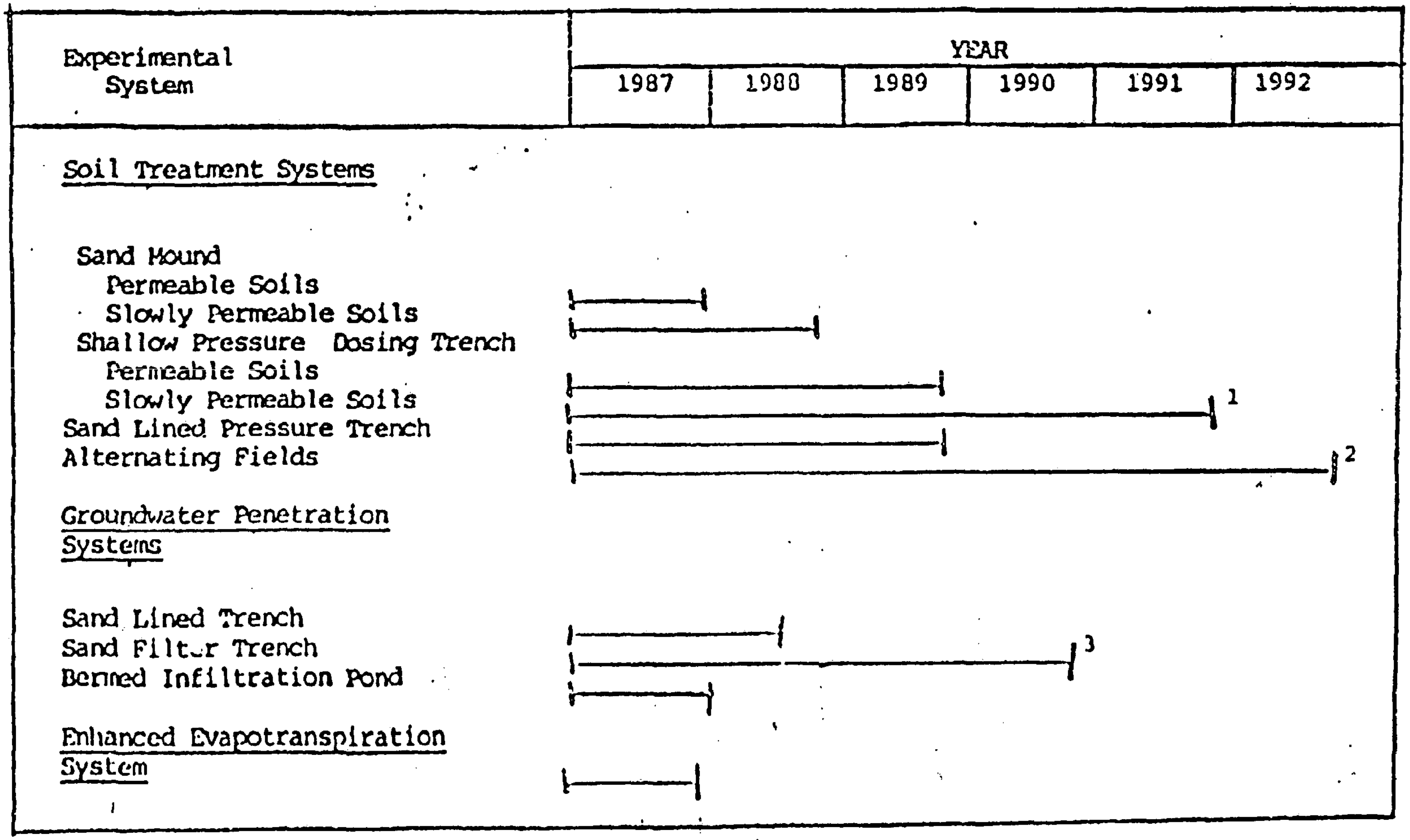
Innovative systems would be those systems that are considered experimental or have not been satisfactorily evaluated under site conditions found in Maryland.

Alternative systems would be those systems that have been demonstrated to function satisfactorily but require more detailed site evaluation, system design and more intensive construction inspections than would normally be expected for conventional on-site systems.

The installation of alternative systems may be limited to certain times of the year with favorable soil moisture conditions and weather. They would also require extraordinary measures to be taken to prevent damage to soil absorption areas during construction on the site. Procedures for permit issuance and design review and construction need to be investigated. Permit authority for some systems at the State level with subsequent delegation to counties with acceptable programs should also be investigated.

This new category would also help facilitate homeowner education regarding increased responsibility, maintenance and risks associated with these types of systems.

PROPOSED DECISION SCHEDULE



[1] Potential freezing, groundwater mounding and installation techniques are being investigated.

[2] Only one experimental system presently installed in Maryland and evaluating system longevity requires years of observation.

[3] Several different prototypes providing for nitrogen removal being evaluated simultaneously.